COURSE GUIDE

CRP 517
ORGANIC AND URBAN FARMING (2 Units)

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INTRODUCTION

CPR 517: Organic and Urban Farming is a two-credit unit course for students offering B. Agriculture in the School of Agricultural Science. The course consists of Four (4) modules that are divided into16 units. These units will educate the student that organic farming or organic agriculture is a food production system that excludes the use of synthetic inputs, such as synthetic fertilizers, pesticides, herbicides and genetically modified organisms (GMOs). The student will also understand that in addition to the exclusion of synthetic agrichemicals, organic goals and practices include protection of the soil, promotion of biodiversity and protection of the environment. Furthermore the student will comprehend the fact that Urban agriculture refers to agricultural practices in urban areas and their surrounding regions (peri-urban), and is a centralized operation involving horticulture, animal husbandry, aquaculture, and other practices for producing fresh food or other agricultural products.

In addition the student who completes the course will understand that Horticulture is the practice of growing plants (vegetables, fruit and flowers) in a relatively intensive manner with protected culture as the more extreme form of the system where the plants are grown under protective materials or in glasshouses. The student will eventually understand that both organic agriculture and urban farming plays an important role in enhancing urban food security and nutrition, local economic development, poverty alleviation and social inclusion of disadvantaged groups and sustainable environmental management in the cities.

The course material has been developed to suit undergraduate students in Agriculture at the National Open University of Nigeria (NOUN) by using an approach that provides the student with requisite knowledge in Organic and Urban Farming. A student who successfully completes the course will know that organic farming is the production of food and livestock without the use of farm chemicals, fertilizers and genetically modified organism but use natural resources such as manure and compost. The pupil will also understand that organic agriculture is a sustainable and environmentally friendly production method that contributes to poverty alleviation and food security for small farmers in developing countries. In addition, the student will appreciate the fact that urban farming, or urban horticulture, is an agricultural practices in the middle of the city. The student will also get to know that urban agriculture provides many benefits, including food security for people in the city, a reduction of energy used in conventional agricultural practices and food service, a reduction of carbon footprints, and environmental services for cities in terms of providing open green space.

Furthermore, the student who takes this course will be exposed to the ideas of home gardening, market gardening and commercial gardening; learn the purpose of certification of organic horticultural products and understand the environmental and health implications of organic and urban farming

The Course Guide tells you briefly what the course is about, what course materials you will be using and how you can work your way through these materials. It suggests some general guidelines for the amount of time you are likely to spend on each unit of the course in order to complete it successfully. It also gives you some guidance on your tutor- Marked assignments. Detailed information on tutor-Marked assignment is found in the separate assignment file which will be available in due course.

WHAT YOU WILL LEARN IN THIS COURSE

On successful completion of these modules, you should be able to:

1. Define organic and urban farming and explain their concepts
2. Describe the types of horticultural crops grown under organic and under urban farming system
3. Discuss the importance of organic and urban farming
4. Define and explain the importance of protected crops cultivation
5. Know the peculiarities of organic and urban farming
6. Explain the concepts of home gardening
7. Discuss the meaning and importance of market gardening and commercial gardening.
8. Explain the idea and purpose of certification of organic horticultural products
9. Know the materials used in organic crops production
10. Understand and explain the sources of organic fertilizer materials
11. Describe the environmental and health implications of organic and urban farming
12. Discuss the influence of urbanization and environmental factors on organic farming
13. Understand the problems of organic and urban/ dry season horticultural farming
14. Explain maintenance of soil fertility and crop protection practices in organic and urban farming.
15. Know the purpose and importance of irrigation in urban farming.
16. Discuss the Prospects in urban/dry season horticulture farming.

COURSE AIMS

The course is designed to enable student understand the concept, definition, peculiarities and importance of organic and urban farming. The

course is also aimed at exposing the pupil to the ideas of home gardening, market gardening and commercial gardening; the purpose of certification of organic horticultural products and the environmental and health implications of organic and urban farming practices.

COURSE OBJECTIVES

The aims of the course stated above can only be realized through a set of objectives. Each unit of this course also has its specific objectives that are enumerated at the beginning. You will need to go through and have a grasp of the objectives before you start working through the unit. You are encouraged to refer to them periodically to check on your progress in learning and assimilating the content. On completion of a unit, you may re-examine the objectives to ensure that you learning has taken place and knowledge was acquired. This will enable your track your progress and assess if the requirement of the unit has been met. Consequent on the above and in line with stated aim, the course has the following specific objectives:

1. Understand the concepts and definition of organic and urban farming.
2. Know the types of horticultural crops grown under organic and under urban farming system
3. Highlight the importance of organic and urban farming.
4. Comprehend the importance of protected crops cultivation
5. Discuss the peculiarities of organic and urban farming
6. Understand the concepts of home gardening
7. Define market gardening and commercial gardening and describe their importance.
8. Understand the idea and purpose of certification of organic horticultural products
9. Discuss the materials and methods used in organic crops production
10. Know the sources of organic fertilizer materials in organic farming
11. Understand the environmental and health implications of organic and urban farming
12. Comprehend the influence of urbanization and environmental factors on organic farming
13. Explain the problems of organic and urban/ dry season horticultural farming
14. Understand the maintenance of soil fertility and crop protection practices in organic and urban farming
15. Describe the importance of irrigation in urban farming
16. Highlight the Prospects in urban/dry season horticulture farming

WORKING THROUGH THE COURSE

To successfully complete this course, you are required to read the study units, reference books and other materials that will guide and assist you achieve the objectives of course. Each unit contains self-assessment exercises in addition to Tutor- Marked Assignments (TMAs). The TMA will eventually form part of your continuous assessment; therefore you will be required to submit the assignment for assessment. At the end of the course there will be a final examination. This course should take about 15 weeks to complete and some components of the course are outlined under the course material subsection.

COURSE MATERIALS

The major components of the course are:

1. Course Guide
2. Course Material
3. Tutor Mark Assignment (TMA)
4. References for Further Reading
5. Presentation schedule

COURSE GUIDE

The material you are reading now is called the course guide which introduced you to this course.

STUDY UNITS

The course is divided in to four modules each of which contains four units. Each unit should take you 2 to 3 hours to work through. Each unit has a table of contents, introduction, specific objectives, and summary. The following are the study units contained in this course:

MODULE 1 HORTICULTURE, ORGANIC AND URBAN FARMING

Unit 1 Horticulture
Unit 2 Organic Farming
Unit 3 Urban Farming
Unit 4 Protected Crop Cultivation

MODULE 2 ORGANIC FARMING PRACTICES

Unit 1 Principles of Organic Farming
Unit 2 Organic Farming Management
Unit 3 Organic Farming Techniques and Materials
Unit 4 Sources of Organic Fertilizer Nutrients

MODULE 3 ORGANIC FARM MANAGEMENT

Unit 1 Crop Nutrition Management
Unit 2 Soil Management
Unit 3 Water Management
Unit 4 Pest and Disease Management

MODULE 4 ORGANIC AND URBAN FARMING PRACTICES

Unit 1 Environmental and Heath Impact of Organic Farming
Unit 2 Green House Protected Cultivation System
Unit 3 Other Issues in Urban Farming System
Unit 4 Certification of Organic Horticultural Products

REFERENCES FOR FURTHER READINGS

Every unit contains a list of references and Further Readings. Try to get as many as possible of those textbooks and materials listed. The textbooks and materials are meant to deepen your knowledge of the course.

ASSESSMENT

There are two components of assessment for this course. The Tutor Marked Assignment (TMA) and the End of Course Examination. Your assessment will be based on tutor-Marked assignments (TMAs) and a final examination which you will write at the end of the course.

TUTOR-MARKED ASSIGNMENTS (TMAs)

There are many assignments in this course and you are expected to do all of them. You should follow the schedule prescribed for them in terms of when to attempt the homework and submit same for grading by your Tutor.

Assignment questions for the 15 units in this course are contained in the Assignment File. You will be able to complete your assignments from the information and materials contained in your set books, reading and study units. However, it is desirable that you demonstrate that you have read and researched more widely than the required minimum. You should use other references to have a broad viewpoint of the subject and also to give you a deeper understanding of the subject. When you have completed each assignment, send it, together with a TMA form, to your tutor. Make sure that each assignment reaches your tutor on or before the deadline given in the presentation file. If for any reason, you cannot complete your work on time, contact your tutor before the assignment is due to discuss the possibility of an extension. Extensions will not be granted after the

due date unless there are exceptional circumstances. The TMAs usually constitute 30% of the total score for the course.

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MAIN COURSE

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MODULE 1 HORTICULTURE, ORGANIC AND URBAN FARMING

Unit 1 Horticulture
Unit 2 Organic Farming
Unit 3 Urban Farming
Unit 4 Protected Crop Cultivation

UNIT 1 HORTICULTURE

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4.0 Conclusion
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1.0 INTRODUCTION

Horticulture is the branch of plant agriculture dealing with garden crops, generally fruits, vegetables, and ornamental plants. The word is derived from the Latin *hortus*, "garden," and *colere*, "to cultivate." As a general term, it covers all forms of garden management, but in ordinary use it refers to intensive commercial production. In terms of scale, horticulture falls between domestic gardening and field agriculture though all forms of cultivation naturally have close links.

Horticulture is divided into the cultivation of plants for food (pomology and olericulture) and plants for ornament (floriculture and landscape horticulture). Pomology deals with fruit and nut crops. Olericulture deals with herbaceous plants for the kitchen, including, for example, carrots (edible root), asparagus (edible stem), lettuce (edible leaf), cauliflower (edible flower buds), tomatoes (edible fruit), and peas (edible seed).

Floriculture deals with the production of flowers and ornamental plants; generally, cut flowers, pot plants, and greenery. Landscape horticulture is a broad category that includes plants for the landscape, including lawn turf but particularly nursery crops such as shrubs, trees, and vines. The

specialization of the horticulturist and the success of the crop are influenced by many factors. Among these are climate, terrain, and other regional variations.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- define the term horticulture and list the different types with example
- describe the features horticulture and state its importance
- discuss the health value of horticultural crops

3.0 MAIN CONTENT

3.1 Definition and Branches of Horticulture

3.1.1 Definition of horticulture

The term horticulture is derived from latin words: "hortus" meaning "garden" and "cultura" meaning "cultivation". Horticulture is defined by Webster's dictionary as "the science and art of growing fruits, vegetables, and flowers." It is the intensive commercial production of high-value and high-yielding plants. But it also includes the cultivation of garden crops and landscape ornamentals and the interaction of science and art.

In ancient days the gardens were protected enclosures with high walls or similar structures surrounding the houses. The enclosed places were used to grow fruit, vegetables, flowers and ornamental plants. Therefore, in original sense "Horticulture refers to cultivation of garden plants within protected enclosures". However, in light of the present reality horticulture may be defined as the "science and technique of production, processing and merchandizing of fruits, vegetables, flowers, spices, plantations and medicinal and aromatic plants".

3.1.2 Branches of horticulture

In addition to the definitions above, horticulture contributes to the economy, provides good nutrition, and is a valuable spiritual and psychological therapy. Horticulture beautifies and enhances the environment. It is a wide field that includes a great variety and diversity of crops. The science of horticulture can be divided into several branches depending upon the crops it deals with. Horticulture is made up of the following branches.

1. **Pomology** (the cultivation of fruit crops)
   Fruit culture, including pome fruits (apple, pear, quince), stone fruits (peach, cher-ry, plum, nectarine, apricot), small fruits (blue-berry, raspberry, grape, strawberry), and nut tree fruits.

2. **Olericulture** (the cultivation of vegetable crops)
   This is the cultivation of vegitables. More than 40 vegetables belonging to Solanaceaeous, cucurbitaceous, leguminous, cruciferous, root crops and leafy vegetables are grown in tropical, sub-tropical and temperate regions of the world. Important vegetables grown in different parts of the world are onion, tomato, potato, brinjal, peas, beans, okra, chilli, cabbage, cauliflower, bottle gourd, cucumber, watermelon, carrot, radish etc.

2. **Floriculture** (the cultivation of flower crops)
   Flower cultivation is an old traditional practiced since ages. It is an important/integral part of socio-cultural and religious life of many people in different parts of the world. It has taken a shape of industry in recent years. Many countries are known for growing traditional flowers such as jasmine, marigold, chrysanthemum, tuberose, crossandra, aster, etc. There is also the commercial cultivation of cut flowers like, rose, orchids, gladiolus, carnation, anthurium, gerbera etc.

3. **Plantation crops** (the cultivation of plantation crops)
   This is an important sector that is making significant contribution to export earning in many countries of the world. The major plantation crops include coconut, arecanut, oil palm, cashew, tea coffee, rubber cocoa, betel vine, vanilla etc.

4. **Spices crops** (cultivation of spices)
   Spices constitute an important group of horticulture crops and are defined as vegetable products or mixture thereof, free from extraneous matter used for flavoring, seasoning and imparting aroma in foods. Many countries produce a wide variety of spices like black pepper, cardamom, ginger, turmeric, chilli, Coriander etc.

5. **Medicinal and aromatic crops** (cultivation of medicinal and aromatic crops)
   There is a diverse collection of medicinal and aromatic plants species distributed around the world. Several of these species have medicinal properties and their demand is increasing progressively in both domestic and export market. Important medicinal plants are Isabgol, Periwinkle, coleus, ashwagandha, etc. and aromatic plants are mint, grasses, davana, patchouli etc.

6. **Post harvest technology** (Postharvest physiology)
   This deals with post harvest handling, grading, packaging, storage, processing, value addition, marketing etc. of horticultural crops including flowers, fruits, and vegetables

7. **Plant propagation** (propagation of plants)
   This is also referred to as Environmental Horticulture that involves nursery production of herbaceous and woody plants for landscape design and management.

3.2 Features, Crops Grown and Importance of Horticulture

3.2.1 Features of horticulture and Major Horticultural Crops Grown

The science and practice of horticulture has the following innate features:

1. Horticultural produce are mostly utilized in the fresh state and are highly perishable.
2. Horticultural crops need intensive cultivation requiring a large input of capital, labour and technology per unit area.
3. Cultural operations like propagation, training, pruning and harvesting are skilled and specific to horticultural crops.
4. Horticultural produce are rich source of vitamins and minerals and alkaloids.
5. Aesthetic gratification is an exclusive phenomenon to horticultural science.

Figure 1: Major types of horticultural crops grown under organic and under urban farming system includes:




Carrot **Watermelon** **Tomatoes** **Bhendi (Okro)**




Capsicum **Chinese Potato** **Bellary Onion** **Muskmelon**


Pumpkin


Brinjal


Cucumber


Sweet Potato


Amaranthus


Cabbage


Paprika


Ribbed gourd

3.2.2 Importance of horticulture

There is a high demand of fruits and vegetables around the world. Therefore, production of horticultural produce needs to be increased to meet the requirements of export and processing industry. In view of these, there is lot of scope of increasing production and potentiality of horticulture crops.

In addition to fruits and vegetables, the floriculture industry comprising of florist trade (nursery plants, potted plants, seed and bulb products) is seen as a sunrise industry. There is soaring business of flowers in almost all metropolitan cities of the developed world with area under cut flowers like rose, chrysanthemum, gladiolus, carnation and orchids increasing day by day.

Plantation crop production is another potential sector with lots of opportunities of employment generation, foreign exchange earnings and livelihood support and sustenance of mankind at large. These crops form the mainstay of lives especially in coastal areas of the world where stands of plantation crops are found. Therefore, horticulture is important for the following considerations:

1. It is a source of variability in produce.
2. As a source of nutrients, vitamins, minerals, flavour, aroma, alkaloids, oleoresins, fibre, etc.
3. It is a source of medicine.
4. It is a source of economic empowerment as they give higher returns per unit area in terms of energy, money, job, etc.
5. Employment generation 860 man days/annum for fruit crops as against 143 man days/annum for cereal crops and the crops like grapes and banana need 1000- 2500 man days per annum.

6. Effective utilization of waste land through hardy fruits and medicinal plants.
7. It is a substitute of family income being component of home garden.
8. As a foreign exchange earner has higher share compare to agriculture crops.
9. As an input for industry being amenable to processing, especially fruit and vegetable preservation industry.
10. Aesthetic consideration and protection of environment.
11. It has a religious significance.

In summary horticulture supplies quality food for health and mind, more calories per unit area, develops better resources and yields higher returns per unit area. It also enhances land value and creates better purchasing power for those who are engaged in this industry. Therefore, horticulture is important for health, wealth, hygiene and happiness.

3.3 Scope of Horticulture

Like most agricultural enterprise, the scope of horticulture depends on the incentive available to the farmers, adaptability of the crops, necessity and facilities for future growth such as inputs availability and infrastructure for the distribution of produce/marketing etc. Generally horticulture has great scope for the following reasons.

1. To exploit great variability of agro climatic conditions.
2. To meet the need for fruits, vegetables, flowers, spices, beverages in relation to population growth based on minimum nutritional and other needs.
3. To meet the requirement of processing industry.
4. To substitute import and increase export.
5. To improve the economic conditions of the farmers and to engage more laborers to avert the problem of unemployment.
6. To protect environment.
7. Horticultural trees work in near semblance to forest trees in maintaining ecosphere as they:

i. They help in transforming micro climate.
ii. Provides shelter to birds, reptiles and other micro organisms and add to the geo-ecological diversity on the land.
iii. Provides impetus to the writers, poets, thinkers and analysts and thus keeps their cultural impulse alive.
iv. Adds to the survival of life-spheres of living entity

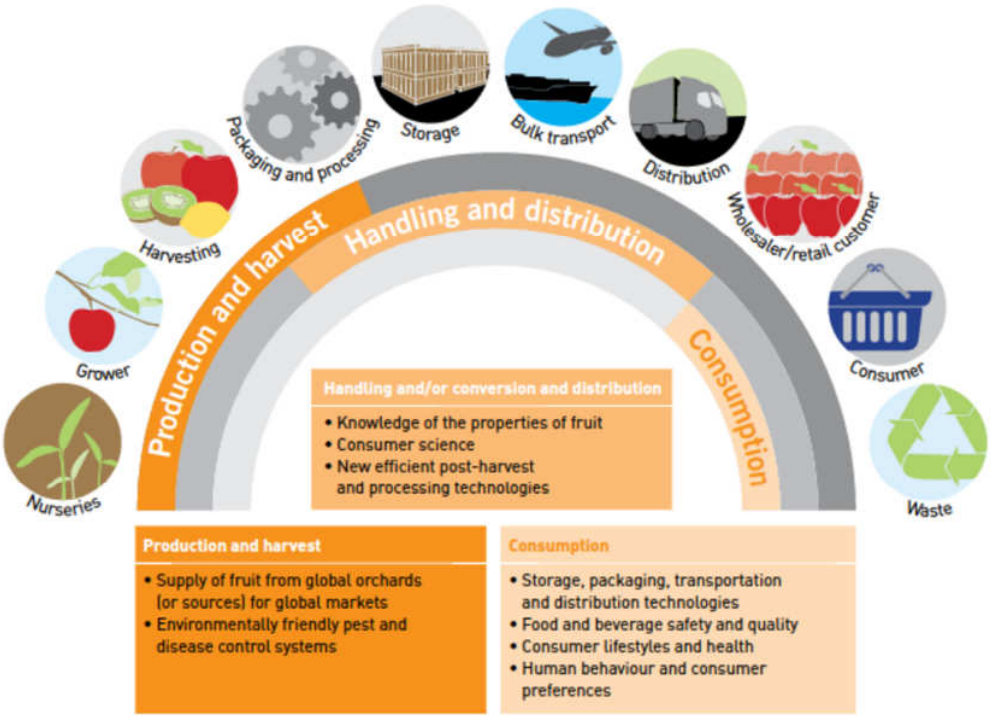

Figure 2: The Horticulture Supply Chain

3.3 The Health Value of Horticultural Crops

3.3.1 Horticultural crops and human nutrition

1. Fruits and vegetables play an important role in balanced diet.
2. These provide not only energy rich food but also provide vital protective nutrients/elements and vitamins.
3. Comparatively fruits and vegetables are the cheapest source of natural nutritive foods.
4. The incorporation of horticulture produce in daily diet is essential for good health.
5. With the growing awareness and inclination towards vegetarianism worldwide the horticulture crops are gaining tremendous importance.

3.3.2 Functions of fruits and vegetables in human body

1. Fruits and vegetables are attractive in appearance, palatable and delicious in taste, improves appetite, provides fibre and easily digestible thereby overcoming constipation.
2. They neutralize the acids produced during digestion of proteins and fatty acids.
3. Fruits are also a good source of enzymes which are helpful in metabolic activities leading to proper digestion of food. Eg., Jamun and Papaya.
4. All fruits have medicinal value and they improve the general immunity of human body against diseases, deficiencies etc.
5. They are the important source of vitamins and minerals that are used in several bio-chemical reactions taking place in the human body
6. Fruits are also a good source of energy (eg. Avocado, Olive) and provide higher energy value per unit area compared to cereals.
7. Fruits provide minerals that are essential for the growth and development for the human body.
8. Regular consumption of fruits reduces obesity, maintain health and increase the longevity of life.

SELF ASSESSMENT EXERCISE

i. Define horticulture and describe its features
ii. Discuss the importance of horticulture and explain its scope
iii. List the values of horticultural crops in human nutrition

4.0 CONCLUSION

This unit describes horticulture as the intensive commercial production of high-value and high-yielding plants and defines horticulture as “the science and art of growing fruits, vegetables, and flowers”. You were informed that horticulture also includes the cultivation of garden crops and landscape ornamentals and the interaction of science and art. The unit also highlights that horticulture contributes to economy, provides good nutrition, and is a valuable spiritual and psychological therapy and it beautifies and enhances the environment. You were informed that the branches of horticulture are Pomology, Olericulture, Floriculture, Plantation crops cultivation, Spices crops production, Medicinal and aromatic crops cultivation, Post harvest technology and Plant propagation. You learnt that the scope of horticulture depends on the incentive available to the farmers, the crops adaptability, the necessity and facilities for future growth such as inputs availability and infrastructure for the distribution and marketing of produce. This unit also explained

that the health value of horticultural crops includes their role in human nutrition and their function in the human body.

5.0 SUMMARY

Horticulture is "the science and art of growing fruits, vegetables, and flowers". It is also the intensive commercial production of high-value and high-yielding plants that includes the cultivation of garden crops and landscape ornamentals and the interaction of science and art. Horticulture makes significant contributions to human economy, it provides good nutrition, and is a valuable spiritual and psychological therapy. In addition, horticulture beautifies and enhances the environment. The practice of horticulture is divided into: Pomology, Olericulture, Floriculture, Plantation crops cultivation, Spices crops production, Medicinal and aromatic crops cultivation, Post harvest technology and Plant propagation.

Horticulture supplies quality food for health and mind, generates more calories per unit space, enhances land value and increase purchasing power of those in the industry. Horticulture is important for health, wealth, hygiene and happiness. The scope of horticulture depends on farmer incentive, crops adaptability, necessity and facilities for growth and infrastructure for produce distribution and marketing. Horticultural Crops plays a significant role in human nutrition and are important in the human body as they; are palatable and delicious in taste, are a good source of enzymes, improve the general immunity, are important source of vitamins and minerals, are a good source of energy, provide minerals that are essential for the growth and development and reduces obesity, maintain health and increase the longevity of life.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define the term horticulture and list and explain 5 types.
2. Enumerate the features of horticulture and explain its importance
3. List 5 functions of fruits and vegetables in human body

7.0 REFERENCES/FURTHER READING

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UNIT 2 ORGANIC FARMING

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4.0 Conclusion
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1.0 INTRODUCTION

Organic agriculture was developed out of the conscious efforts by people to create the best possible relationship between the earth and men. Since its beginning the sphere surrounding organic agriculture has become considerably more complex and faces three major challenges that include: its entry into the policy making arena, its entry into anonymous global market and the transformation of organic products into commodities. During the last two decades, there has also been a significant sensitization of the global community towards environmental preservation and assuring of food quality.

Ardent promoters of organic farming consider that it can meet both these demands and become the means for complete development of rural areas. Currently however, the development of organic agriculture is now being embraced by the mainstream and shows great promise commercially, socially and environmentally. While there is continuum of thought from earlier days to the present, the modern organic movement is radically different from its original form. It now has environmental sustainability at its core in addition to the founders concerns for healthy soil, healthy food and healthy people.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- define and explain the concept and philosophy of organic farming
- describe the features and importance of organic farming
- discuss the justification and need for organic farming

3.0 MAIN CONTENT

3.1 Definition, Philosophy and Concept of Organic Farming

3.1.1 Definitions

Organic farming is defined as a production system that avoids or largely eliminates the usage of synthetic compounded fertilizers, growth regulators, pesticides, and farm animal feed additives.

Organic farming may also be defined as the production of food and livestock without the use of herbicides, pesticides, weedicides, fertilizers or genetically modified organism and use natural resources such as manure and compost instead.

According to a USDA study team on organic farming, organic farming is define as:
"*organic farming is a 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*".

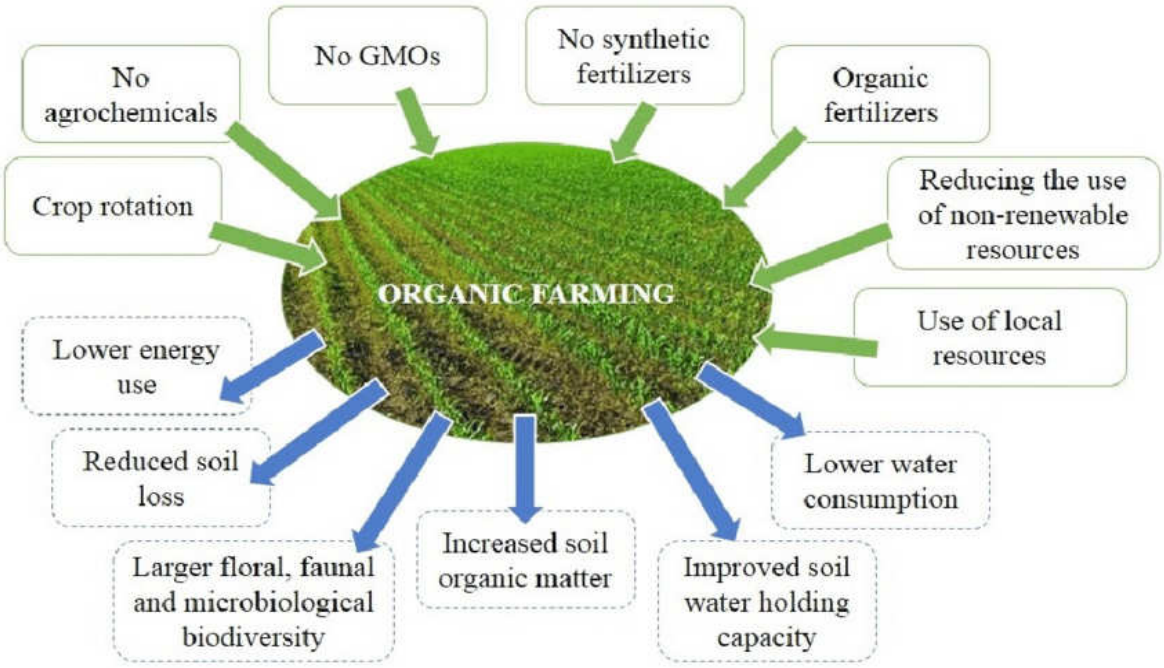

Figure 3: The main principles and effects of organic farming

In addition to the definations above, the International Federation of Organic Agriculture Movements (IFOAM), an international organization established in 1972 for organic farming organizations defines the goal of organic farming as:

"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…"

3.1.2 Philosophy and Concepts

In philosophical terms organic farming means "farming in spirits of organic relationship". In this system everything is connected with everything else. Since organic farming means placing farming on integral relationship, we should be well aware about the relationship between the soil, water and plants, between soil-soil microbes and waste products, between the vegetable kingdom and the animal kingdom of which the apex animal is the human being, between agriculture and forestry, between soil, water and atmosphere etc. It is the totality of these relationships that is the bed rock of organic farming.

The philosophy of agriculture living in harmony with nature is deeply rooted in ancient agriculture and is still practiced in India, China and the

Andes. Organic agriculture reflects this philosophy, but the recent history of concepts such as organic, bio dynamic, natural farming and other related concepts, can be traced back to early 20th century. Conventional agriculture differ from organic farming in terms of usage of chemical fertilizers which increase the nutrient of the soil, usage of genetically modified seeds for better crop production. Thus the concept of organic farming is based on following principles:

1. Nature is the best role model for farming, since it does not use any inputs nor demand unreasonable quantities of water.
2. 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.
3. The soil in this system is a living entity.
4. 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.
5. The total environment of the soil, from soil structure to soil cover is more important.

In view of the fore going, organic agriculture is a method of farming system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (biofertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment.

Figure 4: The Concept of Organic Farming

3.2 Features of Organic Farming and Advantages to Small Scale Farmer

3.2.1 Key Features of Organic Farming

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

1. Maintains the fertility of the soil by relaying primarily on local, renewable resources
2. Maximizes recycling of plant nutrients, organic matter and nitrogen fixation in soils using legumes
3. Protects soil quality using organic material that encourages biological activity of soil microorganisms which indirectly provides crop nutrients.
4. Controls weed and pest based on methods like crop rotation, biological diversity, natural predators, organic manures and suitable chemical, thermal and biological intervention.
5. Makes efficient use of solar energy and the production potential of biological systems.
6. Does not use organisms or substances foreign to nature (e.g. GMOs, chemical fertilisers or pesticides)

7. Maintains diversity in the production system as well as the agricultural landscape.
8. Care for the larger environment and conservation of natural habitats and wildlife.
9. Rearing of livestock by taking care of their housing, nutrition, health, and breeding in a way that provides them life conditions corresponding to their ecological role.

Figure 5: Features of organic farming

3.2.2 Advantages of organic agriculture to small-scale farmers

Organic agriculture is also a sustainable and environmentally friendly production method, which has particular advantages for small-scale farmers. Available evidence indicates the appropriateness of organic agriculture for small farmers in developing countries. Organic agriculture contributes to poverty alleviation and food security by a combination of many features, such as;

1. Increasing yields in low-input areas;
2. Conserving bio-diversity and nature resources on the farm and in the surrounding area;
3. Increasing income and/or reducing costs;
4. Producing safe and varied food;
5. Being sustainable in the long term

Research carried out among small-scale farmers by IFAD in some developing countries (India and China) has shown that the income of participating farmers can increase substantially by adopting organic practices of farming. The result has further proved that certified production gives the farmers access to a premium market, or better market access.

3.3 The Justification and Need for Organic Farming

After the launch of green revolution in some parts of the world, substantial growth in the output of food grains was achieved. This was achieved through the utilization of improved crop varieties and higher levels of inputs of plant foods and plant protection chemicals. This increased output and production was accomplished at the expense soil health with attendant problems of soil degradation and declining soil fertility.

The population of the planet is skyrocketing and providing food for the world is becoming extremely difficult. The need of the hour is sustainable cultivation and production of food for all. The Green Revolution and its chemical-based technology are losing its appeal as dividends are falling and returns are unsustainable. In addition, Pollution and climate change are other negative externalities caused by the use of fossil fuel based chemicals.

Thus organic farming and ecological agriculture are one of the alternative agriculture systems to overcome these problems, and in spite of our diet choices, organic food is the best choice ever, and this means embracing organic farming methods. Here are the reasons why we need to take up organic farming methods:

1. **Benefits of higher nutrients**
   Foods from organic farms are loaded with nutrients such as vitamins, enzymes, minerals and other micro-nutrients compared to those from conventional farms. This is because organic farms are managed and nourished using sustainable practices. In fact, some past researchers collected and tested vegetables, fruits, and grains from both organic farms and conventional farms. The conclusion was that food items from organic farms had way more nutrients than those sourced from commercial or conventional farms.

2. **Stay away from GMOs**
   Statistics show that genetically modified foods (GMOs) are contaminating natural foods sources manifesting grave negative health effects. It has been reported that some of these GMOs are not even labeled. Therefore sticking to organic foods sourced from

veritable sources is the only way to mitigate these grave effects of GMOs.

3. Natural and better taste

Organically farmed foods have been found to have a natural and better taste. The natural and superior taste stems from the well balanced and nourished soil. Organic farmers always prioritize quality over quantity.

4. Direct support to farming

Purchasing food items from organic farmers is a surefire investment in a cost-effective future. Conventional farming methods have enjoyed great subsidies and tax cuts from most governments over the past years. This has led to the proliferation of commercially produced foods that have increased dangerous diseases like cancer. Most governments are now investing in organic farming technologies to mitigates these problems and secure the future.

5. Conserve agricultural diversity

These days, it is normal to hear news about extinct species and this should be a major concern. In the last century alone, it is approximated that 75 percent of the agricultural diversity of crops has been wiped out. A classic example is a potato. There were different varieties available in the marketplace in the past. However, today, only one species of potato dominate. This is a dangerous situation because if pests knock out the remaining potato specie available, there will be no potatoes anymore. This is why we need organic farming methods that produce disease and pest-resistant crops to guarantee a sustainable future.

SELF ASSESSMENT EXERCISE

- define organic farming and discuss its philosophy and concept
- list 5 characteristics of organic farming
- describe the advantages of organic farming to small-scale farmers
- discuss the justification for adopting organic farming methods

4.0 CONCLUSION

This unit defines organic farming as an agricultural production system that avoids or largely eliminates the usage of synthetic compounded fertilizers, growth regulators, pesticides, and farm animal feed additives. It was explained that in philosophical terms organic farming means "farming in spirits of organic relationship". You were informed that organic agriculture is primarily aimed at raising crops by use of organic

wastes and beneficial microbes to release nutrients to crops for sustainable production in an eco-friendly pollution free environment.

The unit also describes the key features of organic farming as: maintenance of soil fertility by supplying organic matter; pest and weed control through crop rotation, biological diversity, natural predators, organic manures and biological intervention; absent of GMOs, and farm chemical; and caring for the environmental and conservation of natural habitats. The unit informs that organic agriculture is a sustainable and environmentally friendly production method that contributes to poverty alleviation and food security among small scale farmers.

5.0 SUMMARY

Organic farming is defined as a production system that avoids or largely eliminates the usage of synthetic compounded fertilizers, growth regulators, pesticides, and farm animal feed additives. It is a method of farming which primarily cultivates land and raising crops by using organic wastes and biofertilizers to release nutrients to crops for sustainable production in an eco-friendly pollution free environment. The key features of organic farming are: the maintenance of soil fertility by supplying organic matter; pest and weed control through crop rotation, biological diversity, natural predators, organic manures and biological intervention; absent of GMOs, chemical fertilisers or pesticides; and caring for the environmental and conservation of natural habitats.

Organic agriculture is a sustainable and environmentally friendly production method that contributes to poverty alleviation and food security among small scale farmers. Organic farming and ecological agriculture are the alternative agriculture systems to overcome the problems of soil degradation, declining soil fertility, pollution, climate change and loss of biodiversity associated with the green revolution and its chemical based technology. The justification for adopting organic farming includes: benefits of higher nutrients produce; avoiding genetically modified organisms; natural and better taste fruits and vegetables; direct support to farming and conserving agricultural diversity.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define and discuss the concept and philosophy of organic farming
2. Explain the features of organic farming and state its importance
3. Highlight the justification and need for organic farming

7.0 REFERENCES/FURTHER READING

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UNIT 3 URBAN FARMING

CONTENTS

1.0 Introduction
2.0 Learning Objectives
3.0 Main Content
    3.1 Background, Definition and Function of Urban Farming
    3.2 Types and Characteristics of Urban Agriculture
    3.3 The Impacts of Urban Agriculture
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1.0 INTRODUCTION

The rapid growth of cities in the developing world is placing enormous demands on urban food supply systems. Agriculture – including horticulture, livestock, fisheries, forestry, and fodder and milk production – is increasingly spreading to towns and cities. Urban agriculture provides fresh food, generates employment, recycles urban wastes, creates greenbelts, and strengthens cities' resilience to climate change.

Urban agriculture — also known as urban farming, urban horticulture, foodscaping, and by many other terms relating to agricultural practices in the middle of the city — is becoming all the rage in societies all over the world. Urban agriculture provides many benefits, including food security for people in the city, a reduction of energy used in conventional agricultural practices and food service, a reduction of carbon footprints, and environmental services for cities in terms of providing open green space.

Urban agriculture uses the resources in cities that would otherwise go to waste. Gardens can be built in an empty lot, on top of buildings, on steep slopes and river banks, all examples of spaces that would otherwise be unproductive. These gardens can use waste water to water their crops, therefore doing away with the issue of waste water treatment. The urban farm could use compost from food scraps in kitchens all over the city, these food scraps might otherwise be thrown away, wasting valuable nutrient**s. City farms use resources that would have been wasted to produce new resources for the community.** They produce food, jobs, and a variety of less quantifiable benefits.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- define urban farming and explain its background.
- describe the functions of urban farming
- understand the various aspects of urban farming systems that determine different types of urban agriculture.
- discuss the impact of urban agriculture on the society.

3.0 MAIN CONTENT

3.1 Background, Definition and Function of Urban Agriculture

3.1.1 Background of urban agriculture

City dwellers have been growing their own food for millennia. Only since the mid-1990s, however, has the concept of urban agriculture (UA) been formally recognized as the subject of research and public policy. Before the 1990s, interest in unregulated "city farming" had been largely confined to academic research, often conducted by individual scholars who approached UA primarily from the viewpoint of the informal economy.

The rising costs of energy and food, water shortages, and worries about food safety shifted the perspective on city farming toward concerns like food security, eco-development, and self-reliance. Later still, it moved toward urban environmental management and sustainability issues such as waste recycling.

Food grown in urban areas may be consumed by the person who grew it, shared with family, friends, or neighbors, or sold to other urban consumers. People who grow food may also have flower or rain gardens, but these are not technically urban agriculture since they do not produce food. Urban agriculture can occur on land held under a variety of property ownership models, including private property, public property, or institutional land.

Urban agriculture is helping poor people cope with food scarcity and hunger. Growing crops or raising livestock in backyards or on undeveloped plots of land improves food sources and offers many urban poor a viable income. And this type of agriculture is also being practiced in new ways in an increasing variety of locations, and often by the poorest of the poor.

Figure 6: The real value of urban farming is not always the food

3.1.2 Definition of Urban Agriculture

Urban agriculture, urban farming or urban gardening can be defined as the practice of growing fruits, herbs, and vegetables and raising animals in cities. It is a process that is accompanied by many other complementary activities such as processing and distributing food, collecting and reusing food waste and rainwater, and educating, organizing, and employing local residents.

Urban agriculture can also be broadly defined as growing food within a city. The term can embody a range of activities, including home, school, rooftop, and community gardens, urban livestock and poultry, beekeeping, commercial farming, and the use agricultural structures such as of greenhouses and hoophouses. Some definitions of urban agriculture encompass postproduction activities such as processing, distribution, and marketing.

Urban agriculture can be commercial, noncommercial, or a hybrid. In terms of scale, urban food production can occur in a space as small as a container on a balcony all the way up to agricultural fields many acres in size. Urban agriculture is integrated in individual communities and neighborhoods, as well as in the ways those cities function and are managed, including municipal policies, plans, and budgets. While this definition encompasses an extremely wide range of growing spaces and practices.

Figure 7: Urban residents' engagement in agricultural activities

3.1.3 The Functions of Urban Agriculture

Urban farming has the following functions:

1. Source of fresh and safe products, including organic and low-chemical crops.
2. Opportunity for urban residents' engagement in agricultural activities.
3. Open space for disaster management, including fire spread prevention, evacuation space for earthquakes and other disasters.
4. Resource for recreation and well-being, including green space for personal leisure and spiritual comfort.
5. Education and awareness-raising for improving urban residents' understanding of agriculture and food issues.
6. Contribute to sustainability and well-being in cities.
7. Contribute to biodiversity and ecosystem services.
8. Reduce food miles (the distance that food must be transported) and even provide bio-energy resources (e.g., from managed forests).

3.2 Types and Characteristics of Urban Agriculture

Urban agriculture encompasses large variety of urban farming systems, with varying characteristics according to local socio-economic, physio geographic and political conditions. Therefore, the types and characteristics of urban agriculture will be determined by its products,

type of economic activities, its location, the scales of production and technology used, its product destination / degree of market orientation and the actors involved the system. These 6 different aspects of urban farming systems determine the types and characteristics of urban agriculture in the local context.

1. Types of products

Urban agriculture may include different types of crops (grains, root crops, vegetables, mushrooms, fruits) or animals (poultry, rabbits, goats, sheep, cattle, pigs, guinea pigs, fish, etc.) or combinations of these. Often the more perishable and relatively highly valued vegetables and animal products and by-products are favoured. Non-food products include aromatic and medicinal herbs, ornamental plants, tree products (seed, wood, fuel, etc.), tree seedlings, and so on. Production units in urban agriculture in general tend to be more specialised than rural enterprises, and exchanges take place across production units.

2. Types of economic activities

Urban agriculture includes production activities as well as related processing and marketing activities, input production, services delivery (e.g. animal health services) by specialised micro-enterprises or NGOs, etc. The interactions between these activities are also important (chains, clusters). In urban agriculture, production and marketing (and also processing) tend to be more interrelated in terms of time and space than is the case for rural agriculture, as a result of greater geographic proximity and quicker resource flow. Economies of agglomeration seem to prevail over those of scale.

3. Types of location

Urban agriculture may take place in locations inside the cities (intra-urban) or in the peri-urban areas. The activities may take place on the homestead (on-plot) or on land away from the residence (off-plot), on private land (owned, leased) or on public land (parks, conservation areas, along roads, streams and railways), or semi-public land (grounds of schools and hospitals).

4. Scales of production and technology used

In the city, we may encounter individual or family farms, group or cooperative farms and enterprises, micro-, small- and medium-sized enterprises, as well as large-scale undertakings. The technological level of the majority of urban agriculture enterprises in developing countries is still rather low. However, the tendency is towards more technically advanced and intensive agriculture and various examples of such can be found in all cities.

5. Product destination / degree of market orientation

In most cities in developing countries, an important part of urban agricultural production is for domestic consumption, with surpluses being traded. However, the importance of market-oriented urban agriculture, both in volume and economic value, should not be underestimated (as will be shown later). Products are sold at the farm gate, from the cart in the same or other neighborhoods, in local shops, on local (farmers) markets or to intermediaries and supermarkets. Mainly fresh products are sold, but part of these are processed for own use, cooked and sold on the streets, or processed and packaged for sale to one of the outlets mentioned above.

6. Types of actors involved

Many of the people involved in urban agriculture belong to the urban poor. However, they are often not the most disadvantaged people, nor are they - contrary to general belief recent immigrants from rural areas. In many cities, one will often also find lower and mid-level government officials, school teachers and the like involved in agriculture, as well as richer people who are seeking a good investment for their capital.

Women constitute an important part of the urban farmer population, since agriculture and related processing and selling activities can often be more easily combined with their other tasks in the household. It is however more difficult to combine these with urban jobs that require travelling to the town centre, industrial areas or to the houses of the rich.

3.3 The Impacts of Urban Agriculture

Urban agriculture plays an important role in enhancing urban food security and nutrition, local economic development, poverty alleviation and social inclusion of disadvantaged groups and sustainable environmental management in the cities. Urban food production has a measurable impact on the society as follows:

1. Economic

Urban and peri-urban agriculture (UPA) expands the economic base of the city through production, processing, packaging, and marketing of consumable products. This results in an increase in entrepreneurial activities and the creation of jobs, as well as reducing food costs and improving quality. UPA provides employment, income, and access to food for urban populations, which helps to relieve chronic and emergency food insecurity.

In addition, urban production of food reduces food costs in view of the savings in transport, and storage, and because fewer middlemen and lower marketing costs may be involved. Since the largest component of household expenditure is that spent on food, any savings on food expenditure will be used for other, non-food expenditures.

2. Social

Urban agricultural practices improves overall social and emotional well-being, improved health and nutrition, increased income, employment, food security within the household, and community social life. Urban agriculture can have a large impact on the social and emotional well-being of individuals. Individuals are report to have decreased levels of stress and better overall mental health when they interact with nature through a garden. Urban gardens are thought to be relaxing and calming, and offer a space of retreat in densely populated urban areas

3. Energy efficiency

The current industrial agriculture system is accountable for high energy costs for the transportation of foodstuffs. The energy used to transport food is decreased when urban agriculture can provide cities with locally grown food. Studies have shown that traditional, non-local, food distribution system used 4 to 17 times more fuel and emitted 5 to 17 times more CO_2 than the local and regional transport.

4. Carbon footprint

As mentioned above, the energy-efficient nature of urban agriculture can reduce each city's carbon footprint by reducing the amount of transport that occurs to deliver goods to the consumer. Also these areas can act as carbon sinks offsetting some of carbon accumulation that is innate to urban areas, where pavement and buildings outnumber plants. Plants absorb atmospheric carbon dioxide (CO_2) and release breathable oxygen (O_2) through photosynthesis. The process of Carbon Sequestration can be further improved by combining other agriculture techniques to increase removal from the atmosphere and prevent release of CO_2 during harvest time.

5. Reduction in ozone and particulate matter

The reduction in ozone and other particulate matter can benefit human health. Reducing these particulates and ozone gases could reduce mortality rates in urban areas along with increase the health of those living in cities. According to the article, only one square

meter of green roof is needed to offset the annual particulate matter emissions of a car.

6. Soil decontamination

Vacant urban lots are often victim to illegal dumping of hazardous chemicals and other wastes. They are also liable to accumulate standing water and "grey water", which can be dangerous to public health. The implementation of urban agriculture in these vacant lots can be a cost-effective method for removing these chemicals. In the process known as Phytoremediation, plants and the associated microorganisms are selected for their chemical ability to degrade, absorb, convert to an inert form, and remove toxins from the soil.

7. Noise pollution

Large amounts of noise pollution not only lead to lower property values and high frustration, they can be damaging to human hearing and health. Exposure to noise is reported to result in hearing impairment, hypertension and ischemic heart disease, annoyance, sleep disturbance, and decreased school performance among school children. Since most roofs or vacant lots consist of hard flat surfaces that reflect sound waves instead of absorb them, adding plants that can absorb these waves has the potential to lead to a vast reduction in noise pollution.

8. Nutrition and quality of food

Daily intake of a variety of fruits and vegetables is linked to a decreased risk of chronic diseases including diabetes, heart disease and cancer. Urban agriculture is associated with increased consumption of fruits and vegetables which decreases risk for disease and can be a cost-effective way to provide citizens with quality, fresh produce in urban settings. Produce from urban gardens can be perceived to be more flavorful and desirable than store bought produce which may also lead to a wider acceptance and higher intake. Garden-based education can also yield nutritional benefits in children.

9. Economy of scale

Using high-density urban farming, as for instance with vertical farms or stacked greenhouses, many environmental benefits can be achieved on a city-wide scale that would be impossible otherwise. These systems do not only provide food, but also produce potable water from waste water, and can recycle organic waste back to energy and nutrients.

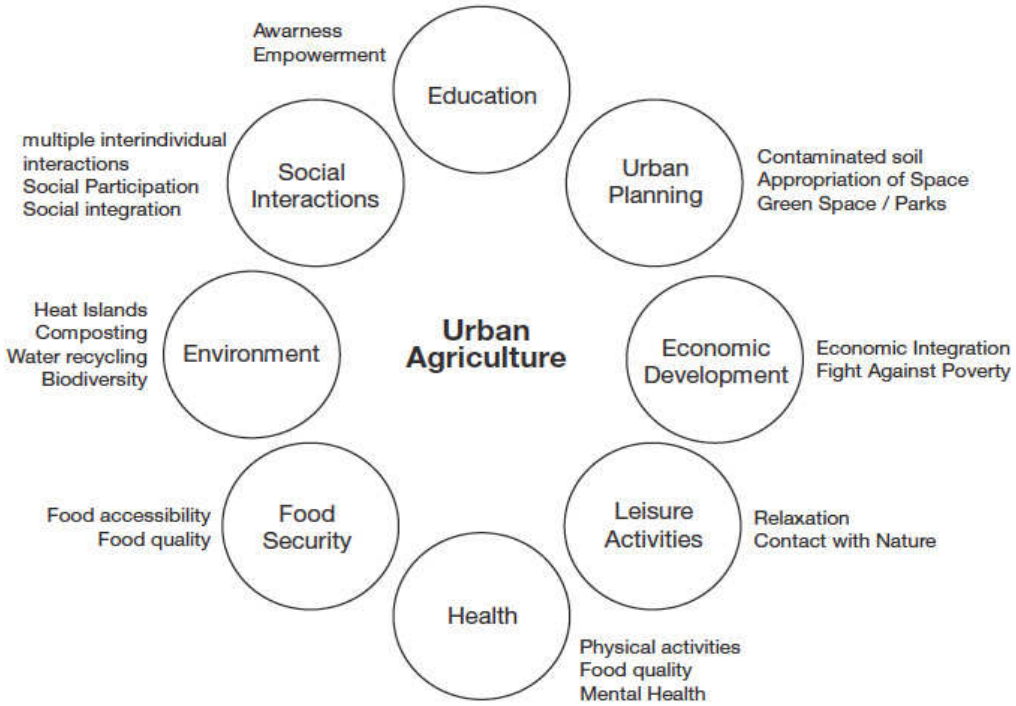

Figure 8: Urban agriculture for social development

SELF ASSESSMENT EXERCISE

i. Define urban farming and discuss its background
ii. Explain 4 functions of urban farming
iii. Enumerate the various aspects of urban farming systems that determine different types of urban agriculture.
iv. Describe the impact of urban farming on the society.

4.0 CONCLUSION

This unit defines urban farming as the practice of growing fruits, herbs, and vegetables and raising animals in cities. You were informed that urban farming process is accompanied by activities such as processing and distributing food, collecting and reusing food waste and rainwater, and educating, organizing, and employing local residents. The unit explains that urban agriculture is integrated in individual communities and neighborhoods, as well as in the ways those cities function and are managed, including municipal policies, plans, and budgets. It further states that urban agriculture encompasses large variety of urban farming systems, with varying characteristics according to local socio-economic, physio geographic and political conditions. You were made to understand that urban agriculture plays an important role in enhancing urban food security and nutrition, local economic development, poverty alleviation

and social inclusion of disadvantaged groups and sustainable environmental management in the cities.

5.0 SUMMARY

Urban farming is the practice of growing fruits, herbs, and vegetables and raising animals in cities. It is accompanied by other activities such as processing and distributing food, collecting and reusing food waste and rainwater, and educating, organizing, and employing local residents. Urban agriculture can be commercial, noncommercial, or a hybrid and in terms of scale, urban food production can occur in a space as small as a container on a balcony all the way up to agricultural fields many acres in size.

Urban agriculture serves: as a source of fresh and safe products; as an opportunity for individual engagement in agricultural; to provide open space for disaster management; as a resource for recreation and well-being; as a source education and awareness-raising; to contribute to sustainability and well-being of cities; to contribute to biodiversity and ecosystem services and to reduce food miles and provide bio-energy resources. Urban agriculture encompasses large variety of urban farming systems, with varying characteristics according to local socio-economic, physiogeographic and political conditions. Urban agriculture plays an important role in enhancing urban food security and nutrition, local economic development, poverty alleviation and social inclusion of disadvantaged groups and sustainable environmental management in the cities.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define urban farming and describe its background
2. List 6 and explain 3 different aspects of urban farming systems that determine types of urban agriculture.
3. Highlight the functions of urban farming
4. Discuss 4 impacts of urban farming of the society

7.0 REFERENCES/FURTHER READING

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UNIT 4 PROTECTED CROPS CULTIVATION

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    3.2 Benefit, Advantages and Limitations of Protected Cultivation
    3.3 Types of protected Cultivation Practices
    3.4 Production Systems (Media and Components) of Protected Cultivation
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Protected cultivation is a technique wherein the microclimate in the surrounding area of the plant is controlled partially or fully or modified to protect the crop from weather especially very low or high temperatures, hail storms and heavy rains. This technology is also useful for protecting the plants from birds, insects etc. and conserving the soil moisture simultaneously. Protected cultivation of vegetables offers distinct advantages of quality, productivity and favorable market price to the growers.

Protected cultivation is a unique and specialized form of agriculture. Devices or technologies for protection (windbreaks, irrigation, soil mulches) or structures (greenhouses, tunnels, row covers) may be used with or without heat. Protected cultivation enables some control of wind velocity, moisture, temperature, mineral nutrients, light intensity, and atmospheric composition.

The purpose of protected cultivation is to grow crops where otherwise they could not survive by modifying the natural environment to prolong the harvest period, often with earlier maturity, to increase yields, improve quality, enhance the stability of production, and make commodities available when there is no outdoor production. The primary emphasis is on producing high-value horticultural crops (vegetables, fruit, flowers, woody ornamental, and bedding plants)

Vegetable growers can substantially increase their income by protected cultivation in off-season under low plastic tunnels. Walk-in tunnels are also suitable and effective to raise off-season nursery due to their low initial cost. Insect proof net houses can be used for virus free cultivation of tomato, chili, sweet pepper and other vegetables mainly during the rainy season. These low cost structures are also suitable for growing pesticide free green vegetables. Poly trenches have proved extremely useful for growing vegetables under cold desert conditions in upper reaches of Himalayas.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- define and explain protected crop cultivation.
- discuss the objectives of protected cultivation of vegetables, fruits, herbs, and flowers
- understand the benefits and advantages of protected cultivation.
- know the different types and limitations of protected crop cultivation
- know the different types of media for protected cultivation.
- understand the components of protected cultivation structure

3.0 MAIN CONTENT

3.1 Background, Definition and Objectives of Protected Cultivation

3.1.1 Background of protected cultivation

Protected cultivation is a process of growing plants in a controlled environment. This means that the temperature, humidity, light, and other factors of the environment can be regulated as per the requirement of the crop to assist in the production of healthier and larger produce. In addition, protected agriculture can be described as the cultivation of high-value vegetables and other horticultural crops in greenhouses. This system of farming allows farmers to grow cash crops on small plots in marginal, water-deficient areas where traditional cropping is not viable.

Protected cultivation also known as controlled environment agriculture (CEA) is highly productive, conservative of water and land, and also protective of the environment. The growth and yield of vegetable in an open-field is faced with many environmental constraints such as heavy rain, thunderstorms, excessive solar radiation, temperatures and humidity levels above plant growth optima, high insect pest infestation pressure,

and fungal diseases. Thus, protected cultivation is being used to mitigate and control the adverse effect of the environment.

Protected cultivation enables the producer to control climate (temperature, humidity, wind and light intensity, etc.), atmospheric gas composition (mainly co_2 concentration), fertilization, watering, pest and diseases, etc., which results in better plant growth, better reproduction, minimized harmful effects of different factors such as climate and agronomy and higher production with a better quality of produce. The technology was originally developed and tested by ICARDA in the Arabian Peninsula, and it has been adapted and successfully used in smallholder farming systems in Afghanistan, Pakistan, and Yemen.

3.1.2 Definition and objectives of protected cultivation

Protected cultivation practices can be defined as a cropping technique wherein the micro environment surrounding the plant body is controlled partially/ fully as per plant need during their period of growth to maximize the yield and resource saving.

Protected cultivation can also be briefly defined as cropping techniques in which the microclimate surrounding the growing plant is controlled partly or completely, as per the requirement of the plant species.

The objectives of protected cultivation of vegetables, fruits, herbs, and flowers are:

1. Protection of plants from abiotic stress (physical or by the non-living organism) such as temperature, excess or deficit water, hot and cold waves, and biotic factors such as pest and disease incidences, etc.
2. Efficient water use with minimum weed infestation.
3. Enhancing productivity per unit area.
4. Minimizing the use of pesticides in crop production.
5. Promotion of high value, quality horticultural produce.
6. Propagation of planting material to improve seed germination percentage, healthy, uniform, disease-free planting material, and better hardening.
7. Year-round and off-season production of flower, vegetable, and fruit crops.
8. Production of disease-free and genetically better transplants.

Figure 9: Protected cultivation

3.2 Benefit, Advantages and Limitations of Protected Cultivation

3.2.1 Benefits of protected cultivation

In most developing countries, the small and medium farmers have started flower and vegetable cultivation under different kinds of modular protected structures depending upon their investment capacity and availability of the market in the area. Among all the protected cultivation practices, greenhouse farming cultivation provides maximum benefits.

1. Provides favorable micro climatic conditions for the plants
2. Cultivation in all seasons is possible.
3. Higher yield with better quality per unit area.
4. Conserves moisture thus needs less irrigation.
5. More suitable for cultivating high value / off season crops.
6. Helps to control pest and diseases.
7. Helps in hardening of tissue cultured plants.
8. Helps in raising early nurseries.
9. Round the year propagation of planting material is possible.
10. Protects the crops from wind, rain, snow, Birds, hail etc.
11. There is efficient and less use of resources especially land, irrigation water, fertilizers, and insecticides.
12. Vegetables with higher productivity and uniform quality than open field cultivation are produced and can be exported for higher returns.

13. Organic farming of vegetables is easier in greenhouses and these structures are ideally suited for production of genetically engineered and micro-propagated vegetable varieties and hybrids.
14. Early nursery raising, easy management, protection from biotic and a biotic stresses and production of healthy vegetable seedlings.
15. Vegetable crops can be grown under adverse weather conditions round the year and in the off-season.

3.2.2 Advantages of protected cultivation

1. Higher productivity resulting in increased crop yield, produce quality, and revenue
2. Provides a better growing environment for plants.
3. Protects from rain, wind, high temperatures and minimizes the damage of insect pests and diseases thereby improving the quality and crop yield.
4. Facilitates year-round production coupled with yield enhancement by 2 to 3 times compared to open cultivation.
5. High water productivity and saving significant amounts of water.
6. Significant reduction in pesticide use for lower production costs and healthier crop produce.
7. Year-round crop production, allowing farmers to take advantage of market seasonality and higher prices.
8. The crop grows healthier, uniform quality fruits and matures fast.
9. Fertilizer use efficiency increases by 30% and the cost of fertilizers, inter-culturing, and labor use get reduced.

3.2.3 Limitations of protected cultivation of vegetables and other produce

The protected cultivation technology is not common due to lack of knowledge and awareness by famers in most developing countries. The commercial viability and sustainability of the technology is limited to few clusters. Generally the issues and problems surrounding the adoption, growth and sustainability of protected cultivation technology are:

1. The high cost of initial infrastructure (capital investment).
2. High cost of seeds and planting materials that are mostly imported
3. Non-availability of skilled human power and their replacement locally.
4. Lack of technical knowledge of growing crops under protected structures.
5. All the operations are intensive and require constant effort.
6. Requires close supervision and monitoring.

7. A few pests and soil-borne pathogens are difficult to manage.
8. Repair and maintenance are major hurdles.
9. Requires assured marketing, since the investment of resources such as time, effort, and finances is expected to be very high.
10. Absence of credit and capital subsidy support and lack of insurance coverage against income and production risks
11. Lack of a dedicated institutional arrangement for R&D, planning and promoting protected cultivation and for providing backward and forward linkage.

3.3 Types of Protected Cultivation Practices

The various types of protective cultivation practices have been adopting based upon the prevailing climatic condition. Among them, Greenhouse or Poly-house is extremely useful for Round-the-year vegetable cultivation in temperate conditions. There are several types of protected cultivation practices. Some of the practices are forced ventilated greenhouse, naturally ventilated Poly-house, insect-proof net house, shade net house, plastic tunnel, and mulching, raised beds, trellising, and drip irrigation.

These practices can be used independently or in combination, to provide a favorable environment to save plants from the harsh climate and extend the duration of crop cultivation or off-season crop production. Adoption of drip irrigation system under raised beds covered with mulch films not only eradicates weeds but also maintains moisture in the soil for a prolonged period by minimizing evaporation losses. The various types of protective cultivation practices are:

1. **Shade net house**

   Net house is made up with shade Net or Insect-proof net mounted on support structure. Net houses are basically naturally ventilated climate controlled structure. Net houses have a variety of applications, the majority being, growing of vegetables, floriculture and for nurseries. Net houses are built of a pre-galvanized channel cum tubular structure/ tubular structure, wooden or bamboo structures mainly used in regions with less rainfall. Shade nets are used to cut down the solar radiations and protect the crops from wilting or scorching.

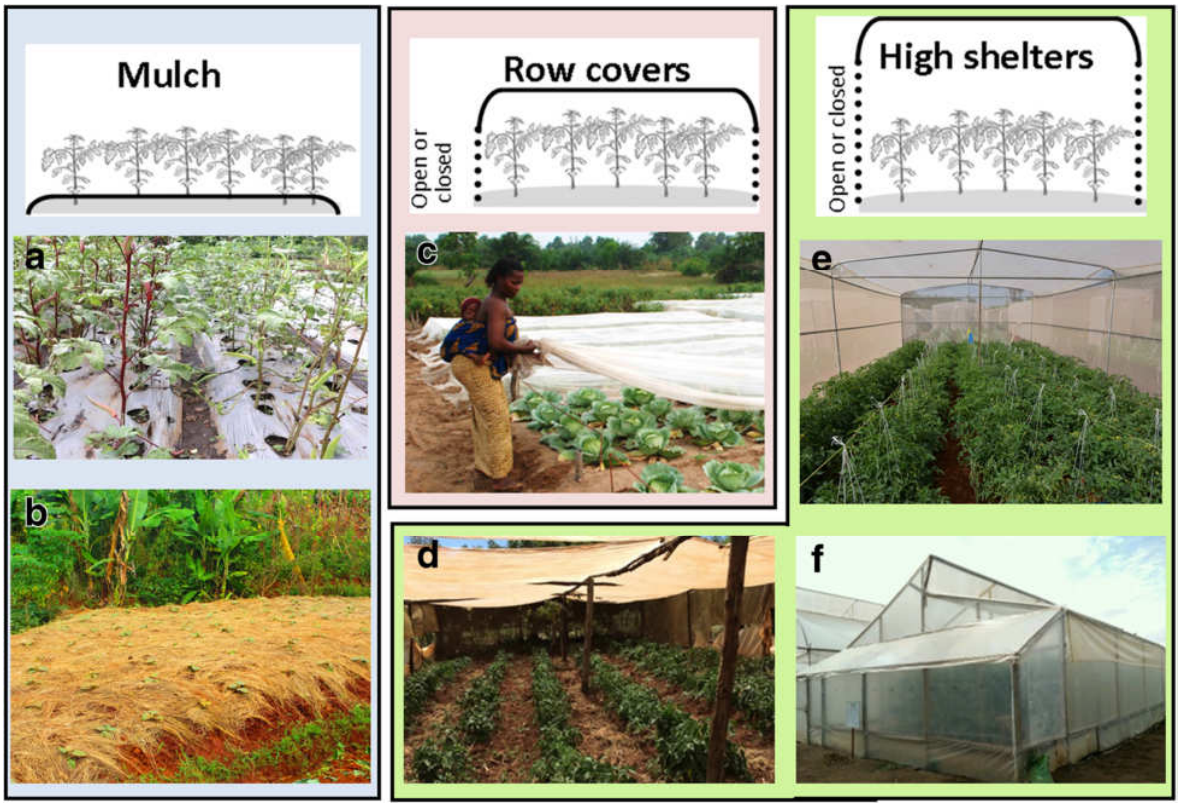

Figure 10: Diversity of protected cultivation techniques in SSA, plastic mulch on okras in Tanzania (a), organic mulch on African eggplants in Burundi (b), low insect proof nets tunnels on cabbages in Benin (c), shade nets on tomatoes in Senegal (d), tomato cultivation in a nethouse in Kenya (e) and cultivation of sweet peppers in a polyhouse in Tanzania (f)

2. **Walk-in-tunnels**

These are simple structures which are generally arc shaped of about 2 to 2.5 m height at the center and a width of about 4m. These accommodate almost 2 to 3 beds of vegetables and are suitable for crops of low canopy like capsicum, lettuce, bush type beans etc. they are suitable for nursery raising.

3. **Plastic low tunnels/row covers**

These structures are laid in open fields to cover rows of plants with transparent plastic film stretched over steel hoops of about 50cm height and about 1m width. Polyethene film of 30-50 micron thickness is used. These are also called miniature greenhouses. They conserve warmth, thus protect crops from frost injury. They hasten growth for early markets, especially in cucurbits.

4. **Greenhouses**

Green houses are climate controlled with cooling and heating system and mainly used for growing exotic varieties of vegetables, off-season growing of vegetables, floriculture, planting material acclimatization and plant breeding and varietals improvement under adverse agro climatic conditions.

A greenhouse is a framed or an inflated structure covered with a transparent or a translucent material in which crops could be grown under the conditions of at least partially controlled environment and which is large enough to permit persons to work within it to carry out cultural operations. It is a technique of providing favorable environmental or growth conditions to the plants. There are different types of greenhouses but major types are Forced Ventilated greenhouse, Naturally Ventilated greenhouse or Fan Pad greenhouse.

5. **Poly House**

Poly house is less sophisticated version of green house with naturally ventilated climate controlled as against the fully climate controlled green houses. Usage of poly houses are similar to green houses for growing exotic varieties of vegetables, off season vegetables, floriculture, planting material acclimatization, etc., under ideal agro climatic conditions suitable for growing these crops.

6. **Poly Tunnel**

Poly tunnels are basically naturally ventilated climate controlled. Poly tunnels have a variety of applications, the majority being, growing of vegetables, floriculture, planting material acclimatization, Poly tunnels are built of a pre-galvanized tubular structure and mainly uses in hilly and temperate regions with moderate temperature.

7. **Plastic mulch**

Mulching is a practice of covering the surface around the plant to make conditions more conducive for plant growth through moisture conservation, weed control, better Co_2 exchange for the root system and soil structure maintenance. It permits cleaner crop cultivation as the fruits don't come in contact with the soil. Silver and yellow colored films are successfully used to repel insects like aphids and white flies. Black polyethene mulches are more popular due to their opacity.

8. **Floating plastic covers**
   Transparent plastic sheet is used to cover large open fields to protect vegetables from frost/ snow and low temperature.

9. **Soil trenches**
   Trench is a simple and cheap structure for growing vegetables in extreme winters. They are also called Underground solar green houses. Generally they have a width of 5 to 6m and a depth of 2 to 3m. Trench cultivation harnesses soil and sun heat for vegetable growing. They are very popular in the cold desert areas.

10. **Beds**
    The traditional hot beds work on the principle that the heat generated from the decomposition of dung can be utilized in growing vegetables even in sub-zero temperature conditions. These are made over the ground by alternating layers of straw and half rotten dung. These are suitable for off-season nursery raising.

3.4 Production Systems (Media and Components) of Protected Cultivation

3.4.1 Media for protected cultivation

There are several production systems currently being utilized worldwide by commercial greenhouse vegetable producers. All the greenhouse production systems require the use of similar environment control, shade structures, support wires and other general production practices. The major differences would be in the irrigation and nutrient delivery methods and control. The different media for greenhouse production systems and the components of a protected cultivation structure are presented below:

1. **Soil system/ Ground culture/ Geoponics**
   In this system, plants are grown directly in the natural soil under protected cultivation. It is the easiest way to start greenhouse vegetable production. Plants re oriented in double rows and irrigation is handled through the use of proportioners, injection pumps, or large nutrient storage tanks with sump pumps. Drip or ring emitters are placed at the base of each plant to provide water and nutrients to the plants. The demerit of the system includes diseases and insect incidence in soil. In addition, flood irrigation water causes a high water table which reduces aeration and plant root growth.

2. **Soil-less cultivation**
   Growing of vegetables in the media other than soil is called soil-less culture. The soilless cultivation has increased significantly due

to the use of methyl bromide as a soil disinfectant between crop cycles. New types of substrates are increasing in the same way to increase crop yield and quality for the plants grown in the soil. Several types of substrates are used as soilless media and it protects the crops from different soil infections. Containers of various shapes and sizes with drainage holes are required for soil-less culture and the system is called container system. The containers are irrigated and fertilized through a drip irrigation system.

3. **Hydroponics**

The system of growing plant in nutrient solution and water solution without soil is known as hydroponics or water culture. Terrestrial can be grown with their roots in the mineral solution only or an inter medium, such as perlite or gravel. It involves the production of vegetables in sand, gravel, or artificial soilless mixes in bags, tubes, tanks, or troughs designed to allow the circulation of nutrient media needed for crop growth.

4. **Nutrient film technique (NFT)**

This is a type of water culture system in which the bare roots are continuously bathed in a flowing nutrient solution. True NFT consists of growing the plants in a shallow plastic-lined trough in which oxygenated nutrient solution is flowed continuously. Channels are on a slope to allow the nutrient solution to flow from one end to the other and collected for return to the sump tank. Nutrient solution is pumped continuously from the sump tank back to the channels. Vegetables suited for NFT system are tomato and cucumber.

5. **Aeroponics**

This system involves growing of plants in a trough, tubes, and other type of chambers in which the roots are suspended or hung in air and sprayed with a nutrient mist. So, it easily absorbs nutrients and oxygen. The rooted plants are placed in a special type of box with computer controlled humid atmosphere. It is relatively a new production system used especially for research purposes. Aeroponics is proved to have several advantages over soil based gardening and hydroponics.

3.4.2 Components of protected cultivation structure

Protected cultivation comprises different devices and technologies such as windbreaks, and irrigation soil mulches, etc., and the structures which are a greenhouse, tunnel, row covers made the production throughout the year by modifying the natural environment.

The main components of protected cultivation structure are frame, cladding material, and ventilation/climate control systems.

1. The frame needs to be constructed strong enough to sustain against different types of damaging factors such as wind, rain/snow, soil/climatic moisture, physical and chemical deterioration, etc.

2. The cladding material must be transparent enough to provide required photo synthetically active radiation (PAR), entrap enough heat during cold weather, and protect the plants from outside conditions.

3. The ventilation/climate control system must be designed to provide congenial climatic conditions for better plant performance with a reasonable compromise.

Figure: 10 Components of protected cultivation structure: Frame; Cladding Material, and Ventilation/Climate Control Systems.

SELF ASSESSMENT EXERCISE

i. Define protected crop cultivation and explain it.
ii. Explain the objectives of protected cultivation.
iii. Enumerate 10 benefits and 10 advantages of protected cultivation.
iv. Describe limitations of protected cultivation of vegetables
v. What are the different types of protected cultivation practices?
vi. Discuss 4 different types of media for protected cultivation.
vii. Explain the components of protected cultivation structure

4.0 CONCLUSION

This unit taught you that protected cultivation is a technique where the microclimatic environment of the plant is controlled partially or fully or modified to protect the crop from temperature fluctuations, hail storms and heavy rains. You were also informed that the technology is useful for: protecting the plants from birds, insects, weeds and diseases; conserving water and land, and also protecting the environment. The unit also informs you that some of the protected cultivation practices are forced ventilated greenhouse, naturally ventilated Poly-house, insect-proof net house, shade net house, plastic tunnel, mulching, raised beds, trellising, and drip irrigation. It further explained that among all the protected cultivation practices, greenhouse farming cultivation provides maximum benefits.

You were also informed that the problems surrounding the adoption, growth and sustainability of protected cultivation technology are: high cost of initial investment and seeds/planting materials; non-availability of skilled human power; lack of technical knowledge; the need for an intensive operations, constant effort, close supervision and monitoring; hard to manage pests and soil-borne pathogens; the need for repair and maintenance; requires assured marketing and absence of credit and capital subsidy support.

5.0 SUMMARY

Protected cultivation practices is a cropping technique wherein the micro environment surrounding the plant body is controlled partially or fully as per plant need during their period of growth to maximize the yield and resource saving. The technology also protects the plants from birds, insects etc. and conserve the soil moisture. Protected cultivation of vegetables offers distinct advantages of quality, productivity and favorable market price to the growers. The benefits of protected crop cultivation include: the provision of s favorable micro climatic conditions; cultivation in all seasons; higher yield with better quality; conserves moisture and less irrigation; cultivation of high value / off season crops; control pest and diseases; raising early nurseries; less use of fertilizers, and insecticides and round the year propagation of planting material.

Some of the protected cultivation practices are forced ventilated greenhouse, naturally ventilated Polyhouse, insect-proof net house, shade net house, plastic tunnel, and mulching, raised beds, trellising, and drip irrigation. Among all the protected cultivation practices, greenhouse farming cultivation provides maximum benefits. The different media for greenhouse production systems are: Soil system/ Ground culture/ Geoponics; Soil-less cultivation; hydroponics; nutrient film technique

(NFT**)** and Aeroponics. The main components of protected cultivation structure are frame, cladding material, and ventilation/climate control systems.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define and discuss the concept of protected crop cultivation
2. List 5 objectives of protected cultivation of crops.
3. Highlight 10 benefits and 10 advantages of protected crop cultivation
4. Enumerate 10 limitations of protected cultivation of vegetables and other produce
5. List 4 different types of protected cultivation practices and describe them.
6. Explain 4 different types of media for protected cultivation.
7. Discuss the components of protected cultivation structure

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MODULE 2 ORGANIC FARMING PRACTICES

Unit 1 Principles of Organic Farming
Unit 2 Organic Farming Management
Unit 3 Organic Farming Techniques and Materials
Unit 4 Sources of Organic Fertilizer Nutrients

UNIT 1 PRINCIPLES OF ORGANIC AGRICULTURE

CONTENTS

1.0 Introduction
2.0 Learning Objectives
3.0 Main Content
    3.1 The Principles of Organic Production Methods
    3.2 The principles of Health
    3.3 The principle of Ecology
    3.4 The principle of Fairness
    3.5 The principle of Care
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Organic farming aims to produce superior quality products, with high nutritional value and no chemicals, with the purpose of good health. It aims to create a sustainable system that conserves energy, soil and water; while at the same time providing general maintenance of the environment. The driving force behind the organic agricultural sector is the lack of or absent of (not using) pesticides and herbicides, growth hormones and antibiotics in the production process.

Organic agriculture is the counter movement to conventional agriculture that supports a more natural relationship between production and the environment in which production takes place. The need to support this relationship and to reduce the negative impact of horticulture and agriculture on the environment necessitates that all organic production methods around the world should be based on four main principles: Health, Fairness, Ecological Balance and Care.

These principals provide a vision for agriculture that inspires environmentally friendly cultivation and production and also influence the practices of organic producers. The Principles of Organic Agriculture

were established by the International Federation of organic Agriculture Movements (IFOAM). The General ssembly of IFOAM approved the Principles of Organic Agriculture on September 28, 2005. The principles were developed during an intensive two-year participatory process.

These Principles 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. Composed as inter-connected ethical principles to inspire the organic movement — in its full diversity, they guide our development of positions, programs, and standards. The aim of the principles is both to inspire the organic movement and to describe the purpose of organic agriculture to the wider world.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- understand the guiding principles of organic agriculture and its objectives.
- state the organic agricultural principles of health, know its idea and purpose
- describe the organic principles of ecology, explain its concepts and objectives
- discuss the organic principles of fairness, its idea and importance
- explain the organic agricultural principles of care, its meaning and purpose

3.0 MAIN CONTENT

3.1 Principles of Organic Production Methods

The guiding principles of organic agriculture encompass the fundamental motivation, practice, goals and caveats that are considered important for producing high quality food, fiber and other goods in an environmentally sustainable way.

The principles apply to agriculture in the broadest sense, including the way people tend soils, water, plants and animals in order to produce, prepare and distribute food and other goods. They concern the way people interact with living landscapes, relate to one another and shape the legacy of future generations. 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:

The principle of health
The principle of ecology
The principle of fairness and
The principle of care

Figure 11: The Principles of Organic Agriculture

Each principle is articulated through a statement followed by an explanation. The principles are to be used as a whole. They are composed as ethical principles to inspire action.

3.2 Principle of Health

This principle states that;

"Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible".

The principle of health in organic agriculture refers to the health of eco-systems, as well as the health of people and communities. Healthy soil produces healthy crops, and in turn, healthy produce leads to healthy animals and humans. 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. Immunity, resilience and regeneration are key characteristics of health.

The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of

ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Organic agriculture aims to provide healthy food that is nutritious and superior in quality. In addition it must contribute to the health and well being of soil, plants, animals, humans and the earth. It is the sustenance of mental, physical, ecological and social well being. For instance, it provides pollution and chemical-free, nutritious food items for humans.

3.3 Principle of Ecology

This principle states that;

"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 implies 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. Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature.

The principle dictates that organic farms are to be based on an ecological system that balances with the environment and nature, including recycling and taking care of the eco-system. If you produce and raise organic animals, you need to take care of the farm itself. For crops, take care of the living soil. Ecological balance includes managing conditions and culture; and farmers, producers, traders and consumers should take environmental protection on board. Air, water, biodiversity, climate and land needs to be protected and can be done through the use of high-tech farming systems.

These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic

products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

3.4 Principle of Fairness

This principle states that;

"Organic Agriculture should build on relationships that ensure fairness with regard to the 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. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products.

The principle of fairness refers to good human relationships and quality of life. Organic agriculture is based on providing a fair and just environment for people to live in. Organic farmers are expected to ensure work completed at their farm is fair to all involved, from the farmers and pickers, through to the distributors and consumers. It aims to provide quality food and other products, and animals are to be housed in conditions that are in accordance with their natural behavior and wellbeing. Organic agriculture merges human life with animals and plants – and ensures they are all used sensibly now, and into the future.

This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and wellbeing. Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

Fairness is evident in maintaining equity and justice of the shared planet both among humans and other living beings. Organic farming provides good quality of life and helps in reducing poverty. Natural resources must be judiciously used and preserved for future generations.

3.5 Principle of Care

This principle states that;

"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. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken. This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture.

In this regard science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

When it comes to organic agriculture, it's not just the environment today that matters, but we also need to have consideration for the environment of the future. This is where the principle of care comes in. Many organic farmers aim to increase their production, and while this is great – it must be done with care to ensure the future health of the planet is taken care of. Using organic farming technology is the best way to do this, and it's recommended organic producers keep up to date with new methods.

Organic agriculture should be practiced in a careful and responsible manner to benefit the present and future generations and the environment. As opposed to modern and conventional agricultural methods, organic farming does not depend on synthetic chemicals. It utilizes natural, biological methods to build up soil fertility such as microbial activity boosting plant nutrition.

It is imperative to note that, multiple cropping practiced in organic farming boosts biodiversity which enhances productivity and resilience and contributes to a healthy farming system. Conventional farming systems use mono-cropping that destroys soil fertility.

SELF ASSESSMENT EXERCISE

i. Discuss the guiding principles of organic agriculture and its objectives.
ii. State the organic principles of health and explain its idea and purpose
iii. Describe the organic principles of ecology and explain its concepts and objectives
iv. Discuss the organic principles of fairness and importance
v. State the organic principles of care and discuss its meaning and purpose

4.0 CONCLUSION

This unit taught you that the aim of organic farming is to produce superior quality products, with high nutritional value and no chemicals, for good health. It also stated that the purpose of organic farming is to create a sustainable system that conserves energy, soil and water; while maintaining the environment. You were informed that the driving force behind the organic agricultural sector is the absent of pesticides and herbicides, growth hormones and antibiotics in the production process. The unit presented the fact that organic agriculture supports a more natural relationship between production and the environment in which production takes place. It also explained that the need to support this relationship and to reduce the negative impact of horticulture and agriculture on the environment necessitates that all organic production methods around the world should be based on four main principles: Health, Fairness, Ecological Balance and Care.

According to the unit the principles of health, ecology, fairness and balance respectively states that; “Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible”. ; “Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them”.; “Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities”.; “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”. The unit also stated that, these are composed as ethical principles to inspire action and are the roots from which organic agriculture grows and develops.

5.0 SUMMARY

Organic farming aims to produce superior quality products, with high nutritional value and no chemicals, for good health. It aims to create a

sustainable system that conserves energy, soil and water; while at the same time providing general maintenance of the environment. Organic agriculture supports a more natural relationship between production and the environment in which production takes place. The need to support this relationship and to reduce the negative impact of horticulture and agriculture on the environment necessitates that all organic production methods around the world should be based on four main principles: Health, Fairness, Ecological Balance and Care. Each principle is articulated through a statement followed by an explanation. These principals provide a vision for agriculture that inspires environmentally friendly cultivation and production and also influence the practices of organic producers.

The four principles of health, ecology, fairness and balance respectively states that; “Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible”. ; “Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them”.; “Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities”.; “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”. These Principles are the roots from which organic agriculture grows and develops.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the guiding principles of organic agriculture and its objectives.
2. Discuss the organic principles of health and explain its idea and purpose
3. State the organic principles of ecology and discuss its objectives
4. Describe the organic principles of fairness and explain its importance
5. Explain the organic principles of care and highlight its purpose

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UNIT 2 ORGANIC FARMING MANAGEMENT

CONTENTS

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1.0 INTRODUCTION

The International Federation of Organic Agriculture Movements (IFOAM) describes *organic agriculture as a production system that sustains the health of soils, ecosystems and people. That it relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. The organization further explains that 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.*

Consequent on the above, organic agriculture can be said to be a method of farming system which involves cultivating the land and raising crops so as to keep the soil in good health by using organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (biofertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment.

Growing a crop under organic farming management is an integrated approach, where all aspects of farming systems are interlinked with each other and work for each other. A healthy biologically active soil is the source of crop nutrition, on-farm biodiversity controls pests, crop rotation and multiple cropping maintains the system's health and on-farm resource management with integration of cattle ensure productivity and sustainability.

Organic management stresses on optimization of resource use and productivity, rather than maximization of productivity and over

exploitation of resources on the cost of resources meant for future generations.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- understand organic management principles and enumerate the steps for proper management of a crop under organic farming.
- explain multiple cropping and its importance in organic agricultural
- know crop rotation and its relevance in organic agricultural
- discuss the use of organic inputs for soil enrichment and its benefit.
- explain pest management methods and its importance in organic agricultural

3.0 MAIN CONTENT

3.1 Management Principles

3.1.1 Introduction

A living soil is the basis of organic farming. A live, healthy soil with proper cropping patterns, crop residue management and effective crop rotation can sustain optimum productivity over the years, without any loss in fertility. Organic farming envisages a comprehensive management approach to improve soil health, the ecosystem of the region and the quality of produce. It includes all agricultural systems that promote environmentally sound production of food and fibers.

These systems take local soil fertility as a key to successful production, by respecting the natural capacity of plants, animals and the landscape; they aim to optimize quality in all aspects of agriculture and environment. A living soil can be maintained by continuous incorporation of crop and weed biomass, use of animal dung, urine-based manures (FYM, NADEP, vermicompost), biofertilisers and bioenhancers, special liquid formulations (like vermiwash, compost tea etc) during a crop's duration.

As a thumb rule, crop residues should be returned to the plot, directly or indirectly. Cattle droppings may be returned to the field as compost. As a strategy, the quantity of biomass removed for human food and fiber, cattle feed or firewood from an organic farm should be replaced with any other bio-waste on the farm. But it is important to account for it for preparing the balance sheet of nutrients for each crop being cultivated on the farm. In phosphorous-deficient and acidic soils, some quantity of mineral grade

rock phosphate and lime can also be added either by direct application to the field or through addition to compost. The compost can be further enriched by incorporation of biofertilisers, microbial inoculants, etc.

3.1.2 Steps in organic crop management

While turning towards organic it is essential that the basic requirements of the system and the area are properly understood and long term strategies are addressed first. In most agricultural regions poor soil health due to loss of organic matter and soil microbial load is a major problem. Reducing water availability and increasing temperature is further adding to the problems.

Too much dependence on market for supply of inputs and energy has made the agriculture a cost intensive high input enterprise with diminishing returns. There is a need to address all these concerns and develop a system which is not only productive and low cost but also resource conserving and sustainable for centuries to come. The following steps should be taken for proper management of a crop under organic farming:

1. Enrichment of soil: Abandon use of chemicals, use crop residue as mulch, use organic and biological fertilizers, adopt crop rotation and multiple cropping, avoid excessive tilling and keep soil covered with green cover or biological mulch.
2. Management of temperature:_ Keep soil covered, Plant trees and bushes on bund
3. Conservation of soil and rain water:_ Dig percolation tanks, maintain contour bunds in sloppy land & adopt contour row cultivation, dig farm ponds, maintain low height plantation on bunds.
4. Harvesting of sun energy:_ Maintain green stand throughout the year through combination of different crops and plantation schedules.
5. Self reliance in inputs:_ Develop your own seed, on-farm production of compost, vermicompost, vermiwash, liquid manures and botanical extracts.
6. Maintenance of life forms:_ Develop habitat for sustenance of life forms, never use pesticides and create enough diversity.
7. Integration of animals:_ Animals are important components of organic management that provide animal products and enough dung and urine for use in soil.
8. Use of renewable energy:_Use solar energy, bio-gas and bullock driven pumps, generator and other machine.

3.2 Multiple Cropping

Mix cropping is the outstanding feature of organic farming in which variety of crops are grown simultaneously or at different time on the same land. In every season care should be taken to maintain legume cropping at least 40%. Mix cropping promotes photosynthesis and avoids the competition for nutrients because different plants draw their nutrients from different depth of soil. The legume fixes atmospheric nitrogen and make available for companion or succeeding crops. Deep rooted plants drew nutrient from deeper layer of soil and bring them to the surface of soil through their leaf fall.

So the nutrients leached down to lower strata are further brought back to upper layer by these deep rooted plants. Also help in protecting soil from soil erosion. Farmers should select the crops combination according to their needs and season. In selecting crop combinations, it is also to be kept in mind that plants also have their feelings, likes and dislike e.g. maize gets along well with beans and cucumber, tomatoes go well with onions and marigold. On the other hand beans and onions do not go well with each other.

Entire farm should have at least 8-10 types of crops at all the times. Each field/ plot should have at least 2-4 types of crops out of which one should be legume. In case if only one crop is taken in one plot then adjacent plots should have different crops. For maintenance of diversity and pest control randomly plant 50-150/acre vegetable seedlings for home consumption and 100 plants/acre of marigold (Genda) in all crop fields. Even high nutrient demanding crops such as sugarcane can also be grown with suitable combination of various legume and vegetable crops with optimum productivity.

3.3 Crop Rotation

Crop rotation is the back bone of organic farming practices. To keep the soil healthy and to allow the natural microbial systems working, crop rotation is must. Crop rotation is the succession of different crops cultivated on same land. Follow 3-4 years rotation plan. All high nutrient demanding crops should precede and follow legume dominated crop combination. Rotation of pest host and non pest host crops helps in controlling soil borne diseases and pest. It also helps in controlling weeds.

It is better for improving productivity and fertility of soil. Crop rotations help in improving soil structure through different types of root system. Legumes should be used frequently in rotation with cereal and vegetable crops. Green manure crops should also find place in planning rotations. High nutrient demanding crops should always be followed by legume

crops and returned back to soil. Some important benefits of crop rotations are:

1. Not all plants have same nutritive needs
2. Soil structure is improved through different types of roots
3. Pest build up is avoided and
4. Rotations help against the build up of weeds.

Under Network Project on Organic Farming (NPOF of ICAR) important cropping systems, which were found economically better or at par with conventional system at different experimental stations in the country are as follows:

1. Soybean - Berseem/ Mustard/ chickpea at Raipur, Chattisgarh
2. Tomato/ Cabbage – cauliflower – pea and maize – garlic at Bajaura, Himachal Pradesh
3. Rice – wheat/ potato/ mustard/ lentil at Ranchi, Jharkhand

3.4 Manuring and Soil Enrichment

3.4.1 Use of organic inputs for soil enrichment

During conversion period, soil fertility can be improved and maintained initially through use of organic inputs like well decomposed organic manure/ vermicompost, green manure and biofertilizers in appropriate quantity. These organic inputs are used for feeding the soil. Well fed healthy soil rich in microflora and microfauna takes care of the crop nutrient requirement. Plant biomass, FYM, Cattle dung manure, enriched compost, biodynamic compost, Cow-pat-pit compost and vermicompost are key sources of on-farm inputs. Among off-farm inputs, important components are non-edible oil cakes, poultry manure, biofertilizers, mineral grade rock phosphate and lime etc.

Lopping from Glyricidia and other plants grown on bunds, on-farm produced compost and vermicompost, animal dung and urine and crop residue should form the major source of nutrient and concentrated manures such as crushed oil cakes, poultry manure, vegetable market waste compost and other novel preparations such as biodynamic formulations etc can be used in appropriate quantity. Use of high quantities of manures should be avoided. Changing crop rotations and multiple crops ensure better utilization of resources. Depending upon the type of crop and requirement of nutrients for different crops, the quantity of externally produced inputs
is determined.

Application of liquid manure (for soil enrichment) is essential to maintain the activity of microorganisms and other life forms in the soil. 3-4 applications of liquid manure is essential for all types of crops. Vermiwash, compost tea, cow urine, Pachgavya and Biosol etc are excellent growth promoters when used as foliar spray. 3-5 sprays after 25-30 days of sowing ensure good productivity. Use of Biodynamic preparations, such as BD-500 and BD-501 as foliar spray has also been found to be effective in growth promotion.

3.4.2 Use of biofertilizers and microbial Cultures

Biofertilizers viz: Rhizobium, Azotobacter, Azospirillum, PSB and Pseudomonas etc have been found to be very effective tools of fertility management and biological nutrient mobilization. Recently customized consortia of such biofertilizer organisms, better adapted to local climatic conditions have also been developed and are available commercially. Efficiency of such microbial formulations is much higher under no-chemical use situations, therefore application of such inputs need to be ensured under all cropping situations.

3.5 Pest Management

As in organic farming management use of synthetic chemicals are prohibited, the pest management is done by: (i) cultural or agronomic (ii) mechanical (iii) biological or by (iv) organically acceptable botanical extract or some chemicals such as copper sulphate and soft soap etc.

1. **Cultural alternative**
   Use of disease free seed or stock and resistant varieties are best preventive practice in organic pest management. Maintenance of biodiversity, effective crop rotation, multiple cropping, habitat manipulation and use of trap crops are also effective practices which can keep the population of pests below economical threshold limit (ETL).

2. **Mechanical alternative**
   Removal of affected plants and plant parts, collection & destruction of egg masses and larvae, installation of bird perches, light traps, sticky colored plates and pheromone traps are most effective mechanical methods of pest control.

3. **Biological alternative**
   Use of pest predators and pathogens has also proved to be effective method of keeping pest problem below ETL. Inundative release of *Trichogramma sp*. @ 40,000 to 50,000 eggs per hectare, *Chelonus blackburni* @15,000 to 20, 000 per hectare, *Apanteles* sp.@15,000

to 20,000 per ha and *Chrysoperla sp*.@ 5,000 per ha., after 15 days of sowing & others parasites & predators after 30 days of sowing, can also effectively control pest problem in
organic farming .

4. **Use of Biopesticides**

Trichoderma viride or *T. harazianum* or *Pseudomonas fluorescence* formulation @ 4gm/kg seed either alone or in combination, manage most of the seed borne & soil borne diseases. There are other formulations viz. *Beauvaria bassiana*, *Metarizium anisopliae*, *Numeria rileyi*, *Verticillium* sp, which are available in the market and can manage their specific host pest. *Bacillus thurengensis stenebrionis and B.thurengensis sandigo* are effective against coleopterans as well as some other insect species. Bt. has been used in the management of diamond back moth on crucifers and vegetables @ 0.5-1.0 kg. formulation per ha. Viral biopesticides of baculovirus group viz. granulosis viruses (GV) and nuclear polyhedrosis viruses provided a great scope in plant protection field. Spray of nuclear polyhedrosis viruses (NPV) of *Helicoverpa armigera* (H) or *Spodoptera litura* (S) @ 250 larval equivalents are very effective tools to manage the *Helicoverpa* sp. or *Spodoptera* sp. respectively.

5. **Botanical pesticides**

Many plants are known to have pesticidal properties and the extract of such plants or its refined forms can be used in the management of pests. Among various plants identified for the purpose, neem has been found to be most effective.

Neem (*Azadirachta indica*) – Neem has been found to be effective in the management of approximately 200 insects, pests and nematodes. Neem is very effective against grasshoppers, leaf hoppers, plant hoppers, aphids, jassids, and moth caterpillars. Neem extracts, are also very effective against beetle larvae, butterfly, moth and caterpillars such as Mexican bean beetle, Colorado potato beetle and diamondback moth. Neem is very effective against grasshoppers, leaf minor and leaf hoppers such as variegated grasshoppers, green rice leaf hopper and cotton jassids. Neem is fairly good in managing beetles, aphids and white flies, mealy bug, scale insects, adult bugs, fruit maggots and spider mites.

SELF ASSESSMENT EXERCISE

i. Discuss organic management principles and enumerate the steps for crop management.
ii. Define multiple cropping and explain its importance in organic agricultural.
iii. Explain crop rotation and state its relevance in organic agricultural.
iv. Highlight the use of organic inputs for soil enrichment and its benefit organic farming.
v. Describe pest management methods and its importance in organic agricultural.

4.0 CONCLUSION

You were informed in this unit that the International Federation of Organic Agriculture Movements (IFOAM) describes *organic agriculture as a production system that sustains the health of soils, ecosystems and people. The unit also stated that g*rowing a crop under organic farming management is an integrated approach, where all aspects of farming systems are interlinked with each other and work for each other. You also understood that Organic management stresses on optimization of resource use and productivity, rather than maximization of productivity and over exploitation of resources on the cost of resources meant for future generations. The unit describes mix cropping as an outstanding feature of organic farming in which variety of crops are grown simultaneously or at different time on the same land. It further states that mix cropping promotes photosynthesis and avoids the competition for nutrients because different plants draw their nutrients from different depth of soil.

The unit defines crop rotation as the succession of different crops cultivated on same land. It also explains that in rotation, all high nutrient demanding crops should precede and follow legume dominated crop combination and that rotation of pest host and non pest host crops helps in controlling soil borne diseases, pest and weeds. The unit taught you that in organic farming, soil fertility is improved and maintained by the use of organic inputs like well decomposed organic manure/ vermicompost, green manure and biofertilizers in appropriate quantity. It was stated that biofertilizers are very effective tools of fertility management and biological nutrient mobilization with pest management done through the following: (i) cultural or agronomic (ii) mechanical (iii) biological or by (iv) organically acceptable botanical extract or some chemicals such as copper sulphate and soft soap etc.

5.0 SUMMARY

The International Federation of Organic Agriculture Movements (IFOAM) describes *organic agriculture as a production system that sustains the health of soils, ecosystems and people*. Growing a crop under organic farming management is an integrated approach, where all aspects of farming systems are interlinked with each other and work for each other. A healthy biologically active soil is the source of crop nutrition, on-farm biodiversity controls pests, crop rotation and multiple cropping maintains the system's health and on-farm resource management with integration of cattle ensure productivity and sustainability. Organic management stresses on optimization of resource use and productivity, rather than maximization of productivity and over exploitation of resources on the cost of resources meant for future generations.

Mix cropping is the outstanding feature of organic farming in which variety of crops are grown simultaneously or at different time on the same land. Mix cropping promotes photosynthesis and avoids the competition for nutrients because different plants draw their nutrients from different depth of soil. Crop rotation is defined as the succession of different crops cultivated on same land. During conversion period, soil fertility is improved and maintained through the use of: a well decomposed organic manure/ vermicompost, green manure and biofertilizers in appropriate quantity. Because the use of synthetic chemicals in organic farming management is prohibited, pest management is done by: (i) cultural or agronomic (ii) mechanical (iii) biological or by (iv) organically acceptable botanical extract or some chemicals such as copper sulphate.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain organic management principles and enumerate the steps for crop management.
2. Discuss multiple cropping and explain its importance in organic agricultural
3. Define crop rotation and state its relevance in organic agricultural
4. Describe the use of organic inputs for soil enrichment and its benefit organic farming
5. Explain pest management methods and its importance in organic agricultural

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UNIT 3 ORGANIC FARMING TECHNIQUES AND MATERIALS

CONTENTS

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1.0 INTRODUCTION

Organic farming works in harmony with nature rather than against it. This involves using techniques to achieve good crop yields without harming the natural environment or the people who live and work in it. The methods and materials that organic farmers use are to 1) keep and build good soil structure and fertility 2) control pests, diseases and weeds 3) use water resources carefully and engage in good animal husbandry

Organic farming does not mean going 'back' to traditional methods. Many of the farming methods used in the past are still useful today. Organic farming takes the best of these and combines them with modern scientific knowledge. Organic farmers do not leave their farms to be taken over by nature; they use all the knowledge, techniques and materials available to work with nature. In this way the farmer creates a healthy balance between nature and farming, where crops and animals can grow and thrive.

To be a successful organic farmer, the farmer must not see every insect as a pest, every plant out of place as a weed and the solution to every problem in an artificial chemical spray. The aim is not to eradicate all pests and weeds, but to keep them down to an acceptable level and make the most of the benefits that they may provide.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- understand weed control methods in organic farming.
- know and explain pest and disease control methods in organic agricultural
- explain genetic diversity as an organic farming technique
- discuss the careful use of water and animal husbandry as an organic farming practice.
- describe international standard and its importance in organic agricultural

3.0 MAIN CONTENT

3.1 Weed Control

Weeds are often cited as the most significant problem in organic farming systems, and they are certainly the problem that most concerns the farmers, who are looking at changing over their farm from a standard one into an associate-in-nursing organic one. In organic farming systems, the aim is not necessarily the elimination of weeds but their control.

Weed control means reducing the effects of weeds on crop growth and yield. Organic farming avoids the use of herbicides which, like pesticides, leave harmful residues in the environment. Beneficial plant life such as host plants for useful insects may also be destroyed by herbicides. In organic farming, weeds can be controlled by the following methods.

1. Crop rotation
2. Hoeing
3. Mulches, which cover the soil and stop weed seeds from germinating
4. Hand-weeding or the use of mechanical weeders
5. Planting crops close together within each bed, to prevent space for weeds to emerge
6. Green manures or cover crops to outcompete weeds
7. Soil cultivation carried out at repeated intervals and at the appropriate time, when the soil is moist. Care should be taken that cultivation does not cause soil erosion.
8. Animals as weeders to graze on weeds

Weeds do have some useful purposes. They can provide protection from erosion, food for animals and beneficial insects and food for human use.

3.2 Pest and Disease Control

Pests and diseases are part of nature. In the ideal system there is a natural balance between predators and pests. If the system is imbalanced then one population can become dominant because it is not being preyed upon by another. The aim of natural control is to restore a natural balance between pest and predator and to keep pests and diseases down to an acceptable level. The aim is not to eradicate them altogether.

There are many natural ways in which the organic farmer can control pests and diseases that includes the following:

- Growing healthy crops that suffer less damage from pests and diseases.
- Choosing crops with a natural resistance to specific pests and diseases. Local varieties are better at resisting local pest and diseases than introduced varieties.
- Timely planting of crops to avoid the period when a pest does most damage.
- Companion planting with other crops that pests will avoid, such as onion or garlic.
- Trapping or picking pests from the crop.
- Identifying pest and diseases correctly.
- Using crop rotations to help break pest cycles and prevent a carryover of pests to the next season.
- Providing natural habitats to encourage natural predators that control pests. To do this, the farmer should learn to recognize insects and other animals that eat and control pests.

Through careful planning and using all the other techniques available it should be possible to avoid the need for any crop spraying. If pests are still a problem natural products can be used to manage pests, including sprays made from chillies, onions, garlic or neem. Even with these natural pesticides, their use should be limited as much as possible and only the safest ones used. It is wise to check with national and international organic standards to see which ones are allowed or recommended.

3.2 Genetic Diversity

Within a single crop there can be many differences between plants. They may vary in height or ability to resist diseases, for example. These differences are genetic. Traditional crops grown by farmers contain greater genetic diversity than modern bred crops. Traditional varieties have been selected over many centuries to meet the requirements of farmers. Although many 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 prone to disease, all the other plants are as well. Although some modern varieties may be very resistant to specific pests and diseases they are often less suited to local conditions than traditional varieties. It can therefore be dangerous to rely too much on any one of them.

In organic systems, some variation or 'genetic diversity' between the plants within a crop is beneficial. Growing a number of different crops rather than relying on one is also very important. This helps to protect against pests and diseases and acts as insurance against crop failure in unusual weather such as drought or flood. It is important to remember this when choosing which crops to grow an organic farmer should try to:

1. Grow a mixture of crops in the same field (mixed cropping, intercropping, strip cropping)
2. Grow different varieties of the same crop
3. Use as many local crop varieties as possible
4. Save the seed of local and improved crop varieties rather than relying on buying seed from outside the farm every year.

3.3 Careful us of Water and Animal Husbandry

3.3.1 Careful use of water

In arid lands the careful use of water is as much a part of organic growing as is any other technique. As with other resources, organic farmers should try to use water which is available locally, avoiding using water faster than it is replaced naturally.

There are many ways to use water carefully, including:

1. The use of terracing, rain water basins or catchments and careful irrigation.
2. The addition of organic matter to the soil to improve its ability to hold water.
3. The use of mulches to hold water in the soil and stop its surface from heating/drying out.

3.3.2 Animal husbandry

In an organic system, the welfare of the animals is considered very important. Animals should not be kept in confined spaces where they cannot carry out their natural behaviour such as standing and moving around in an inadequate amount of space. However, care should be taken

that animals do not damage crops. Food for animals should be grown organically. Breeds should be chosen to suit local needs and local conditions and resources These factors help to ensure that livestock are healthier, better able to resist diseases and to provide good yields for the farmer.

3.4 International Standards

The International Federation of Organic Agriculture Movements (IFOAM) has produced a set of international organic standards, laid down by people from many countries. These give guidelines about what organic farming is and how it should be practised on the farm.

International standards are also used to help countries set their own standards, which take into account different farming systems. Many countries have an organic standards authority which lays down national standards and awards a symbol to farms which have followed the standards. This symbol then allows farmers to market certified organic produce. This is important, as it ensures that people know that the food which they buy is organic.

The main principles of organic farming were laid down by IFOAM in 1992 to:

1. Produce food of high nutritional quality in sufficient quantity.
2. Interact in a constructive and life enhancing way with all natural systems and cycles.
3. Encourage and enhance biological cycles within the farming system, involving micro-organisms, soil flora and fauna, plants and animals.
4. Maintain and increase long term fertility of soils.
5. Use, as far as possible, renewable resources in locally organized agricultural systems.
6. Work, as far as possible, within a closed system with regard to organic matter and nutrient elements. This aims to reduce external inputs.
7. Work, as far as possible, with materials and substances which can be reused or recycled, either on the farm or elsewhere.
8. Give all livestock living conditions which will allow them to perform the basic aspects of their innate behaviour.
9. Minimise all forms of pollution that may result from agricultural practices.
10. Maintain the genetic diversity of the agricultural system and its surroundings, including the protection of plant and wildlife habitats.

11. Allow agricultural producers a living according to the UN human rights; to cover their basic needs and obtain an adequate return and satisfaction from their work, including a safe working environment.
12. Consider the wider social and ecological impact of the farming system.

Organic food is becoming popular in Europe and America. However for food to be sold as organic it must bear a symbol that proves that it is truly organic. This is obtained through a certification organization. This is quite a complex procedure and is potentially expensive if there are not certification organizations in your country.

SELF ASSESSMENT EXERCISE

i. Explain weed control methods in organic farming.
ii. Discuss pest and disease control methods in organic agricultural.
iii. Describe genetic diversity and its relevance as an organic farming technique.
iv. Discuss the practice and need for careful us of water and animal husbandry in organic farming.
v. Highlight the importance of international standard in organic agricultural.

4.0 CONCLUSION

This unit explains that weeds affect crop growth and yield and therefore are the most significant problem in organic farming systems, and certainly the major concerns to the farmers. You were informed that organic farming avoids the use of herbicides which, like pesticides, leave harmful residues in the environment. You also know that pests and diseases are part of nature and in the ideal system there is a natural balance between predators and pests. The unit stated that the aim of natural control is to restore a natural balance between pest and predator and to keep pests and diseases down to an acceptable level but not to eradicate them altogether. The unit taught us that genetic differences exist between plants and the traditional crops grown by farmers contain greater genetic diversity than modern bred crops.

The unit further explained that in organic systems, the 'genetic diversity' between the plants within a crop is beneficial as it helps to protect against pests and diseases and acts as insurance against crop failure in unusual weather such as drought or flood. You were informed that in arid lands the careful use of water is a part of organic growing thus as with other resources, organic farmers should use water judiciously. The unit stress that in an organic system, the welfare of the animals is considered very

important. We also know that the International Federation of Organic Agriculture Movements (IFOAM) has produced a set of international organic standards which give guidelines about organic farming and how it should be practiced on the farm.

5.0 SUMMARY

Weeds are reported to be most significant problem in organic farming systems. Weed control means reducing the effects of weeds on crop growth and yield. Organic farming avoids the use of herbicides which, like pesticides, leave harmful residues in the environment. Pests and diseases are part of nature and in an ideal system a natural balance exist between predators and pests. The aim of natural control is to restore a natural balance between pest and predator and to keep pests and diseases down to an acceptable level and not to eradicate them altogether. Genetic variation exists among crop plants and in organic systems, some variation or 'genetic diversity' between the plants within a crop is beneficial. Since it helps to protect against pests and diseases and acts as insurance against crop failure in unusual weather such as drought or flood.

In arid lands the careful use of water is as much a part of organic growing as is any other technique. As with other resources, organic farmers should try to use water which is available locally, avoiding using water faster than it is replaced naturally. In an organic system, the welfare of the animals is considered very important as such animals should be kept spaces where they can carry out their natural behavior. The International Federation of Organic Agriculture Movements (IFOAM) has produced a set of international organic standards that gives guidelines about what organic farming is and how it should be practiced on the farm. Food sold as organic must bear a symbol that proves that it is truly organic. This logo is obtained through a certification organization.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define and explain weed control methods in organic farming.
2. Explain pest and disease control methods in organic agricultural
3. Discuss genetic diversity as an organic farming technique
4. Describe the careful use of water and animal husbandry as an organic farming practice.
5. How is the concept of international standard important in organic agricultural

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UNIT 4 SOURCES OF ORGANIC FERTILIZER NUTRIENTS

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1.0 Introduction
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1.0 INTRODUCTION

Organic fertilizer for plant growth and development are supplied naturally from the decomposition of organic matter and are released as clay weathers in the soil. In horticulture, additional supplies are made by the use of organic and inorganic fertilizers, bulky organic matter and through green manuring. A typical mineral soil contains between 2 and 5 per cent organic matter. This is made up of living organisms such as plant roots, earthworms, insects, fungi and bacteria.

When these organisms die they decompose along with any other organic matter that is incorporated, either naturally such as leaves or by the addition of organic matter from elsewhere such as compost, farmyard manure, spent mushroom compost, coir and bark. Many of the living organisms in soil are responsible for the decomposition of the dead organic matter which is broken down into carbon dioxide, water, and minerals. When this process continues for a very long time, the organic matter is transformed in to a group of organic compounds collectively known as humus.

The dead organic matter has an important effect on the soil. The fresh, still recognizable material physically ‘opens up’ the soil, improving aeration. Active micro-organisms gradually decompose this material until it consists of unrecognizable plant and micro-organism remains. This finer material has less physical effect, but usually improves the water holding capacity of the soil.

In general, the succulent (‘green’, leafy) organic matter decomposes very rapidly as long as conditions are right, and it has only a short-term physical effect, but yields nutrients, especially nitrogen compounds. The fibrous or woody (‘brown’) plant material tends to decompose very

slowly so its physical effect persists, but nutrient contributions are low. The distinction between the 'green' and 'brown' organic matter is a crude but useful one when composting.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- know the sources of organic fertilizer material and their importance in organic farming.
- describe soil organic matter and its benefit in soil management
- distinguish between farmyard manure and green manure
- list the different types of bio-fertilizers you know and discuss any 4 of them.

3.0 MAIN CONTENT

3.1 Organic Fertilizer Material

Organic fertilizers are plant and animal wastes that are used as nutrients after decomposition. Examples of organic manures (fertilizers) are farmyard manure, compost, and green manure. They are added to the soil to improve the existing stock of organic matter in it. It improves the soil tilth, aeration, water holding capacity and activity of micro-organism. The sources of organic fertilizers include the following:

3.1.1 Soil organic matter

Soil Organic Matter (SOM) is an essential soil ingredient in organic farming practice. Organic matter is the residual of dead plants, animals, and microbial tissues. A major source of soil organic matter is organic manures that include farmyard manure, compost, and green manure. They are added to the soil to improve the existing stock of organic matter in it. These added organics undergo a series of microbial decompositions to form humus.

1. **Humus**
   Humus is form as a result of a long microbial decomposition process that reduces organic matter to carbon dioxide, water, minerals and humus. It is a light bulky amorphous material of dark brown to black color composed of organic compounds. The humus arises from a small proportion of the fi brous (' brown') organic matter which is highly resistant to decomposition; the lignin and other resistant chemicals form a collection of humic acids which forms a black colloidal (jelly-like) material. The humus coats soil particles and gives topsoil its characteristic dark colour.

This colloidal material has a high cation exchange capacity and therefore can make a major contribution to the retention of exchangeable cations, especially on soils low in clay. It also adheres strongly to mineral particles, which makes it a valuable agent in soil aggregation . In sandy soils it provides a means of sticking particles together, whereas in clays it forms a clay-humus complex that makes the heavier soils more likely to crumble. Its presence in the soil crumbs makes them more stable. Bacteria eventually decompose humus so the amount in the soil is very dependent on the continued addition of appropriate bulky organic matter.

Tropical soils are characterized by low organic matter primarily due to climate, high temperature and existing cultural practices. Generally, soil organic matter contents increase with rainfall in tropical and subtropical areas where much organic matter is created and it decays very quickly.

2. Benefit of organic matter

Organic matter plays an important part in the management of soils. The main benefits are:

1. The living organisms in the soil play their part in the conversion of plant and animal debris to minerals and humus;
2. *Rhizobia* and *Azotobacter spp* . fix gaseous nitrogen;
3. Plant roots, earthworms and other burrowing organisms improve the soil structure;
4. Many types of bacteria play an important role in the detoxification of harmful organic materials such as pesticides and herbicides;
5. Dead organic matter is food for soil organisms and increases microbial activity;
6. Dead but recognizable organic matter physically opens up the soil and improves aeration;
7. The fine, unrecognizable organic matter helps improve the water holding capacity of the soil;
8. Decomposing organic matter provides a source of dilute slow release fertilizer;
9. Humus coats soil particles with a black colloid and modifies their characteristics:

    a. Darker soils warm up faster in the spring;
    b. Organic matter improves water-holding capacity;
    c. Cation exchange capacity is increased, which can reduce the leaching of cations from the profile;
    d. On sandy and silty soils the humus enables stable crumbs to be formed;

e. The surface charges on humus are capable of combining with the clay particles, thereby making heavy soils less sticky and more friable.

3.1.2 Farmyard manure (FYM)

This is the traditional material used to maintain and improve soil fertility. It consists of straw or other bedding, mixed with animal faeces and urine. The exact value of this material depends upon the proportions of the ingredients, the degree of decomposition and the method of storage. Much of the FYM is rotted down in the first growing season, but almost half survives for another year and half of that goes on to a third season and so on. A full range of nutrients is released into the soil and the addition of major nutrients should be allowed for when calculating fertilizer requirements .

FYM is most valued for its ability to provide organic matter and humus for maintaining or improving soil structure. As with any bulky organic matter, FYM must be worked into soils where conditions are favourable for continued decomposition to occur. Where fresh organic matter is worked into wet and compacted soils, the need for oxygen outstrips supply and anaerobic conditions develop to the detriment of any plants present. Where this occurs a foul smell and grey colourings occur. FYM should not be worked in deep, especially on heavy soil. The nutrient contents of different organic manures are presented in table 1 below.

Table 2: Nutrient Contents of Organic Manures

Organic Manure	Nitrogen (N%)	P2O5 %	K2O %
Bulky Organic Manures			
Cattle dung	0.40	0.20	0.17
Poultry manure	3.03	0.63	1.40
Farmyard manure	0.50	0.25	0.50
Rural compost	0.75	0.20	0.50
Urban compost	1.75	1.00	1.50
Vermicompost	3.00	1.00	1.50
Concentrated Organic Manure			
Castor cake	4.37	1.85	1.39
Coconut cake	3.00	1.80	1.90
Neem cake	5.22	1.08	1.48
Blood meal	12.00	2.00	1.00
Groundnut cake	7.30	1.50	1.30
Pressmud	2.10	4.40	0.80
Sodium nitrate	16	-	-
Calcium nitrate	15.5	-	-
Potassium nitrate	13.8	-	-

Anhydrous ammonia	82	-	-
Urea	46	-	-
SSP	-	16	-
Double SP	-	32	-
Triple SP	-	46-48	-

3.1. Green Manures

Unlike leys, green manuring is the practice of growing a cover crop primarily to incorporate in the soil. It is undertaken to:

1. Provide organic matter which can improve soil structure, aeration, water-holding capacity and, on decomposition, increase microorganism activity in the soil;
2. Add some nutrients, especially nitrogen (depending on the plants involved), for the following crop;
3. Take up and store nitrogen that would otherwise be leached from bare soil over the winter period;
4. Deep rooted plants can bring up nutrients which have become unavailable to shallower plants;
5. Suppress weeds;
6. Provide cover to protect the soil from wind or water erosion;
7. Provide flowers for pollinating insects.

Green manure has many benefits, but there are some points to note in their management. If the plants are left to the stage when they become fibrous or woody, e.g. when allowing flowering to help pollinators, they will not provide extra nitrogen but are likely to ‘ rob ’ the soil of it (see C:N ratio). There can be difficulties when the following planting requires a fine seedbed, especially if this is to be early in the season; alternative approaches might be to cut and compost the foliage, cut or hoe off and use as a mulch or grow a plant killed by cold and remove the residue. Whilst it is highly valued in organic gardening, the value of the result when the cost of seeds, time and energy is taken into account is less clear cut in other systems.

3.2 Bio-fertilizers (bacterial, fungal, etc)

Nitrogen fixation on the surface of the earth is mainly by microorganisms, representing 67.3% among all the bases of N fixation. Subsequent microorganism and plant life bio-fertilizers will be utilized as an ingredient of organic farming in numerous crops. These bacterial and fungal bio-fertilizers include the following:

Rhizobium
The efficiency of nitrogen-fixing microorganisms viz. *Rhizobia* for legume crops e.g. *Rhizobium*, *Bradyrhizobium*, *Azorhizobium*, *Mesorhizobium*, and *Sinorhizobium*. Legumes are infected by these bacteria all over the world. These rhizobia have a N_2-fixing capability up to 450 metric weight units N ha^{-1} counting on host-plant species and microorganism strains. Carrier based inoculants will primarily be coated with seeds for the introduction of microorganism strains into soil.

Azotobacter
Nitrogen will be fixed by independent microorganisms in cereal crops with no interdependency. Such free-living bacteria are: *Azotobacter sp*. for dissimilar cereal crops; *Herbaspirillum spp* and *Acetobacter diazotrophicus*.

Azospirillum
The gram-positive bacteria *Azospirillum* colonizes in a remarkably kind of yearly and perennial florae. Studies indicate that *Azospirillum* will proliferate the development of crops like flowers, cotton, oak, tomato, sugar beet, pepper, carrot, wheat, and rice. The crop yield can upsurge from 5 to 30%. Inoculum of *Azotobacter* and *Azospirillum* will be created and applied as in humate origination finished seed coating.

Plant growth promoting rhizobacteria
Numerous microorganisms promote plant growth area. The unit is jointly known as plant growth-promoting rhizobacteria (PGPR). PGPR improves plant growth by colonizing the root system. Huge inhabitants of microorganisms recognized in implanting material and roots develop an incomplete sink for nutrients in the rhizosphere

Phosphorus solubilizing microorganism (PSB)
Phosphorus is also an important nutrient similar to nitrogen for plants. This part is important for the nodulation by bacteria genus and even to nitrogen fixers, *Azolla* and BGA. Phosphorus-solubilizing microorganism (PSB) fungi create on the market are insoluble phosphorus to the plants. It will increase crop weight up to 200–500 metric unit/ha and so 30–50 kg Super Phosphate will be preserved. Most predominant phosphorus-solubilizing microorganism (PSB) belongs to the genera *Bacilli* genus.

Mycorrhizal fungi
Mycorrhizal fungi which cause root-colonizing increase tolerance to many sever metal contamination and drought. Mycorrhizal fungi improve soil quality additionally by having an on-the-spot influence on soil aggregation and also aeration and water dynamics. An interesting

potential of these fungi is their ability to permit plant access to nutrient sources .

Blue chlorophyta (BGA)
The BGA represents the most important, most numerous and cosmopolitan cluster of microscopic organisms that perform an oxygenic chemical process. These are as well-known as Cyanophyceae and cyanobacteria.

Azolla biofartilizer
A floating fern *'Azolla'* hosts element fixing BGA *Anabaena azollae*. *Azolla* contains 3.4% nitrogen (on dry weight basis) and adds organic matter in soil. This biofertilizer is used for rice cultivation. There are six species of *Azolla* viz. *A. pinnata, A. microphylla*, *A. mexicana*, *A. filiculoides, A. nilotica,* and *A. caroliniana*

SELF -ASSESSMENT EXERCISE

i. List the different sources of organic fertilizer material and explain any two in detail.
ii. Define soil organic matter discuss its importance
iii. Describe farmyard manure and green manure
iv. Enumerate the different types of bio-fertilizers you know and discuss any 4 of them.

4.0 CONCLUSION

This unit explains that organic fertilizers are plant and animal wastes that are used as nutrients after decomposition. It states that this class of fertilizer improves soil tilth, aeration, water holding capacity and activity of micro-organism. You also learnt from the unit that soil organic matter is an essential soil ingredient in organic farming practice. You were informed that organic matter is the residual of dead plants, animals, and microbial tissues. The unit further explained that a major source of soil organic matter is organic manures that include farmyard manure, compost, and green manure which are added to the soil to improve the existing stock of organic matter in it. You were told that these added organics undergo a series of microbial decompositions to form humus a light bulky amorphous material of dark brown to black color composed of organic compounds. The unit confirms that humus is formed as a result of a long microbial decomposition process that reduces organic matter to carbon dioxide, water, minerals and humus.

The unit informs us that organic matter plays an important part in the management of soils. It also confirm that soil organic matter contents increase with rainfall in tropical and subtropical areas where much

organic matter is created and it decays very quickly. You now know that farmyard manure is the traditional material used to maintain and improve soil fertility and it consists of straw or other bedding, mixed with animal faeces and urine. The unit explains that green manures provide organic matter which can improve soil structure, aeration, water-holding capacity and, on decomposition, increase microorganism activity in the soil. The unit also reports that bio-fertilizers (bacterial, fungal, etc) are microorganism and plant life that fix nitrogen and are utilized as an ingredient of organic farming in numerous crops.

5.0 SUMMARY

Organic fertilizers are plant and animal wastes that are used as nutrients after decomposition. It improves soil tilth, aeration, water holding capacity and activity of micro-organism. Soil organic matter is an essential soil ingredient in organic farming practice. Organic matter is the residual of dead plants, animals, and microbial tissues. A major source of soil organic matter is organic manures which are added to the soil to improve the existing stock of organic matter in it. Organics undergo a series of microbial decompositions to form humus a light bulky amorphous material of dark brown to black color composed of organic compounds. Humus is formed as a result of a long microbial decomposition process that reduces organic matter to carbon dioxide, water, minerals and humus.

Organic matter plays an important part in the management of soils. Soil organic matter contents increase with rainfall in tropical and subtropical areas where much organic matter is created and it decays very quickly. Farmyard manure (FYM) is the traditional material used to maintain and improve soil fertility and it consists of straw or other bedding, mixed with animal faeces and urine. Green Manures provide organic matter which can improve soil structure, aeration, water-holding capacity and, on decomposition, increase microorganism activity in the soil. Bio-fertilizers (bacterial, fungal, etc) are microorganism and plant life that fix nitrogen and are utilized as an ingredient of organic farming in numerous crops.

6.0 TUTOR-MARKED ASSIGNMENT

1. Enumerate the various sources of organic fertilizer material you know and discuss any 2 in details.
2. Explain soil organic matter and its importance in soil management
3. Describe farmyard manure and green manure and state their differnce
4. List the different types of bio-fertilizers you know and discuss any 4 of them.

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MODULE 3 ORGANIC FARM MANAGEMENT

Unit 1 Crop Nutrition Management
Unit 2 Soil Management
Unit 3 Water Management
Unit 4 Pest and Disease Management

UNIT 1 CROP NUTRITION MANAGEMENT

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1.0 INTRODUCTION

Organic farming aims to produce superior quality products, with high nutritional value and no chemicals, with the purpose of good health. It aims to create a sustainable system that conserves energy, soil and water; while at the same time providing general maintenance of the environment.

The driving force behind the organic agricultural sector is the lack of or absent of pesticides and herbicides, growth hormones and antibiotics in the production process. Organic farming practice is based on the use of a range of organic production methods at the same time to allow them to work together for the maximum benefit. For example the use of green manures and careful cultivation, together provide better control of weeds than if the techniques were used on their own.

Organic farming provides long-term benefits to people and the environment. The aims and purpose of organic farming are to:

1. Increase long-term soil fertility.
2. Control pests and diseases without harming the environment.
3. Ensure that water stays clean and safe.

4. Use resources which the farmer already has, to reduce the money to buy farm inputs.
5. Produce nutritious food, feed for animals and high quality crops to sell at a good price.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- understand the choice of crops with respect to the factors affecting its growth and yield.
- explain crop rotation and its benefit in soil management.
- define compost and state its advantage over chemical fertilizer.
- describe mulching and list its benefit in soil improvement.
- discuss green manure and enumerate its advantages.

3.0 MAIN CONTENT

3.1 Crop Nutrition

To produce a healthy crop an organic farmer needs to manage the soil well. This involves considering soil life, soil nutrients and soil structure. Artificial fertilizers provide only short term nutrient supply to crops. They encourage plants to grow quickly but with soft growth which is less able to withstand drought, pests and disease. Artificial fertilisers do not feed soil life and do not add organic matter to the soil. This means that they do not help to build good soil structure, improve the soils water holding capacity or drainage.

The soil is a living system. As well as the particles that make up the soil, it contains millions of different creatures. These creatures are very important for recycling nutrients. Feeding the soil with manure or compost feeds the whole variety of life in the soil which then turns this material into food for plant growth. This also adds nutrients and organic matter to the soil. Green manures also provide nutrients and organic matter. These are plants with high nitrogen content that are sown as part of a rotation and are dug into the soil when young.

It is important to remember, however, that using too much animal manure or nutrient rich organic matter, or using it at the wrong time, could be as harmful as using man-made, artificial fertilisers. The organic farmer must cultivate the soil at the right time and in the right ways to provide the best living conditions for the soil life and plant roots.

3.2 Choice of Crops and Crop Rotation

3.2.1 Choice of crop

Each crop and crop variety has its own specific needs. In some places it will grow well and others it will not. Crops are affected by;

1. Soil type
2. Rainfall
3. Altitude
4. Temperature
5. The type and amount of nutrients required
6. The amount of water needed

These factors affect how a crop grows and yields. If a crop is grown in a climate to which it is not suited, it is likely to produce low yields and be more susceptible to pest and diseases. This then creates the need to use agrochemicals to fertilise the crop and control pest and diseases.

The successful organic farmer learns to grow the crops and varieties which are suited to the local conditions. He should grow crops which are suited to his geography and climate. He should choose varieties which are suited to the local conditions such as local varieties.

3.1.2 Crop rotation

Growing the same crops in the same site year after year reduces soil fertility and can encourage a buildup of pests, diseases and weeds in the soil. 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 means having times where the fertility of the soil is being built up and times where crops are grown which remove nutrients. Crop rotation also helps a variety of natural predators to survive on the farm by providing diverse habitats and sources of food for them. A typical 4 year rotation would include a cycle with maize and beans, a root crop and cereals 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.

3.3 Composting

Compost is organic matter (plant and animal residues) which has been rotted down by the action of bacteria and other organisms, over a period of time. Materials such as leaves, fruit skins and animal manures can be used to make compost. Compost is cheap, easy to make and is a very effective material that can be added to the soil, to improve soil and crop quality.

1. Compost improves the structure of the soil. This allows more air into the soil, improves drainage and reduces erosion.
2. Compost improves soil fertility by adding nutrients and by making it easier for plants to take up the nutrients already in the soil. This produces better yields.
3. Compost improves the soil's ability to hold water. This stops the soil from drying out in times of drought.
4. Compost can reduce pests and diseases in the soil and on the crop.

Compost has many advantages over chemical fertilizers. These provide nutrients for plants but do not improve soil structure. They usually only improve yields in the season in which they are applied. Because compost feeds soil life and improves soil structure, the beneficial effects are long lasting. There are many ways to make compost depending on available materials and climate, for example:

1. Indore method
2. Bangalore method
3. Heating process/Block method
4. Chinese high temperature stack
5. Pit composting
6. Trench composting
7. Basket composting
8. Boma composting

3.4 Mulching

Mulching means covering the ground with a layer of loose material such as compost, manure, straw, dry grass, leaves or crop residues. Green vegetation is not normally used as it can take a long time to decompose and can attract pests and fungal diseases. Mulches have several effects on the soil which help to improve plant growth:

1. Decreasing water loss due to evaporation
2. Reducing weed growth by reducing the amount of light reaching the soil
3. Preventing soil erosion

4. Increasing the number of micro-organisms in the top soil
5. Adding nutrients to the soil and improving soil structure
6. Adding organic matter to the soil

Alternative mulching materials include black plastic sheeting or cardboard. However these materials do not add nutrients to the soil or improve its structure.

Mulches can be used in the following ways::

1. Always apply mulches to a warm, wet soil. Mulch applied to a dry soil will keep the soil dry.
2. Care should be taken as to the thickness of the mulch applied. Too much mulch will prevent air flow and encourage pests.
3. To allow the germination of planted seeds through the mulch, a layer of less than 10cm should be used.
4. To clear an area of land of persistent weeds a layer of 10cm or more can be used.

3.5 Green Manuring

Green manures, often known as cover crops, are plants which are grown to improve the structure, organic matter content and nutrient content of the soil. They are a cheap alternative to artificial fertilisers and can be used to complement animal manures. Growing a green manure is not the same as simply growing a legume crop, such as beans, in a rotation. Green manures are usually dug into the soil when the plants are still young, before they produce any crop and often before they flower. They are grown for their green leafy material which is high in nutrients and provides soil cover. They can be grown together with crops or alone.

Advantages of Green manures

1. Increase and recycle plant nutrients
2. and organic matter
3. Improve soil fertility
4. Improve soil structure
5. Improve the ability of the soil to hold water
6. Control soil erosion
7. Prevent weed growth
8. Stop nutrients being washed out of the soil, for example, when the ground is not used between main crops.

SELF ASSESSMENT EXERCISE

i. List the factors affecting crop growth and yield and explain how they influence crop choice
ii. Describe crop rotation and state its benefit in soil management
iii. Define compost and explain its advantage over chemical fertilizer
iv. Explain mulching and list its importance in soil improvement.
v. Describe green manure and highlight its advantages

4.0 CONCLUSION

This unit informs you that crop nutrition involves feeding the soil life and adding organic matter to it so as to help in building good soil structure, improve the soils water holding capacity or drainage. You also learnt that the soil is a living system containing millions of different creatures that are very important in recycling soil nutrients. You were made to understand that feeding the soil with manure or compost feeds the soil organisms that turn this material into food for plant growth by adding nutrients and organic matter to the soil. It was also stated that green manures also provide nutrients and organic matter.

The unit taught us that many factors affect crop growth, development and yields and that each crop and crop variety has its own specific needs and specific climate witch it is suited. We now know that the choice of crops and varieties which are suited to the local conditions (geography and climate native to the crop) is very important. The unit explains that growing the same crops in the same field year after year reduces soil fertility and encourages a buildup of pests, diseases and weeds. Thus crops should be moved to different area of land each year in a rotation. We have learnt that crop rotation builds up the soil fertility helps a variety of natural predators to survive on the farm by providing diverse habitats and sources of food for them.

The unit defines compost as organic matter which has been rotted down by the action of bacteria and other organisms, over a period of time. We know that compost is cheap, easy to make and is a very effective material added to the soil, to improve soil and crop quality. The unit describes mulching as a process of covering the ground with a layer of loose material such as compost, manure, straw, dry grass, leaves or crop residues. We know that mulches help to improve plant nutrition and growth. The unit informs us that green manures or cover crop are plants which are grown to improve the structure, organic matter content and nutrient content of the soil. It also states that green manures are a cheap alternative to artificial fertilizers used to complement animal manures.

5.0 SUMMARY

Crop nutrition involves feeding the soil life and adding organic matter to help in building good soil structure, improve the soils water holding capacity or drainage. The soil is a living system containing millions of different creatures that are very important in recycling soil nutrients. Feeding the soil with manure or compost feeds the soil organisms that turn this material into food for plant growth by adding nutrients and organic matter to the soil. It was also stated that green manures also provide nutrients and organic matter.

Many factors affect crop growth, development and yields and each crop and crop variety has its own specific needs and specific climate witch it is suited. The choice of crops and varieties which are suited to the local conditions (geography and climate native to the crop) is very important in organic farming. Growing the same crops in the same field year after year reduces soil fertility and encourages a buildup of pests, diseases and weeds. Crops should be moved to different area of land each year in a rotation. Crop rotation builds up the soil fertility helps a variety of natural predators to survive on the farm by providing diverse habitats and sources of food for them.

Compost is organic matter that has been rotted down by the action of bacteria and other organisms, over a period of time. Compost is cheap, easy to make and is a very effective material added to the soil, to improve soil and crop quality. Mulching is a process of covering the ground with a layer of loose material such as compost, manure, straw, dry grass, leaves or crop residues. Mulches help to improve plant nutrition and growth. Green manures or cover crop are plants which are grown to improve the structure, organic matter content and nutrient content of the soil. Green manures are a cheap alternative to artificial fertilizers and are used to complement animal manures and they also provide nutrients and organic matter.

6.0 TUTOR-MARKED ASSIGNMENT

1. Understand the choice of crops with respect to the factors affecting its growth and yield.
2. Explain crop rotation and its benefit in soil management.
3. Define compost and state its advantage over chemical fertilizer.
4. Describe mulching and list its benefit in soil improvement.
5. Explain green manure and enumerate its advantages.

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UNIT 2 SOIL MANAGEMENT

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1.0 INTRODUCTION

Soil management is the application of operations, practices, and treatments to protect soil and enhance its performance (such as soil fertility or soil mechanics). It includes soil conservation, soil amendment, and optimal soil health. In agriculture, some amount of soil management is needed both in nonorganic and organic types to prevent agricultural land from becoming poorly productive over decades. Organic farming in particular emphasizes optimal soil management, because it uses soil health as the exclusive or nearly exclusive source of its fertilization and pest control.

Soil management aims at maintaining soil in good condition, or improving the condition if necessary. This includes protection from direct sunlight and from the impact of rainfall and wind erosion. In annual crops like vegetables and flowers which do not leave vacant space, there is no such problem except that one has to replenish nutrients harvested by crops and leached out.

In tree crops, it is usually several years after planting before a tree which form an extensive canopy can provide adequate protection to the soil, the vacant space needs to be productively utilized and protected through different management practices like intercropping, cover cropping, cultivation, sod culture, mulching, rotation, high density planting.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- Define soil management, explain its concept and know the different methods.
- Understand the objectives and components of soil management
- Explain soil cultivation practice, its advantages and disadvantages.
- Describe mulching as a soil management practice and its advantages.
- Discuss crop rotation as a soil management practice and its advantages.

3.0 MAIN CONTENT

3.1 Definition, Objectives, Components and Method of Soil Management

3.1.1 Definition and Objectives of Soil Management

Soil management practice is the process of maintaining the soil in good condition and improving its quality and nutritional status by protecting it from direct sunlight and from the impact of rainfall and wind erosion. In annual crops like vegetables and flowers which do not leave vacant space between plants, there is no such problem except that one has to replenish nutrients harvested by crops and leached out.

In tree crops however, it is usually several years after planting before a tree which form an extensive canopy can provide adequate protection to the soil, the vacant space needs to be productively utilized and protected through different management practices like intercropping, cover cropping, cultivation, sod culture, mulching, rotation, high density planting.

The objectives of soil management is to:

1. Create favourable conditions for moisture supply and proper drainage.
2. Maintain high fertility level and replenishment against losses.
3. Provide proper soil conditions for gaseous exchange and microbial activities through addition of organic matter.
4. Check or reduce soil erosion.
5. Ensure supply of nutrients for growth and development of plants.
6. Utilize vacant land for additional income because such a loss is inconceivable for small holders.

7. Reduce the cost of cultivation with high economic returns.
8. Suppress weed population.

3.1.2 Components of soil management

The goal of soil management is to build up the fertility of the soil. The soil is managed based on three inextricably interrelated components of soil management.

The components of soil management are:

1. Physical (water-holding capacity, structure, etc.)
2. Chemical (nutrient dynamics, pH), and
3. Biological (soil biota).

Based on these components of soil management, a Fertile Soil can be defined as that soil with a well-managed soil organic matter; a good soil structure, a diverse soil biota and a high nutrient and water-holding capacity. The fertility of a well-managed soil is achieved by using compost and stable manure.

3.1.3 Methods of Soil Management

Appropriate soil management method is important for the control of weeds, incorporation of organic and inorganic fertilizers and to facilitate absorption of water in soil. Common soil management practices are:

1. Cultivation
2. Sod culture
3. Mulching and
4. Rotation.

Choice of the system is determined by many factors as mentioned below:

1) Crop
2) Rooting depth of the crop
3) Slope of the soil
4) Rainfall of the area
5) Climatic condition of the place
6) Economic condition of the farmer

3.2 Cultivation

Cultivation in context with soil management refers to working of the soil by ploughing, harrowing, disking or hoeing. It is essential for removal of weeds, incorporation of manures and fertilizers, green manuring and to facilitate water and nutrient absorption through better aeration. Depth of

tillage and areas are determined by root depth and spread of the canopy of the tree. In cultivation different modifications are made under specific conditions.

3.2.1 Clean cultivation

In this method of soil management the space between plants is kept clean by tillage and removal of weeds.

Advantages of cultivation

1. Removes competition of weeds for light, water and nutrients from crop and avoidance of alternate host for pests and diseases.
2. Improves soil physical condition through better aeration by breaking clods.
3. Helps in breaking hard top and abstructions in the infiltration of water.
4. Improves soil biological activities through better aeration.

Disadvantages of cultivation

1. Loss of organic matter.
2. Loss of soil through erosion even on flat lands through water and wind.
3. Loss of nutrient through excessive leaching.
4. Injury to roots and creation of entry points for pathogens.

Due to several such disadvantages, clean cultivation is not advisable in fruit farming, perhaps just before planting. Even so, it will seem inconceivable to most small holders not to use good land whenever possible and intercrops involving short duration crops and nitrogen fixing annual crops are preferred. If it should be, cultivation should be shallow and infrequent and should be stopped at flowering time.

3.2.2 Cultivation and Cover crops

In areas where soil is eroded during rains and drainage is poor, soil is cultivated and cover crops are grown between the rows during rains. The crop may and may not be turned into soil. These crops not only increase water retaining capacity of soil and biological complex of the soil but also add organic matter when ploughed in besides checking erosion. As cover crops, legumes should be preferred because they add extra N in soil through fixation of atmospheric-N in their nodules. They also suppress weeds during rainy season. Crops like greengram, blackgram, cowpea, cluster bean, soybean should be preferred during kharif season while pea,

fenugreek, broad bean and lentil can be preferred in winter season as cover crops.

Advantages

1. Adds organic matter in soil.
2. Improves soil condition.
3. Improves soil fertility.
4. Increases water retention capacity of soil.
5. Increases biological complexes of soil.
6. Checks soil erosion.
7. Checks nutrient losses through soil erosion.

3.2.3 Cultivation and intercropping

In this case of orchard soil management, cultivation is done for the purpose of raising intercrops. Intercropping is growing of two or more crops simultaneously on the same field so that crop intensification occurs in both time and space dimensions, and there is intercrop competition during all or part of crop growth. This can be mixed strip or relay cropping.

In context of an orchard or a plantation of perennial fruit trees, however, the practices of growing annuals or relatively short duration crop in the inter space during their formative years is referred to as intercropping and the growing of perennial in the interspacing of perennials is called mixed cropping. The term multistory cropping refers to a multispecies crop combination involving both annuals and perennials with an existing stand of perennials.

3.3 Sod Culture and Minimum Tillage

3.3.1 Sod Culture

In this system, in the space between trees, grasses are allowed to grow without tillage or mulching. Sometimes cover is mixed with grasses to improve fertility such as grasses are simply mowed and the surface is kept neat and tidy.

This system is commonly followed in temperate region of Europe and America for apple and pear orchards and does not exist in tropical and subtropical region of India due to scarcity of available nutrients and soil moisture in most part of the year. It is the best system for the control of soil erosion and maintenance of soil organic matter and soil structure. In this case manures and fertilizers are not applied individually to trees but

provided with sod allover the field and the system is satisfactory for deep rooted crops.

Modifications in sod system

1. Grasses are allowed to grow without cutting is not desirable because organic matter is lost.
2. Grasses are grown cut as required and removed for making hay not desirable because organic matter is lost here also.
3. Grasses are grown cut and left behind to decompose.
4. Grasses are grown and pastured i.e., animals are allowed to graze.
5. Temporary sod. Sod is allowed for two years or so, then soil is ploughed, cultivated and sod is reseeded.
6. Sod is not being followed in India due to lack of cool and moist weather.
7. Lack of aeration, rat holes in sod prove harmful and trees die.
8. Nutrient deficiency is also common especially of potassium.

3.3.2 Minimum tillage

In this method inter space is maintained without any traditional soil tillage like ploughing, disking, harrowing, etc. This is receiving widespread adaptation in uneven topography. Here sod, weeds, cover crops and other vegetation are killed by herbicides in springs which forms a layer of dead plant material on soil surface. This controls erosion, conserve moisture and release nutrients.

3.4 Mulching

Mulching is the practice of covering the soil around the plants to make conditions more favourable for growth and conserve the available soil moisture. In this management system the open soil is put under loose cover of straw, hay, crop residue, leaves, saw dust and plastic. It is essentially a surface barrier against evaporation and checks weed growth reducing competition for nutrients. This is one of the important soil management practices adopted in certain countries in orchards. It offers a number of advantages at the same time suffer from disadvantages too.

Advantages of mulching

1. Conserves moisture by suppressing weed growth, regulating soil temperature and protection from sun and wind.
2. Improves soil structure.
3. Reduces soil temperature fluctuations.
4. Increases soil organic matter level.
5. Controls erosion.

6. Improves water infiltration rate.
7. Improves nutrient availability through better soil condition micro flora.
8. Avoids competition for nutrient and moisture with main crop.
9. Controls weed growth.

Disadvantages of mulching

1. High cost.
2. Transportation.
3. Disease and pest infestation through dead plant material.
4. Fire hazards.
5. Roots grow shallow due to the effect through soil temperature and moisture. Therefore, in first year mulching may not be advisable.

Among all the mulching materials, plastic mulches are becoming popular especially black polythene mulch, where weed control is desired. Mulching is common in tropics especially in crops like banana, citrus, pineapple. Some of the recommendations made for different crops are being presented in the following table.

3.5 Rotation

Besides in young orchards when intercrops are taken up, some of the recommended rotations of intercrops are as under: Planting of different crops in a regular sequence on a given piece of land is referred as rotation. When this technique is used for soil management, it is necessary that sequence in the year or the rotation includes legume as one of the crops. Even in plantations of perennial fruit crops like papaya, banana, pineapple, after clearing of fields, these crops should be followed by leguminous green manure crop before planting them again.
Choice of the legumes can be decided on the basis of climatic region. Generally sesbania, crotolaria, cluster- bean and cowpea, are preferred as they add higher quantities of organic matter and nitrogen.

Advantages of crop rotation

1. Helps in controlling insect pests and diseases.
2. Helps in equalization of available nutrients.
3. Avoids bad effects of continuous mono-culture through elimination of build up of toxins, diseases and pests.

Some of the recommendations are:

1. Banana: Crotolaria or Sesbania or Cowpea.
2. **Papaya**: Crotolaria or Cowpea.

3. **Pineapple**: Sesbania or Glyricidia.

Legumes should be included in rotation and crops like papaya, banana, pineapple and vegetables should be preferred for higher returns.

SELF ASSESSMENT EXERCISE

i. Define and explain soil management and its concept.
ii. What are the objectives and components of soil management
iii. Explain soil cultivation practice and give its advantages and disadvantages.
iv. Discuss mulching as a soil management practice and explain its advantages.
v. Describe crop rotation as a soil management practice and state its advantages.

4.0 CONCLUSION

This unit informs you that soil management is the application of operations, practices, and treatments to protect soil and enhance its performance (such as soil fertility or soil mechanics) and it includes soil conservation, soil amendment, and optimal soil health. You were also told that the goal of soil management is to build up the fertility of the soil. The unit also stated that a soil is managed based on three inextricably interrelated components of soil management that includes: 1) physical (water-holding capacity, structure, etc.); 2) chemical (nutrient dynamics, pH); and 3) biological (soil biota).

You now know that agricultural soil has to be managed and protected through different management practices like intercropping, cover cropping, cultivation, sod culture, mulching, rotation, high density planting. The unit explained that cultivation in the context of soil management refers to working of the soil by ploughing, harrowing, disking or hoeing. It also stated that the practice is essential for removal of weeds, incorporation of manures and fertilizers, green manuring and to facilitate water and nutrient absorption through better aeration.

You were told that in sod culture system, the space between trees or grasses are allowed to grow without tillage or mulching and sometimes cover is mixed with grasses and mowed in to the soil to improve fertility then the surface is kept neat and tidy. The unit informs us that mulching is the practice of covering the soil around the plants to make conditions more favorable for growth and to conserve the available soil moisture. It further explained that in this management system the open soil is put under loose cover of straw, hay, crop residue, leaves, saw dust and plastic. You were made to understand that crop rotation is the planting of different

crops in a regular sequence on a given piece of land. The unit then stated that rotation helps in controlling insect pests and diseases, it equalization of available nutrients and avoids bad effects of continuous mono-culture through elimination of buildup of toxins, diseases and pests.

5.0 SUMMARY

Soil management is the application of operations, practices, and treatments to protect soil and enhance its performance (such as soil fertility or soil mechanics) and it includes soil conservation, soil amendment, and optimal soil health. The goal of soil management is to build up the fertility of the soil. The soil is managed based on three inextricably interrelated components of soil management that includes: 1) physical (water-holding capacity, structure, etc.); 2) chemical (nutrient dynamics, pH); and 3) biological (soil biota). Agricultural soil has to be managed and protected through different management practices like intercropping, cover cropping, cultivation, sod culture, mulching, rotation, high density planting.

Cultivation in the context of soil management refers to working of the soil by ploughing, harrowing, disking or hoeing. The practice is essential for removal of weeds, incorporation of manures and fertilizers, green manuring and to facilitate water and nutrient absorption through better aeration. On the other hand in sod culture system, the space between trees or grasses are allowed to grow without tillage or mulching and sometimes cover is mixed with grasses and mowed in to the soil to improve fertility then the surface is kept neat and tidy.

Mulching is the practice of covering the soil around the plants to make conditions more favorable for growth and to conserve the available soil moisture. In this management system the open soil is put under loose cover of straw, hay, crop residue, leaves, saw dust and plastic. Crop rotation is the planting of different crops in a regular sequence on a given piece of land. Rotation helps in controlling insect pests and diseases, it equalization of available nutrients and avoids bad effects of continuous mono-culture through elimination of build up of toxins, diseases and pests.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain soil management and describe its concept.
2. What are the objectives and components of soil management
3. Describe soil cultivation practice and give its advantages and disadvantages.
4. Explain mulching as a soil management practice and list its advantages.
5. Discuss crop rotation as a soil management practice and give its advantages.

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UNIT 3 WATER MANAGEMENT

CONTENTS

1.0 Introduction
2.0 Learning Objectives
3.0 Main Content
    3.1 The Concept of Water Management and Irrigation (dry season farming)
    3.2 Irrigation Systems and Surface Irrigation System
    3.3 Sub-surface, Over-head and Drip Irrigation Systems
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

Most vegetable plants comprise 90 percent water content and some such as lettuce have as much as 95 percent. However it is not the water content of the plant that is important, but the quantity of water that must pass through the plant during its life. The purpose of providing the plant with irrigation, when there is inadequate natural rainfall, is to ensure that the small apertures (stomata) on the leaves remain open. This enables the plant to continue to absorb carbon dioxide from the air, and thereby continue to photosynthesis and have new carbohydrates available to produce further growth.

The closure of the stomata is the first effect of plant water stress. This is followed by the plant wilting and finally damaging the plant through overheating. Crop loss occurs once the plant wilts. The rate at which plants transpire water through their stomata depends primarily on solar radiation, temperature, humidity and wind speed. The role of soil is that of a reservoir for water, and thus the amount of available water in the soil for the crop will depend on the soil type and the effective rooting depth of the crop. Deep rooting crops are able to tap a larger volume of soil for water than shallow rooting crops.

There is a maximum amount of water that the soil can hold, and this is called ‘field capacity’. As the soil dries so the water available to the crop is reduced until, at the ‘permanent wilting point’ (although there is still water in the soil), it is no longer available for plant roots to absorb. The difference between field capacity and wilting point is known as the ‘available soil moisture’, and varies with soil type. For reliable crop yields, irrigation is an important production tool. Even though some crops

are able to 'withstand' drought (e.g. sweet potato, sorghum), they will not produce heavy crops if they experience moisture stress.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- Understand the concept of water management and irrigation.
- Explain Irrigation Systems and discuss surface Irrigation System.
- Describe Sub-surface, Over-head and Drip Irrigation Systems.

3.0 MAIN CONTENT

3.1 The Concept of Water Management and Irrigation

3.1.1 Water Management

Water is one of the most important inputs essential for the production of crops. Plants need it continuously during their life and huge quantities. It profoundly influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients etc. Both its shortage and excess affects the growth and development of a plant directly and consequently its yield and quality. Soil needs the application of water to:

1. Remove stress condition.
2. Release nutrients in the soil solution for absorption by plants.
3. Leach or wash out injurious salts from the soil.
4. Preparation of land for raising crops.
5. To maintain the temperature and humidity of the soil and micro-climate and the activity of soil microbes at the optimum level.
6. For the normal aeration and functioning of roots and shoots of the plants.
7. Excess water needs removal.
8. Excess water creates unworkable soil condition.

3.1.2 Irrigation (dry season farming)

It is defined as the artificial application of water to the crop plants in the event of shortage of natural rains in order to obtain rapid growth and increased yields. It is essential item in the cultivation of crops. Success in gardening depends on how efficiently irrigation's are provided to gardens because it is governed by many factors such as frequency, duration, intensity, source and method of supply. The factors affecting the supply of irrigation water in the field are :

1. Topography and soil characteristics.
2. Kind of plant (root depth, water absorption capacity, growth habit, etc.).
3. Weather condition.

1. When to irrigate?

The time when a plant needs irrigation can only be judged by a keen observing eye. The plants need water when their new leaves begin to show a wilting appearance. A little before the trees show the sign of wilting. The shedding of broad leaves in orchard shows distress symptoms.

2. **How much to irrigate**?

1. If water supply is limited, only a light irrigation can be given at a time with higher frequency of irrigation.
2. If water is available in plenty, the irrigation may be heavy with longer intervals between successive irrigations.
3. However, inadequate irrigation reduces the growth and fruiting of the trees while, over irrigation serves no useful purpose and it may even prove to be harmful.
4. It may create water logging, the nutrients may get leached and fruits may become watery and develop poor quality.
5. Plants which have suffered from drought should not be given liberal doses of irrigations all at once. That may result in the splitting of fruits and even the splitting of bark of the branches and trunk.

3.2 Irrigation Systems and Surface irrigation System

3.2.1 Irrigation Systems

Different systems of irrigation are followed in different parts of the country. The best system is the one which meets the moisture seepage and evaporation. Principally, irrigation systems can be divided under three broad headings:

1. Surface Irrigation: *Flooding, Basin type, Furrow type, Ring type*
2. Sub-Surface Irrigation: Trench method, Through underground pipelines, Perforated pipelines.
3. **Overhead or Aerial Irrigation:** Sprinkler, Revolving Nozzles
4. **Drip or Trickle Irrigation:**

3.2.2 Surface irrigation

1. **Flooding**
   When the land is flat, letting in water from one end floods the entire area. This system is commonly practiced in canal or tank bed areas. It is the easiest method and permits the use of bullock drawn implements in the orchards. But in this there is wastage of water and leads to soil erosion also. It encourages growth of weeds and spread of diseases like gummosis in citrus and collar rot in papaya.

2. **Basin system**
   In this system, circular basins are provided around the trunk of the tree. The basins are inter-connected in series and are fed through the main channel running perpendicular to the tree rows. When compared to flooding, this system minimises the loss of water. In this system of irrigation, the water close to trunk may bring about certain diseases like gummosis and nutrients are likely to be carried over from one basin to the other.

3. **Furrow system**
   Furrow irrigation involves letting water, distributed by gravity, run down furrows that have been made between the crop grown on raised beds. It is the most common system worldwide. This method does not provide for a very efficient way of watering, unless land is accurately contoured and there is a consistent soil type. Unlike the flood system, here the entire land surface is not covered with irrigation water. The furrows are opened in the entire orchard at 4" or less apart, depending upon the age of the trees. Water is let in these furrows from the main channels.

   In orchards, two furrows on each side of the rows are generally made. It is suited to such lands , which have a moderate slope to the extent of 1-2% if the water is to run freely and reach the ends of the furrows. Where the slope is sharp, the furrows are made to follow the contour more or less closely. This method has disadvantage of excess of water penetration at the head than at the farther end, which may result in variation in vigour and growth of trees.

4. **Ring system**
   This is an improvement over the basin system. In this system, a ring is formed close and around the tree and water is let into the basin. This method is recommended for citrus trees thereby reducing the chances of collar rot to which these trees are often susceptible. The size of the ring will increase as the tree grows .In this system, the spread of diseases like collar rot, etc., are

prevented. However, it involves more labour and capital and it does not permit uniform distribution of water throughout the bed or basin as in the basin system of irrigation.

3.3 Sub-surface, Over-head, Sprinkler and Drip irrigation Systems

3.3.1 Sub-Surface Irrigation

This system consists of conducting water in number of furrows or ditches underground in perforated pipelines until sufficient water is taken into the soil so as to retained the water table near the root zone. In limited situation, this may be a very desirable system of irrigation. In general, however, it must be used with great caution because of the danger of water logging and salt accumulation.

If the sub-strata are so slowly permeable that practically no water moves through, water added may stand in soil sufficiently for long time resulting an injury to the plant root due to poor aeration. Where irrigation water or the sub-soil contains appreciable amount of salt, sub-soil irrigation is usually not advisable. Land must be carefully leveled for successful subsoil irrigation so that raising the water table will wet all parts of the field equally.

3.3.2 Over-Head or Aerial Irrigation

In this system, water is applied in the form of spring, somewhat resembling rainfall. This is accomplished by pumping water from original source into the main supply line from where it is distributed to perforated pipes, which operate at low pressure (80 to 120 lb per square inch) and supply the water in a fairly uniform rectangular pattern.

They have a high rate of application, usually 1”/hour or higher. Because of the high application rates, their use is restricted to soils with high infiltration rates, such as sandy or gravelly. Revolving nozzle is also at times used, which operated on either low or high pressure. Usually the rate of application followed in the rate of 0.2” to 0.3” per hour.

3.3.3 Sprinkler irrigation

Overhead sprinkler irrigation not only requires investment in pumps and sprinklers, but also can pose major problems in obtaining an even application of water. Uneven water application can result in certain parts of the field receiving insufficient water to return the soil to ‘field capacity’. Alternatively, applying too much water to certain parts of the

field is a waste of water and can also cause leaching (draining) of valuable soil nutrients.

May have definite economic advantages in developing new land that has never been irrigated, particularly where the land is rough or the soil is too much porous, shallow or highly erodable. It is quite useful where only small streams are available, such as irrigation wells of small capacity. It is helpful in irrigating at the seedling stage when the furrowing is difficult and flooding leads to crusting of soil. Fertilizer materials may be evenly applied by this method.

This is usually done by drawing liquid fertilizer solutions slowly into the pipe. It has several disadvantages like high initial cost, difficult to work in windy location, trouble from clogging of nozzle, interference in pollination process and requirement of more labours while removing or resetting. In general, this system is best adopted for areas where ordinary surface systems are inefficient. Sprinkler systems also wet the foliage and this can stimulate disease problems.

3.3.4 Drip or trickle irrigation system

Drip irrigation is potentially the most valuable of the current water delivery systems. It requires very low water pressure (so it is possible to use small pumps), and can be laid on the soil surface, or in some cases actually buried beneath the soil surface. It can also be used as a means of providing the crop with fertilizer (fertigation); incorporating soluble fertilizers into the water by using a diluter.

This is the most recent system of irrigating the plants. It is usually practise for high value crops, especially in green houses and glass houses. There will be an installation of pipelines with nozzles very close to the soil. The nozzle is fitted in such a way that water is dripped almost in the root-zone of the plants.

Water is allowed to move in pipes under very low or no pressure and it drop at regular interval. This system of irrigation has advantages like no disturbance of the soil; soil moisture is maintained, lesser leaching of nutrients from the soil. The disadvantage is that it is relatively expensive, and since the drippers are small and the water pressure is low, it is essential that the water be filtered. On rolling countryside, care must be taken to ensure that special (pressure egulating) nozzles are used to ensure even application of water both on the ridges and also in the dips.

SELF ASSESSMENT EXERCISE

i. Explain the concept of water management and state the benefit of irrigation.
ii. Discuss the different irrigation systems and describe surface irrigation system.
iii. Describe Sub-surface, Over-head and Drip Irrigation Systems and their benefits.

4.0 CONCLUSION

This unit taught you that water is one of the most important inputs essential for the production of crops and plants need it continuously during their life and in huge quantities. You learnt that water profoundly influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients. You also know that both shortage and excess water affects the growth and development of a plant directly and consequently its yield and quality.

This unit defines irrigation as the artificial application of water to the crop plants in the event of shortage of natural rains in order to obtain rapid growth and increased yields. You also learnt that the purpose of providing the plant with irrigation, when there is inadequate natural rainfall, is to ensure that the small apertures (stomata) on the leaves remain open. Unit explains that irrigation enables the plant to continue to absorb carbon dioxide from the air, and thereby continue to photosynthesis and have new carbohydrates available to produce further growth.

This unit stated that different systems of irrigation are used in different parts of the world. It further explained that the best irrigation system is the one which meets the moisture seepage and evaporation requirements of the soil. You were also informed that in principle, irrigation systems are divided into four broad categories: 1) Surface Irrigation consisting of *flooding, basin furrow and ring types; 2)* Sub-Surface Irrigation made up of trench method, through underground pipelines and perforated pipelines; 3) O**verhead or Aerial Irrigation subdivided into, s**prinkler, revolving Nozzles; and 4) **Drip or Trickle Irrigation.**

5.0 SUMMARY

Water is one of the most important inputs essential for the production of crops and plants need it continuously during their life and in huge quantities. Water profoundly influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients. Both shortage and excess water affects the growth and development of a plant directly and consequently its yield and quality. Irrigation is defined as the

artificial application of water to the crop plants in the event of shortage of natural rains in order to obtain rapid growth and increased yields. The purpose of providing the plant with irrigation, when there is inadequate natural rainfall, is to ensure that the small apertures (stomata) on the leaves remain open.

Irrigation enables the plant to continue to absorb carbon dioxide from the air, and thereby continue to photosynthesis and have new carbohydrates available to produce further growth. Different systems of irrigation are used in different parts of the world. It further explained that the best irrigation system is the one which meets the moisture seepage and evaporation requirements of the soil. Principally, irrigation systems are divided into four broad categories: 1) Surface Irrigation consisting of *flooding, basin furrow and ring types; 2)* Sub-Surface Irrigation made up of trench method, through underground pipelines and perforated pipelines; 3) O**verhead or Aerial Irrigation subdivided into, s**prinkler, revolving Nozzles; and 4) **Drip or Trickle Irrigation.**

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the concept of water management and state the benefit of irrigation.
2. Describe the different irrigation systems and discuss surface irrigation system.
3. Explain Sub-surface, Over-head and Drip Irrigation Systems and state their benefits.

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UNIT 4 PEST AND DISEASE MANAGEMENT

CONTENTS

1.0 Introduction
2.0 Learning Objectives
3.0 Main Content
    3.1 Pest and Disease Control
    3.2 Pest Management
    3.3 Botanical Pesticides Used in Organic Farming
    3.4 Some Other Pest Control Formulations
    3.5 Advantage of natural pest and disease control over chemical control
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

The range of pests and diseases that can (and do) damage vegetables is immense, but specific ones that have a major influence on productivity in any particular region are usually limited. Pests and diseases may be soil borne or air borne and can be crop specific or generic, so the range of potential control measures is huge. Nevertheless there are a number of basic principles which can be applied to reduce their impact on yield and quality.

The first is crop hygiene or the sound agronomic practice of not growing the same crop on the same site year after year. Crop rotation reduces the risk of the buildup of soil borne pathogens. A second factor is to use only 'pathogen free' planting material. The objective of this is to use only healthy planting material. The use of resistant varieties is an efficient method of reducing pathogen impact on the crop, where suitable varieties are available.

The next is biological control which is the reduction of pest populations via natural enemies or natural elements. Although biological control method is knowledge based, specific to local environmental conditions and labor intensive it provide a sound economic return. Pesticides are the most common pests and diseases control methods in vegetables crops in spite of their harmful such as safety and the development of resistance to the pesticide.

In recent years the development of Integrated Pest Management (IPM) systems has reduced the need for regular pesticide application. IPM uses

common-sense practices and comprehensive information on the life-cycles of pests and their interaction with the environment. Such knowledge is used to manage possible pest damage considering least possible hazards to the environment and people, and by the most economical means. IPM is a series of pest management, evaluation, decisions and controls.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- Understand the need and purpose of pest and disease control.
- Explain the concept and method of pest management.
- Know the botanical pesticides used in organic farming.
- Discuss the availability and function of other pest control formulations
- Describe the advantage of natural pest and disease control over chemical control

3.0 MAIN CONTENT

3.1 Pest and Disease Control

Pests and diseases are part of nature. In the ideal system there is a natural balance between predators and pests. If the system is imbalanced then one population can become dominant because it is not being preyed upon by another. The aim of natural control is to restore a natural balance between pest and predator and to keep pests and diseases down to an acceptable level. The aim is not to eradicate them altogether. Nevertheless there are a number of basic principles which can be applied to reduce their impact on yield and quality. These includes the following:

3.1.1 Natural pest and disease control

There are many ways in which the organic farmer can control pests and diseases that includes:

1. Growing healthy crops that suffer less damage from pests and diseases.
2. Choosing crops with a natural resistance to specific pests and diseases. Local varieties are better at resisting local pest and diseases than introduced varieties.
3. Timely planting of crops to avoid the period when a pest does most damage.

4. Companion planting with other crops that pests will avoid, such as onion or garlic.
5. Trapping or picking pests from the crop.
6. Identifying pest and diseases correctly. This will prevent the farmer from wasting time or accidentally eliminating beneficial insects. It is therefore useful to know life cycles, breeding habits, preferred host plants and predators of pests.
7. Using crop rotations to help break pest cycles and prevent a carry over of pests to the next season.
8. Providing natural habitats to encourage natural predators that control pests. To do this, the farmer should learn to recognize insects and other animals that eat and control pests.

Through careful planning and using all the other techniques available it should be possible to avoid the need for any crop spraying. If pests are still a problem natural products can be used to manage pests, including sprays made from chillies, onions, garlic or neem.

3.2 Pest Management

As in organic farming management use of synthetic chemicals are prohibited, the pest management is done by: (i) cultural or agronomic (ii) mechanical (iii) biological or by (iv) organically acceptable botanical extract or some chemicals such as copper sulphate and soft soap etc.

1. Cultural alternative or crop hygiene

Crop hygiene is sound agronomic practice not to grow the same crop on the same site year after year. In fact it is highly desirable not to grow crops of the same family on the same site more frequently than one year in three. Crop rotation reduces the risk of the build up of soil borne pathogens. Good examples of this would be the control of club root in cabbages, or the control of nematodes in carrots.

Furthermore, the use of disease free seed or stock and resistant varieties are best preventive practice in organic pest management. Maintenance of biodiversity, effective crop rotation, multiple cropping, habitat manipulation and use of trap crops are also effective practices which can keep the population of pests below economical threshold limit (ETL).

2. **Mechanical alternative**

Removal of affected plants and plant parts, collection & destruction of egg masses and larvae, installation of bird perches, light traps, sticky colored plates and pheromone traps are most effective mechanical methods of pest control.

3. **Biological alternative**

Biological control is typically the reduction of pest populations via natural enemies or natural elements and it involves considerable labour activity. Simple examples of biological control are conservation of natural enemies, for example lady beetles and lacewings , further the use of such plants as sage, deters the cabbage moth and carrot fly. Biological control methods, even though heavily knowledge based on specific local environmental conditions and labour intensive, do provide sound economic returns; estimates of the cost-benefit ratio have been in the range of 1:11 i.e. for every US$1 invested in biological control, it brings benefits for US$11.

In addition, use of pest predators and pathogens has also proved to be effective method of keeping pest problem below ETL. Inundative release of *Trichogramma sp*. @ 40,000 to 50,000 eggs per hectare, *Chelonus blackburni* @15,000 to 20, 000 per hectare, *Apanteles* sp.@15,000 to 20,000 per ha and *Chrysoperla sp*.@ 5,000 per ha., after 15 days of sowing & others parasites & predators after 30 days of sowing, can also effectively control pest problem in organic farming .

4. **Use of Biopesticides**

Trichoderma viride or *T. harazianum* or *Pseudomonas fluorescence* formulation @ 4gm/kg seed either alone or in combination, manage most of the seed borne & soil borne diseases. There are other formulations viz. *Beauvaria bassiana*, *Metarizium anisopliae*, *Numeria rileyi*, *Verticillium* sp, which are available in the market and can manage their specific host pest. *Bacillus thurengensis stenebrionis and B.thurengensis sandigo* are effective against coleopterans as well as some other insect species. Bt. has been used in the management of diamond back moth on crucifers and vegetables @ 0.5-1.0 kg. formulation per ha.

Viral biopesticides of baculovirus group viz. granulosis viruses (GV) and nuclear polyhedrosis viruses provided a great scope in plant protection field. Spray of nuclear polyhedrosis viruses (NPV) of *Helicoverpa armigera* (H) or *Spodoptera litura* (S) @ 250 larval equivalents are very effective tools to manage the *Helicoverpa* sp. or *Spodoptera* sp. respectively.

3.3 Botanical Pesticides Used in Organic Farming

Many plants are known to have pesticidal properties and the extract of such plants or its refined forms can be used in the management of pests.

Among various plants identified for the purpose, neem has been found to be most effective.

1. **Nicotine**
   Nicotine is obtained from tobacco or related Nicotiana species and is one of the oldest botanical insecticides in use today. It is also one of the most toxic to warm-blooded animals, and it is readily absorbed through the skin.

2. **Sabadilla**
   Sabadilla is another botanical insecticide. It is extracted from the seeds of the sabadilla lilly. The veratrine alkaloid is the active ingredient. Sabadilla is a botanical insecticide with low toxicity. However, its dust can be extremely irritating to the eyes and can produce sneezing if inhaled.

3. **Neem**
   Neem is a botanical pesticide that comes from the neem tree, which is native of India. This tree supplies at least two compounds, salannin and azadirachtin, that have insecticidal activity and other unknown compounds with fungicidal activity. Neem pesticide controls gypsy moths, western flower thrips, sweet potato white flies, leaf miners, loopers, caterpillars, and mealybugs.

3.4 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:

1. **Cow urine**
   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.

2. **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.

3. **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) leaves 2 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.

4. **Neem-Cow urine extrac**t
   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.

5. 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.

6. 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 squeeze 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

7. Broad spectrum formulation
   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.

3.5 Advantage of Natural Pest and Disease Control Over Chemical Control

Pesticides do not solve the pest problem. In the past 50 years, insecticide use has increased tenfold, while crop losses from pest damage have doubled. Here are three important reasons why natural control is preferable to pesticide use.

1. **Safety for people**

Artificial pesticides can quickly find their way into food chains and water courses. This can create health hazards for humans. Human health can also be harmed by people eating foods (especially fruit and vegetables) which still contain residues of pesticides that were sprayed on the crop. There is also much concern for those people using chemical pesticides. The products may be misused because the instructions are not written in the language spoken by the person using them.

This has led to many accidents such as reports of people suffering from severe skin rashes and headaches as a result of using chemical pesticides. There are an estimated one million cases of poisoning by pesticides each year around the world. Up to 20,000 of these result in death. Most of the deaths occur in tropical countries where chemical pesticides which are banned in Europe or the USA are still available.

2. Cost

Using natural pest and disease control is often cheaper than applying chemical pesticides because natural methods do not involve buying materials from the outside. Products and materials which are already in the home and around the farm are most often used.

3. **Safety for the environment**

There are a number of harmful effects that chemical pesticides can have on the environment that includes:

a. Chemical pesticides can kill useful insects which eat pests. Just one spray can upset the balance between pests and the useful predators which eat them.
b. Artificial chemicals can stay in the environment and in the bodies of animals causing problems for many years.
c. Insect pests can very quickly, over a few breeding cycles, become resistant to artificial products and are no longer controlled. This means that increased amounts or stronger

chemicals are then needed creating further economic, health and environmental problems.

SELF ASSESSMENT EXERCISE

i. Explain the need and purpose of pest and disease control.
ii. Discuss the concept and method of pest management.
iii. What are the botanical pesticides used in organic farming.
iv. Describe the availability and function of other pest control formulations
v. Discuss the Advantage of natural pest and disease control over chemical control

4.0 CONCLUSION

This unit explains that pests and diseases are part of nature and there is a natural balance between predators and pests. The unit also states that the aim of natural pest and disease control is to restore a natural balance between pest and predator and to keep pests and diseases down to an acceptable level but not to eradicate them altogether. You learnt that In organic farming, pest management is done by methods that include: cultural or agronomic; mechanical; biological or by organically acceptable botanical extract or some chemicals such as copper sulphate and soft soap.

This unit explains that many plants are known to have pesticidal properties and the extract of such plants or its refined forms can be used in the management of pests. The unit further informs us that among the various plants identified for the purpose are: neem, nicotine, and sabadilla. While other pest control formulations are: cow urine, fermented curd water, dashparni extract, neem-cow urine extract, mixed leaves extract, chilli-garlic extract and broad spectrum formulation. The unit taught us that the advantage of natural pest and disease control over chemical control are: safety for people, cheaper cost and safety for the environment.

5.0 SUMMARY

Pests and diseases are part of nature and there is a natural balance between predators and pests. The aim of natural pest and disease control is to restore a natural balance between pest and predator and to keep pests and diseases down to an acceptable level but not to eradicate them altogether. In organic farming, pest management is done by methods that include: cultural or agronomic; mechanical; biological or by organically acceptable botanical extract or some chemicals such as copper sulphate and soft soap.

Many plants are known to have pesticidal properties and the extract of such plants or its refined forms can be used in the management of pests. Among various plants identified for the purpose are: neem, nicotine, and sabadilla. Other pest control formulations are: cow urine, fermented curd water, dashparni extract, neem-cow urine extract, mixed leaves extract, chilli-garlic extract and broad spectrum formulation. The advantage of natural pest and disease control over chemical control are: safety for people, cheaper cost and safety for the environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the need and purpose of pest and disease control.
2. Explain the concept and method of pest management.
3. Discuss are the botanical pesticides used in organic farming.
4. Explain the availability and function of other pest control formulations
5. Describe the Advantage of natural pest and disease control over chemical control

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MODULE 4 ORGANIC AND URBAN FARMING PRACTICES

Unit 1 Environmental and Heath Impact of Organic Farming
Unit 2 Green House Protected Cultivation System
Unit 3 Other Issues in Urban Farming System
Unit 4 Certification of Organic Horticultural Products

UNIT 1 HEALTH AND ENVIRONMENTAL IMPACT OF ORGANIC FARMING

CONTENTS

1.0 Introduction
2.0 Learning Objectives
3.0 Main Content
  3.1 Health Benefits of Organic Farm Produce
  3.2 Benefit of Organic Agriculture and its Positive Effect on Environment
  3.3 The Differences Between Organic and Conventional Farming Methods
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Reading

1.0 INTRODUCTION

As stated previously, organic farming system depends on crop rotation, green manures, legumes, animal manures, crop residues, off-farming natural squanders, and aspect of biological pest control to preserve soil fertility and productivity, to sustain the crops and thereby curbing pests, diseases, and unwanted weeds. In other words, it is a production system which maintains the quality of soil ecosystem as well as human beings.
The introduction of chemicals in conventional farming was associated with many delirious effects. At the start crop yields exploded, the soil was healthy. pests had not developed resistance to chemicals and the damage brought about by chemical fertilizers was hardly noticeable. The technology spread across the world as it was considered the revolution in agriculture.

Flash forward to today and many people are marveling at organic farming again. This is after learning that conventional farming methods was accompanied with a host of problems including health-related diseases like cancer, pollution, degradation of soil and water, and impact on

domestic animals. Thus organic agriculture provides a viable alternative to the challenges and problems associated with conventional agriculture.

Organic agriculture has the following benefits: it prevents environmental degradation; organic crops are nutritionally healthier; organic manure creates an optimal soil conditions for high yields and quality; pollution is reduced by converting domestic and farm wastes in to fertilizer; provides a better living conditions for humans. In addition, Organic foods are highly authenticated through quality checks and rigorous investigation that enables their certification and organic food labeling.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- List and explain the health benefits of organic farm produce.
- Understand and describe the benefits of organic agriculture.
- Know and enumerate the environmental benefits of organic farming.
- State the differences between organic and conventional farming methods.
- Highlight **t**he unsustainability of conventional farming practice.

3.0 MAIN CONTENT

3.1 Health Benefits of Organic Farm Produce

Organic farm produce have significant health benefit as they are reported to: enhance soil, plant, animal and human nutrition; be free of poisons helping humans stay healthy; have enhanced taste, lower prices and longer shelf life; be eco-friendly and protective of the environment; and be highly authenticated through quality checks and rigorous investigation. The health benefits of organic farm produce includes:

1. **Better nutrition**
   As compared to a longer time conventionally grown food, organic food is much richer in nutrients. The nutritional value of a food item is determined by its mineral and vitamin content. Organic farming enhances the nutrients of the soil which is passed on to the plants and animals.

2. **Helps us stay healthy**
   Organic foods do not contain any chemicals. This is because organic farmers don't use chemicals at any stage of the food-growing process like their commercial counterparts. Organic farmers use natural farming techniques that don't harm humans

and the environment. These foods keep dangerous diseases like cancer and diabetes at bay.

3. Free of poison

Organic farming does not make use of poisonous chemicals, pesticides and weedicides. Studies reveal that a large section of the population fed on toxic substances used in conventional agriculture have fallen prey to diseases like cancer. As organic farming avoids these toxins, it reduces the sickness and diseases due to them.

4. **Lower prices**

There is a big misconception that organic foods are relatively expensive. The truth is they are actually cheaper because they don't require the application of expensive pesticides, insecticides, and weedicides. In fact, you can get organic foods direct from the source at really reasonable prices.

5. Enhanced taste

The quality of food is also determined by its taste. Organic food often tastes better than other food. The sugar content in organically grown fruits and vegetables provides them with extra taste. The quality of fruits and vegetables can be measured using Brix analysis.

6. Longer shelf–life

Organic plants have greater metabolic and structural integrity in their cellular structure than conventional crops. This enables the storage of organic food for a longer time. Organic farming is preferred as it battles pests and weeds in a non-toxic manner, involves fewer input costs for cultivation and preserves the ecological balance while promoting biological diversity and protection of the environment.

7. Organic farming methods are eco-friendly

In commercial farms, the chemicals applied to infiltrate into the soil and severely contaminate it and nearby water sources. Plant life, animals, and humans are all impacted by this phenomenon. Organic farming does not utilize these harsh chemicals so; the environment remains protected.

8. Organic foods are highly authenticated

For any product to qualify as organic food, it must undergo quality checks and the creation process rigorously investigated. The same rule applies to international markets. This is a great victory for consumers because they are getting real organic foods. These

quality checks and investigations weed out quacks who want to benefit from the organic food label by delivering commercially produced foods instead.

3.2 Benefit of Organic Agriculture and its Positive Effect on Environment

3.2 1 Benefits of organic agriculture

Organic farming empowers and improves agro-ecosystem wellbeing, counting biodiversity, natural cycles, and soil biological activity. Organic farming is still only a small industry, which represents only 2% of global food sales. However, it is growing in importance in the world. It is hard to get information due to lack of official statistics and the level of confidentiality of systems of organic produce. Never the less organic agriculture has the following benefits:

1. Organic agriculture helps to prevent environmental degradation and avoid a chain reaction in the environment from chemical sprays and dusts
2. Organically grown crops are believed to be healthier and nutritional as food for man and animals
3. Organic fertilizer is considered as complete plant food. Organic matter restores the pH of the soil, which may become acidic due to the continuous application of chemical fertilizer.
4. Organic manure is the principal component of organic farming to produce optimal conditions in the soil for high yields and good quality.
5. Most of the organic manures are wastes or by products, which on accumulation may contribute to contamination. In this method of organic farming pollution is reduced.
6. Organic farming is labor intensive in the nation which will also help in generating more employment in rural areas that will help in reducing economic inputs.
7. As a whole, adoption of organic farming provides a better and balanced environment and better products and living conditions to the human beings.

3.2.2 Environmental benefits of organic farming

Central to organic farming practices are, soil management activities such as crop rotations, organic fertilizers, symbiotic associations, cover crops, inter-cropping, and minimum tillage. These soil management practices increase the retentive abilities of the soil for nutrients and water. They enhance the cycling of nutrients and energy and ensure the static arrangements of soil through soil fauna and vegetation. Organic farming

has a significant positive impact on the ecosystem and the environment as follows:

1. Reduced pollution

Organic farming has environmental benefits that reduce pollution.

1. The environmental benefits attributable to reduced chemical inputs,
2. less soil erosion,
3. water conservation, and
4. improved soil organic matter and biodiversity were consistently greater in the organic systems than in the conventional systems.
5. Organic farming focuses on enriching the soil with natural additives.
6. Because of the healthier soil, organic farming reduces runoff and therefore creates a lower risk of polluting waterways.
7. The absence of harmful pesticide and fertilizer sprays result in a cleaner atmosphere.

2. Lower energy

Another environmental benefit of organic farming is the reduction of energy use.

1. Some popular crops such as corn require nitrogen rich soil which is a high energy use product if farmed in conventional ways.
2. Conventional farming achieves this by heavily spraying with nitrogen rich fertilizers.
3. Energy calculations begin with the manufacture and transportation of these products.
4. In addition, the use of equipment for repeated applications of the less effective fertilizer result in an overall higher energy need than that of organic farming.
5. Organic farming achieves the nitrogen rich soil, instead, by using composted manure and the use of cover crops.

3.3 The Unsustainability of Conventional Farming Practice and the Differences Between Organic and Conventional Farming Method.

3.3.2 The Unsustainability of Conventional Farming Practice

1. Loss of soil fertility due to excessive use of chemical fertilizers and lack of crop rotation.
2. Nitrate runoff during rains contaminates water resources.

3. Soil erosion due to deep ploughing and heavy rains.
4. More requirements of fuel for cultivation.
5. Use of poisonous bio-cide sprays to curb pest and weeds.
6. Cruelty to animals in their housing, feeding, breeding and slaughtering.
7. Loss of biodiversity due to monoculture.
8. Native animals and plants lose space to exotic species and hybrids.

3.3.1 Differences Between Organic and Conventional Farming Methods and

The differences between organic and conventional farming methods is presented in Figure 11 and Table 2 below.

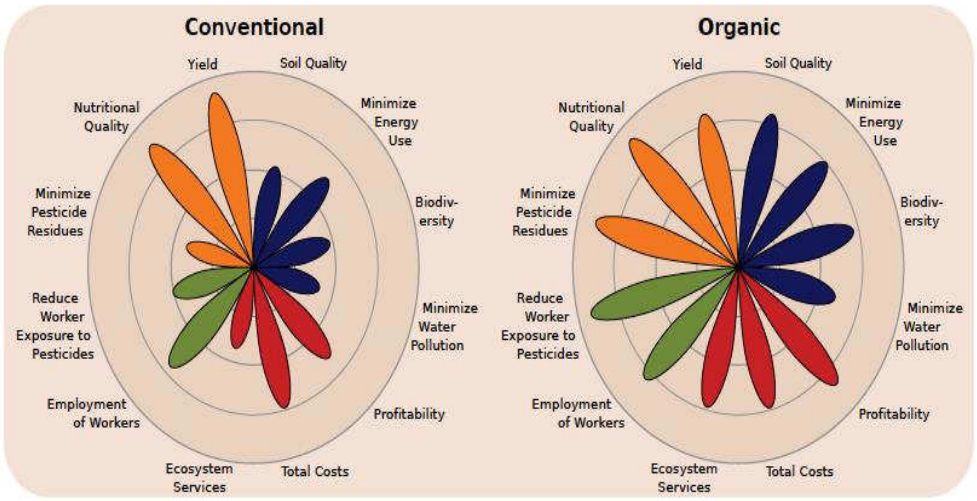

Figure 11: A comparison between organic farming practice and conventional farming method

Table 2: The differences between organic and conventional farming Methods

Conventional Farming Methods	Organic farming methods
As pre-plant operation, seeds are fumigated with hash chemicals to exterminate naturally occurring fungicides	Before seeds are sown, seeds are not reated dressed with chemicals

After land preparation the soil is fertilized with petroleum-based fertilizers	The land is prepared and enrich before sowing by sprinkling natural-based fertilizers such as manure, bone meal or shellfish fertilizer.
Before planting seeds, the organic farmer will soak the seeds in fungicides and pesticides to keep insects and pests at bay. Chemical are also incorporated in the irrigation water to prevent insects from stealing the planted seeds.	On the other hand, the organic farmer will not soak his seeds in any chemical solution nor irrigate the newly planted seeds using water with added chemicals. In fact, he will not even irrigate with council water, which is normally chlorinated to kill any bacteria. He will depend on natural rain or harvest and stored rainwater to use during dry months.
When the seeds have sprung up, and it's time to get rid of weeds, the conventional farmer will use weedicide to exterminate weeds.	The organic farmer will not use such chemicals to get rid of the weed problem. Instead, he will physically weed out the farm, although it's very labor-intensive. Better still, the organic farmer can use a flame weeder to exterminate weeds or use animals to eat away the weeds.
When it comes to consumption, it's a no-brainer that anyone consuming products from the conventional farmer will absorb the pesticide and weedicide residues into the body, which could lead to developing dangerous diseases like cancer. People understand that health is important to them and that's why they are going organic in record numbers today.	
Conventional farming systems use mono-cropping that destroys soil fertility.	Multiple cropping practiced in organic farming boosts biodiversity which enhances productivity and resilience and contributes to a healthy farming system.

SELF ASSESSMENT EXERCISE

- Enumerate and discuss the health benefits of organic farm produce.
- Explain the benefits of organic agriculture.
- Discus the environmental benefits of organic farming.
- Differentiate between organic and conventional farming methods.
- Describe the unsustainability of conventional farming practice.

4.0 CONCLUSION

This unit informs us that organic farmers use natural farming techniques that don't harm humans and the environment. It reported that organic farming improves agro-ecosystem, people's wellbeing, biodiversity, natural cycles, and soil biological activity. The unit also explains that organic farming is preferred to conventional farming as it battles pests and weeds in a non-toxic manner, involves fewer input costs for cultivation and preserves the ecological balance while promoting biological diversity and protection of the environment.

You learnt from the unit that organic farming methods are eco-friendly and protective of the environment due to the absence of hash chemicals that contaminates the soil and water sources. The unit states that by applying natural farming techniques that don't harm humans, organic farming helps us stay healthy and free from dangerous diseases like cancer and diabetes. The unit explains that, organic agriculture has the following benefits**:** it prevents environmental degradation; organic crops are nutritionally healthier; organic manure creates an optimal soil conditions for high yields and quality; pollution is reduced by converting domestic and farm wastes in to fertilizer; and it provides a better living conditions for humans.

You were informed that organic produce are free of poison due to the absence of toxic substances the consumption of which results in sickness and diseases. The unit also reported that organic plants have longer shelf–life due to a greater metabolic and structural integrity in their cellular structure compared to conventional crops. The unit taught us that organic farm produce have significant health benefit as they are reported to**:** enhance soil, plant, animal and human nutrition; be free of poisons helping humans stay healthy; have enhanced text, have lower prices and longer shelf life; be eco-friendly and protective of the environment; and be highly authenticated through quality checks and rigorous investigation.,

5.0 SUMMARY

Organic farmers use natural farming techniques that don't harm humans and the environment. Organic farming improves agro-ecosystem, people's wellbeing, biodiversity, natural cycles, and soil biological activity. Organic farming is preferred to conventional farming as it battles pests and weeds in a non-toxic manner, involves fewer input costs for cultivation and preserves the ecological balance while promoting biological diversity and protection of the environment.

Organic farming methods are eco-friendly and protective of the environment due to the absence of hash chemicals that contaminates the soil and water sources. Therefore by applying natural farming techniques that don't harm humans, organic farming helps us stay healthy and free from dangerous diseases like cancer and diabetes. Generally, organic agriculture has the following benefits**:** it prevents environmental degradation; organic crops are nutritionally healthier; organic manure creates an optimal soil conditions for high yields and quality; pollution is reduced by converting domestic and farm wastes in to fertilizer; and it provides a better living conditions for humans.

Organic produce are free of poison due to the absence of toxic substances the consumption of which results in sickness and diseases. Organic plants have longer shelf–life due to a greater metabolic and structural integrity in their cellular structure compared to conventional crops. Organic farm produce have significant health benefit as they are reported to**:** enhance soil, plant, animal and human nutrition; be free of poisons helping humans stay healthy; have enhanced text, have lower prices and longer shelf life; be eco-friendly and protective of the environment; and be highly authenticated through quality checks and rigorous investigation.,

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the health benefits of organic farm produce.
2. State the benefits of organic agriculture.
3. Explain the environmental benefits of organic farming.
4. Highlight the differences between organic and conventional farming methods.
5. Discuss the unsustainability of conventional farming practice.

7.0 REFERENCES/FURTHER READING

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UNIT 2 GREEN HOUSE PROTECTED CULTIVATION SYSTEM

CONTENTS

1.0 Introduction
2.0 Learning Objectives
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1.0 INTRODUCTION

The open field production of vegetable encounter a variety of production constrains like heavy rain, thunderstorms, excessive solar radiation, temperatures and humidity levels above plant growth optima, high insect pest infestation pressure and fungal diseases. To mitigate these production challenges various types of protective cultivation practices have been adopted based upon the prevailing climatic condition. Among them, greenhouse/polyhouse is extremely useful for Round-the-year vegetable cultivation in temperate condition. Greenhouse protected cultivation of crops is based upon the principle called as greenhouse effects.

A greenhouse is a structure made with the transparent covering material (polythene, glass), that, transmit the solar energy inside the structure. This energy absorbed by the vegetable crops and the objects inside the house releasing light of long wave length, finally this light does not emit out as the cladding material is non-transparent for these light. Finally the light gets trapped inside increasing the inside temperature. This rise in temperature in greenhouse is responsible for growing of vegetable in cold climate. However during summer increase in temperature can be managed by ventilation and cooling system, as in this period temperature rose beyond the critical temperature.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- Know what is a greenhouse and its importance.
- List the different types of greenhouse and describe the attributes of a greenhouse.
- Know the advantages and disadvantages of a green house.
- Understand the different environmental variables in side Green Houses.

3.0 MAIN CONTENT

3.1 Definition, Types and Attributes of Green House

3.1.1 Definition and types of green houses

A greenhouse is a framed or an inflated structure covered with a transparent or a translucent material in which crops could be grown under the conditions of at least partially controlled environment and which is large enough to permit persons to work within it to carry out cultural operations. It is a technique of providing favorable environmental or growth conditions to the plants.

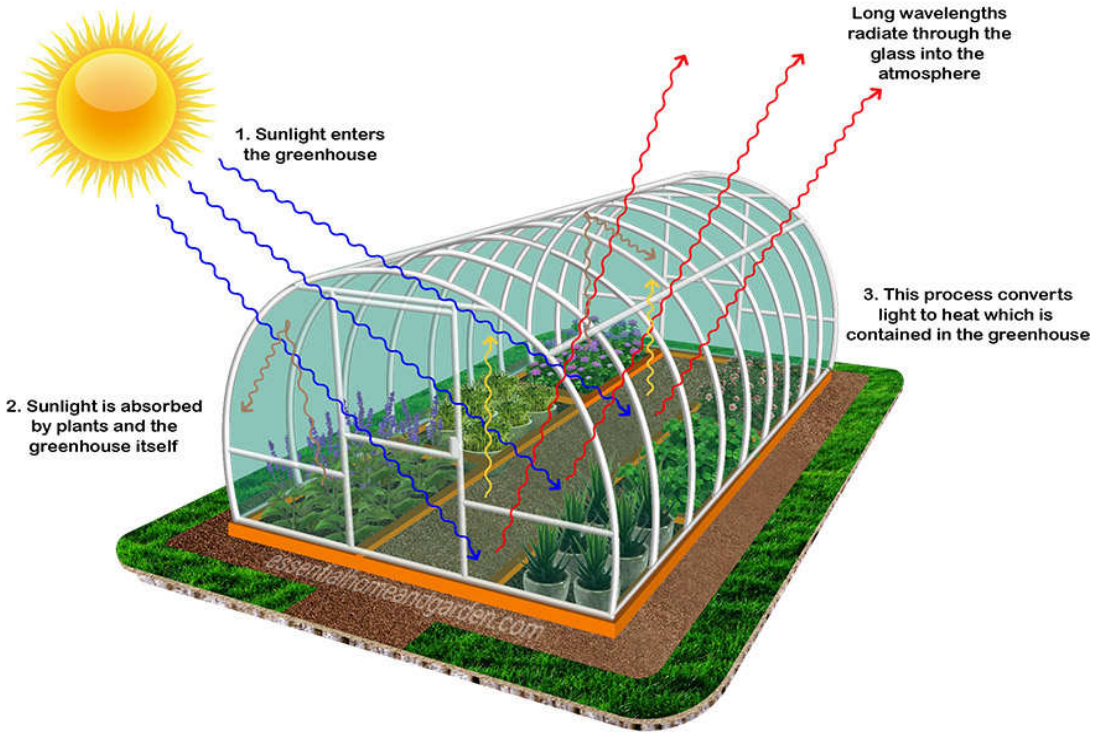

Figure 12: Mordarn Green House

There are three major types of greenhouses:

1. **Forced ventilated greenhouse**

   Green houses are climate controlled with cooling and heating system and mainly used for growing exotic varieties of vegetables, off-season growing of vegetables, floriculture, planting material acclimatization and plant breeding and varietals improvement under adverse agro climatic conditions.

   In greenhouses, the growing environment is altered to suit the specific requirements of the plants. Of all the structures greenhouse is the basic and important structure for harnessing the full potential of this technology. Greenhouse technology is the most effective way to achieve the goal of protected cultivation since it provides favorable and controlled environment for the crop to grow and give high productivity round the year. The degree of sophistication of greenhouses include fully automated systems with poly carbonate sheet roofing (double walled), heating and cooling system and full scale computerized with combination of various other components.

Figure 13: Ventilated green house

2. **Naturally ventilated greenhouse**

Naturally Ventilated Greenhouse is cost effective version of Greenhouse. They have vents at Top and at Sides. By which they exchanges air arising from the density difference of hot and cold air. Air exchange rates are very low and much dependent on the temperature difference between internal and ambient air. These greenhouses mainly rely on the wind pressure generated from one side and released from another side.

Figure 14: Naturally ventilated Green House

3. **Fan pad greenhouse**

Fan pad greenhouse is used to provide a controlled growing environment for growing special crops and plants. This greenhouse is provided with special-purpose fans to draw air into the greenhouse through high-efficiency cooling pads made from high surface area ribbons of cellulose fiber. Humidity is controlled by an elaborate system of foggers. Fertigation is implemented by an efficient drip-irrigation system.

Typically, exotic plants and crops meant for the export market or as import-substitutes are grown in such greenhouses. The temperature and humidity can be controlled to provide the exact growing environment required for plants that grow in temperate regions. Plants that are commonly grown in these greenhouses are carnation, Gerbera, rose, and colored capsicum, cucumber, cherry tomato and so on. This type of greenhouse is ideal for growing nursery plants.

Figure 15: Fan pad Green House

3.1.1 Attributes of greenhouse

A greenhouse has four important attributes:

1. It has a framed or inflated structure.
2. It is covered by a transparent or translucent material to maintain optimum light levels.
3. Crop micro-climate can be at least partially controlled.
4. It is large enough to permit a person to work inside.

3.2 Advantages and Disadvantages of Green House

3.2.1 Advantages of greenhouses

The following are the different advantages of using the green house for growing crops under controlled environment:

1. Throughout the year four to five crops can be grown in a greenhouse due to availability of required plant environmental conditions.
2. The productivity and financial return per unit area of the crop is increased considerably.
3. Superior quality produce can be obtained as they are grown under suitably controlled environment.

4. Gadgets for efficient use of various inputs like water, fertilizers, seeds and plant protection chemicals can be well maintained in a green house.
5. Effective control of pests and diseases is possible as the growing area is enclosed.
6. Percentage of germination of seeds is high in greenhouses.
7. The acclimatization of plantlets of tissue culture technique can be carried out in a green house.
8. Agricultural and horticultural crop production schedules can be planned to take advantage of the market needs.
9. Different types of growing medium like peat mass, vermiculate, rice hulls and compost that are used in intensive agriculture can be effectively utilized in the greenhouse.
10. Export quality produce of international standards can be produced in a green house.
11. When the crops are not grown, drying and related operations of the harvested produce can be taken up utilizing the entrapped heat.
12. Greenhouses are suitable for automation of irrigation, application of other inputs and environmental controls by using computers and artificial intelligence techniques.
13. Self-employment for educated youth

3.2.2 Disadvantages of a greenhouse

The main disadvantage in the development of greenhouse technology is the high initial cost. Since most of the farmers in developing countries are poor, they are unable to establish high cost greenhouse structures for vegetable growing. Moreover lack of awareness about this technology and illiteracy of the farmers are the major impediments. However, the major constraints in greenhouse vegetable cultivation are:

1. The basic cost of construction and operational cost of the climate controlled greenhouse is very high.
2. Uninterrupted and regular power supply is required for operating cooling and heating system of the greenhouse.
3. Cladding material of required quality is not readily available.
4. Non-availability of tools and implements for facilitating crop-production operations under greenhouse.
5. There is a lack of specific research programme on greenhouse vegetable production in the country.
6. No specific breeding work has been initiated for development of suitable varieties/ hybrids for greenhouse cultivation.
7. Exotic seeds are very costly and are out of reach of the Indian growers.

3.3 Environmental Variables and their Control in side Green Houses

Crop growth, development and productivity are influenced not only by its heredity but also by the microclimate in the environment around it. The components of crop microclimate are light, temperature, air compositions and the nature of the root medium. In open fields, only the nature of the root medium can be manipulated through tillage, irrigation and fertilizer application. The closed boundaries in greenhouse permit control of any one or more of the components of the micro climate.

Production of vegetables and other crops during unfavorable climatic conditions, such as high temperature, flooding, and strong winds suffered from high incidence of diseases. Greenhouse production system is one of the most suitable and efficient mean of controlling the production environment for high quality fresh vegetables. Inside, the house there is gradually increased in temperature due to heating effect of high irradiation as the incidence light get trap inside leading to temperature rise. In addition, several methods are available for cooling greenhouses like evaporative cooling, shading and natural ventilation.

3.3.1 Light

The visible light of solar radiation is a source of energy for plants. Light energy, carbon dioxide (Co_2) and water all enter in to the process of photosynthesis to form carbohydrates. The production of carbohydrates from carbon dioxide and water in the presence of chlorophyll, using light energy is responsible for plant growth and reproduction. The rate of photosynthesis is governed by available fertilizer elements, water, carbon dioxide, light and temperature.

The photosynthesis reaction can be represented as follows:

Chlorophyll
Co2 + water+ light energy ---------- carbohydrates + oxygen
Plant nutrients

Considerable energy is required to reduce the carbon that is combined with oxygen in Co_2 gas to the state in which it exists in the carbohydrate. The light energy thus utilized is trapped in the carbohydrate. If the light intensity is diminished, photosynthesis slows down and hence plant growth. If higher than optimal light intensities are provided, growth again slows down because of
the injury to the chloroplasts.

Plants are relatively inefficient at using light and are only able to use about a maximum of 22% of it. The greenhouse intercepts a percent of light falling on it allowing a maximum of 80% of it to reach the crop at around noon with an overall average of 68% over the day. It is important that the crop be oriented in such a way that the light transmitted through the structure is optimized for its efficient distribution to the canopy. The major greenhouse vegetable crops are arranged in either single or double rows to ensure maximum light interception by the crop.

3.3.2 Temperature

Temperature is a measure of level of the heat present. All crops have temperature range in which they can grow well. Below this range, the plant life process stop due to ice formation within the tissue and cells are possibly punctured by ice crystals. At the upper extreme, enzymes become inactive, and again process essential for life cease. Enzymes are biological reaction catalyst and are heat sensitive. All biochemical reactions in the plant are controlled by the enzymes.

The rate of reactions controlled by the enzyme often double or triple for each rise of temperature by 100C, until optimum temperature is reached. Further, increase in temperature begins to suppress the reaction and finally stop it. Generally several crops can be grown in a wide range of temperature but greenhouse crops are grown at a day temperature, which are 3 to 60C higher than the night temperature on cloudy days and 80C higher on clear days. The night temperature of greenhouse crops is generally in the range of 7 to 210C.

3.3.3 Relative humidity

As the green house is a closed space, the relative humidity of the green house air will be more when compared to the ambient air, due to the moisture added by the evapo-transpiration process. Some of this moisture is taken away by the air leaving from the green house due to ventilation. Sensible heat inputs also lower the relative humidity of the air to some extent. In order to maintain the desirable relative humidity levels in the green houses, processes like humidification or dehumidification are carried out. For most crops, the acceptable range of relative humidity is between 50 to 80%. However for plant propagation work, relative humidity up to 90% may be desirable.

In summer, due to sensible heat addition in the daytime, and in winters for increasing the night time temperatures of the green house air, more sensible heat is added causing a reduction in the relative humidity of the air. For this purpose, evaporative cooling pads and fogging system of humidification are employed. When the relative humidity is on the higher

side, ventilators, chemical dehumidifiers and cooling coils are used for de- humidification.

3.3.4 Ventilation

A green house is ventilated either by reducing the temperature of the green house air or by replenishing carbon dioxide supply or by moderating the relative humidity of the air. Air temperatures above 350C are generally not suited for the crops in green house. It is quite possible to bring the green house air temperature below this upper limit during spring and autumn seasons simply by providing adequate ventilation to the green house.

The ventilation in a greenhouse can either be natural or forced. In case of small green houses (less than 6m wide) natural ventilation can be quite effective during spring and autumn seasons. However, fan ventilation is essential to have precise control over the air temperature, humidity and carbon dioxide levels.

3.3.5 Carbon dioxide

Carbon is an essential plant nutrient and is present in the plant in greater quantity than any other nutrient. About 40% of the dry matter of the plant is composed of carbon. Under normal conditions, carbon dioxide (Co_2) exits as a gas in the atmosphere slightly above 0.03% or 345ppm. During the day, when photosynthesis occurs under natural light, the plants in a greenhouse draw down the level of Co_2 to below 200ppm. Under these circumstances, infiltration or ventilation increases carbon dioxide levels, when the outside air is brought in, to maintain the ambient levels of Co_2. If the level of Co_2 is less than ambient levels, Co_2 may retard the plant growth.

In cold climates, maintaining ambient levels of Co_2 by providing ventilation may be uneconomical, due to the necessity of heating the incoming air in order to maintain proper growing temperatures. In such regions, enrichment of the green house with Co_2 is followed. The exact Co_2 level needed for a given crop will vary, since it must be correlated with other variables in greenhouse production such as light, temperature, nutrient levels, cultivar and degree of maturity. Most crops will respond favorably to Co_2 at 1000 to 1200 ppm.

SELF ASSESSMENT EXERCISE

i. Define the term greenhouse and explain its importance.
ii. Discuss the different types of greenhouse and list the attributes of a greenhouse.

iii. Enumerate the advantages and disadvantages of a green house.
iv. List and describe the different environmental variables in side Green Houses.

4.0 CONCLUSION

This unit taught us that a greenhouse is a framed or an inflated structure covered with a transparent or a translucent material (polythene, glass) in which crops could be grown under the conditions of at least partially controlled environment and which is large enough to permit persons to work within it to carry out cultural operations. It also explains that green houses are climate controlled with cooling and heating system and mainly used for growing exotic varieties of vegetables, off-season growing of vegetables, floriculture, planting material acclimatization and plant breeding and varietals improvement under adverse agro climatic conditions.

The unit informed us that the production of vegetables and other crops during unfavorable climatic conditions, such as high temperature, flooding, and strong winds suffered from high incidence of diseases. It stated that greenhouse production system is one of the most suitable and efficient mean of controlling the production environment for high quality fresh vegetables. The unit highlighted three major types of greenhouses as: forced ventilated greenhouse; naturally ventilated greenhouse and fan pad greenhouse. It further enumerated the different environmental variables inside a green house to include; light, temperature, relative humidity, ventilation and carbon dioxide.

The unit explains that the advantages of using the green house for growing crops are: all year round production of crops; higher productivity and financial return per unit area; superior quality produce grown under suitably controlled environment; effective control of pests and diseases and the automation of irrigation, application of other inputs and environmental controls using computers. It also informs us that the major constraint in the development of greenhouse technology is the high initial cost as most farmers in developing countries are poor and unable to afford the high cost and in addition, lack of awareness about this technology and illiteracy of the farmers are other impediments.

5.0 SUMMARY

A greenhouse is a framed or an inflated structure covered with a transparent or a translucent material (polythene, glass) in which crops could be grown under the conditions of at least partially controlled environment and which is large enough to permit persons to work within it to carry out cultural operations. It is a technique of providing favorable

environmental or growth conditions to the plants. Green houses are climate controlled with cooling and heating system and mainly used for growing exotic varieties of vegetables, off-season growing of vegetables, floriculture, planting material acclimatization and plant breeding and varietals improvement under adverse agro climatic conditions.

Production of vegetables and other crops during unfavorable climatic conditions, such as high temperature, flooding, and strong winds suffered from high incidence of diseases. Greenhouse production system is one of the most suitable and efficient mean of controlling the production environment for high quality fresh vegetables. There are three major types of greenhouses: Forced ventilated greenhouse; naturally ventilated greenhouse and fan pad greenhouse. The different environmental variables inside a green house include; light, temperature, relative humidity, ventilation and carbon dioxide.

The advantages of using the green house for growing crops are: all year round production of crops; higher productivity and financial return per unit area; superior quality produce grown under suitably controlled environment; effective control of pests and diseases and the automation of irrigation, application of other inputs and environmental controls using computers. The major constraint in the development of greenhouse technology is the high initial cost as most farmers in developing countries are poor and unable to afford the high cost of greenhouse for vegetable growing. In addition, lack of awareness about this technology and illiteracy of the farmers are other impediments.

6.0 TUTOR-MARKED ASSIGNMENT

1. State what is meant by greenhouse and explain its importance.
2. Describe the different types of greenhouse and enumerate the attributes of a greenhouse.
3. Discuss the advantages and disadvantages of a green house.
4. List and explain the different environmental variables in side Green Houses.

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UNIT 3 OTHER ISSUES IN URBAN FARMING SYSTEM

CONTENTS

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1.0 INTRODUCTION

Urban Agriculture involves the production of food and the rearing of domestic livestock within or immediately adjacent to built-up settlements. Within this context Urban Agriculture has long been recognized for the critical role it plays as an urban survival strategy in the cities of the world. It plays a key role in supplementing the food budget and often serves as a source of income and livelihood for urban residence.

Urban Agriculture is a source of supply in urban food systems and one of several food security options for households; similarly, it is one of several tools for using productively urban open spaces, treating and/or recovering urban solid and liquid wastes, saving or generating income and employment, managing freshwater resources more effectively.

In practice Urban Agriculture has become a sizeable supplier of certain foodstuffs to growing urban sectors, poor and not so poor, and a critical factor in poor households' nutrition. Additionally, it is conveniently managing open spaces, reducing disposal and treatment of urban wastes, generating supplemental income and/or affording cash savings, and providing employment.

In contrast to benefits of urban agriculture presented above the farming system carries health and environmental risks that includes: – potential use of contaminated water, land pollution, bad odor and smells, noise pollution, inappropriate use of pesticides and raw organic manure that can leak into water sources. These issues and others require proper attention.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- Know the importance and benefits of urban agriculture
- List the problems with urban farming system.
- Understand the concept and types of gardens in organic and urban farming system.

3.0 MAIN CONTENT

3.1 Importance and Benefits of Urban Agriculture

3.1.2 Importance of urban agriculture

Generally urban population and rural–urban migration are increasing in the word. In many developing countries however, the urbanization process goes along with increasing urban poverty and polluted environment, growing food insecurity and malnutrition, especially for children, pregnant and lactating women; and increasing unemployment. Urban agriculture represents an opportunity for improving food supply, health conditions, local economy, social integration, and environmental sustainability altogether.

Thus urban agriculture is recognized worldwide for its significant benefits and services to humanity. The social, cultural, technical, economic and environmental dimensions of the importance of urban agriculture is presented as follows:

1. **National and household food security**
   Food security means that safe and nutritious food is consistently available, accessible, and reasonably priced. In Africa, urban agriculture improves food security by providing healthy and plentiful substitutes for purchased food, especially for poor households. Households that practice urban agriculture are also more likely to have access to a wider variety of nutritious foods such as vegetables and animal products.

   In addition, urban agriculture makes an important contribution to household food security, especially in times of crisis or food shortages. The produce from this system is either consumed by the producers, or sold in urban markets, such as the increasingly popular weekend farmers' markets found in many cities.

2. **Better price/short distance**
   Locally produced food requires less transportation and refrigeration therefore, urban agriculture can supply nearby markets with fresher and more nutritious products at competitive prices. Due to this reason, the consumers - especially low-income residents - enjoy easier access to fresh produce, greater choice and better prices.

3. **Employment generation and income**
   Urban agriculture provides employment and incomes for poor women and other disadvantaged groups. Horticulture can generate one job every 100 sq m garden in production, input supply, marketing and value-addition from producer to consumer. Urban agriculture can also provide people with a primary or supplemental income.

   Income from urban agriculture is particularly high in many African cities. In some cities the economic return to urban farmers has been estimated to be comparable to the income of unskilled construction workers or even more lucrative. For example, during the dry season farmers using wastewater irrigation can sell vegetables at more than double the wet-season price, and urban agriculture incomes were estimated to be 50 percent above minimum wage.

4. **Solving transportation problem urban waste**
   The collective benefits from urban agriculture include solving transportation problems and converting urban waste into fertilizer. Cities have more fresh produce and fewer perishable agricultural products coming from rural areas. For example, in some towns almost all the leafy vegetables consumed by poor urban residents are grown in the valleys surrounding the city.

   Livestock in many cities produce more than 20,000 tons of manure per year, two-thirds of which is used as fertilizer by farms. These locally available farm "inputs" reduce the need for purchasing more-expensive commercial supplements.

3.1.2 Benefits of Urban Agriculture

In response to concerns about a lack of food and agricultural knowledge, food insecurity, disparities in access, and corporate control over the food system, many people participate in urban agriculture projects motivated by interests in the social benefits it can provide, including education, increased access to healthy food, community development, and social justice. The benefits of urban agriculture can be classified as follows:

1. Socially it:

a. Helps bring families and communities together by working toward a common goal that will be beneficial for all
b. Gives direct links to food production
c. Creates better living environment by greening up the city and making it more productive
d. Makes people stronger by putting their food security into their own hands, making them more independent and empowered
e. Teaches people life skills such as how to be more self sufficient
f. Creates jobs, income, and food
g. Helps combat hunger
h. Educate people, who have been increasingly removed from food production, to participate in, and respect, its generation.

2. Environmentally it:

a. Greens up the city
b. Can help to clean air and rain water
c. Helps to stop erosion and topsoil removal
d. increases the amount of food grown and bought locally, decreasing carbon footprint
e. Facilitates reuse of wastes for food production
f. Has direct impacts on urban ecology

3. Economically it

a. Creates jobs and income from otherwise completely unproductive space
b. Can be beneficial to people of any income
c. Creates a better local economy that does not rely on food from far away
d. Makes use of valuable resources, such as compost, that would otherwise go to waste in a city

In addition to the aforementioned, urban agriculture has the potential to decrease cost of maintaining public land, increase local employment opportunities, take advantage of underutilized resources and offer opportunities for food microenterprises. Urban agriculture also provides open space benefits and an opportunity for people to obtain food not grown in the conventional food system—a system associated with adverse environmental impacts.

Urban agriculture offer opportunity for ecological restoration through the restoration of degraded land and reduced storm water runoff. Urban agriculture has the potential to increase local biodiversity and provide

green space micro-climate benefits such as mitigation of the urban heat island effect, humidity regulation, wind reduction, and shade provision. From a food system perspective, there are many potential sustainability advantages to local agricultural production, including reduced energy usage, recycling of organic waste, and the use of ecological production methods.

3.2 The Problems with Urban Farming System

Urban agriculture carries health and environmental risks that includes: – potential use of contaminated water, land pollution, bad odor and smells, noise pollution, inappropriate use of pesticides and raw organic manure that can leak into water sources. These issues and others listed below require proper attention.

1. **Lack of space in the city**

The lack of spaces on which to build and sometimes even the lack of open green space in most cities constitute a major problem to urban farming. Even when there are still unused public or private lands, the prices are sky high. While urban agricultural practices often put idle land into productive use, in other cases, farmers take over land planned or set aside for other purposes, mostly economic purposes.

2. **High water requirement for agricultural activities**

The use of water from the potable municipal water supply by some urban farmers creates water shortages in the city. Overuse of surface or groundwater can reduce the city water supply. In some of the cities, this problem is well mitigated by using treated wastewater for irrigation. Low-cost water-saving technologies such as underground and drip irrigation also can help to increase water efficiency, as can allowing safe use of low-quality water resources in some cases.

3. **Soil and water pollution lead to waterborne diseases**

According to FAO, inappropriate and excessive use of agricultural inputs from pesticides, fertilizer, nitrogen, and raw organic matter can pollute the soil in an urban area. The chemical substances become residues in the soil, making it less fertile or even poisonous in the long term. These residues then may leach or runoff into the main water sources of the city. Chemical and mycobacterial contamination of the water sources can lead to several waterborne diseases, such as dysentery, salmonella, cholera, and schistosomisis.

4. **Contaminated food – serious health problems**
   Urban areas used as farms are highly susceptible to containing toxic substances, such as heavy metals including lead, zinc, copper, tin, mercury, and arsenic. The main sources of metals in urban soils are mainly from emissions from factories, automobiles, and sewage. The high amount of heavy metal substances may lead to a serious health problem for consumers. The contaminated food issue becomes even worse if there is an occurrence of food-borne parasitic disease caused by poor hygiene in an urban area.

5. **Air pollution**
   The old problem of any agricultural practice is still the conventional use of pesticides. For urban agriculture, it becomes even worse, because harmful chemicals applied in the middle of the city travel into the atmosphere of the dense and crowded urban environment, potentially harming a big population. Allergies, cancer, birth defects, male sterility, contamination of breast milk, genetic mutations, respiratory diseases, behavioral changes, and a variety of intestinal disorders could add another problem for the city if the pesticides issue not handled properly.

6. **Aesthetic issues**
   Some people say that urban agriculture gives an unpleasant view of the city. In some cases, the image of a cattle corral, pigs at a town dump, poorly tended vegetable patches in a community park, or chickens in a front yard can be offensive to many. Because urban agriculture is more exposed to public view, it should be well designed to make sure the visual appearance is as sweet as possible. This aesthetic issue is a landscape architect's responsibility, so it is important to bring this practice into the city in a beautiful way.

All of these problems can be an obvious reason to ban or stop urban agricultural practices. However, if that happens major issues in the world such as exploding population growth and food security will pose threats to human societies. There are a million ways to solve the problem of urban farming without sacrificing the opportunity to stop world hunger.

3.3 Gardens in Organic and Urban Farming System

A garden is a land available within the compound of the residential building or an open space in private or public space that is utilized for the cultivation of plants. Within the confines of a garden proper care, harvesting, irrigation and other plant cultural operations are carried out. There are different types of gardens including the following:

1. **Home gardens**
   Many local residents have gardens on their properties, either in the ground, in raised beds, or in container gardens. Home gardens have the advantage of being close to where people live, which means that people can easily harvest fruit and vegetables just by walking out their door. One risk associated with home gardens is that urban soils are notoriously contaminated from past industrial uses, unauthorized waste disposal, lead paint, and vehicle exhaust. In additionally, improper application of pesticides, herbicides, or fungicides can be detrimental to the health of both gardeners and their neighbors.

2. **Community gardens**
   Community gardens (also called allotment gardens in Europe), serving those who do not have access to private garden plots, usually are large lots of land divided into smaller plots for individual/household use for production of edibles such as vegetables, fruits, and herbs, but also with ornamental plants dispersed among the gardens. Ownership of these lots varies from a municipality, an institution, a community group, a land trust, or private ownership. The objectives of community gardens today go beyond food production. They build a sense of community by providing gathering spaces for local residents, enhancing social interactions. Additionally, most community gardens mandate sustainable or organic growing methods, contributing to environmental sustainability.

   In addition to providing space for people who don't have access to land to grow their own food in a safe environment, community gardens have many economic, social, and environmental benefits. They have been proven to improve the quality of life for people in the garden, provide a catalyst for neighborhood and community development, stimulate social interaction, encourage self-reliance, beautify neighborhoods, produce nutritious food, conserve resources, create opportunity for recreation, exercise, therapy, and education, reduce crime, preserve green space, create income opportunities and economic development, reduce city heat from streets and parking lots, and provide opportunities for intergenerational and cross-cultural connections. There are several types of community gardens:

3. **Rooftop gardens**
   Rooftop gardens provide the opportunity to utilize the roofs of buildings for food production. A rooftop garden differs from green roof in that it is mainly for aesthetic or recreational purposes, whereas a green roof is usually built to cover a large area in the

most economical and efficient means possible with a focus on improving the insulation or overall energy efficiency of cooling and heating costs within a building.

Typically, rooftop gardens are constructed on a flat roof common to many city commercial, institutional or industrial buildings, although they can be built on private residences as well. Rooftop gardens are generally composed of a structural support, a roofing membrane, water drainage and storage, a growing medium, and vegetation. Rooftop gardens and green roofs can offer many benefits. A home rooftop garden provides readily available food, rainwater absorption, and air filtration.

4. Kitchen garden

Fruits and vegetables play an important role in the balanced diet of human beings by providing not only the energy rich food but also promise vital protective nutrients. In order to make available the requisite quantity and kind of fresh fruit and vegetables every day to a family, it is better to have a nutrition garden to grow them in the house premises.

A kitchen garden a land available within the compound of the residential building that is utilized for the cultivation of plants. It is also called a nutrition garden, where proper care, harvesting, irrigation and other plant cultural operations are carried out. Big trees are planted towards the northern side of the garden as they will not only shade the vegetables but the roots may compete for moisture and nutrition.

5. Market garden

Farms that produce vegetables for supply to consumers in the local market is called a market garden. Since people living in cities usually have neither the space nor the time to devote to gardening, there developed a tremendous demand of vegetables. The ultimate aim of vegetable production in market gardens is their quick disposal in nearby market. Hence, nearness to market with a reliable transport should not be ignored.

For a long time, market gardens were located at a distance of 10-15 km from the cities. However, with the expansion of cities and improvement in road and transport network, such gardens are located even beyond 30-40 km from main cities. The farmers adopt intensive cultivation to earn maximum profit from small to medium land holdings. Therefore, the fertility of soil needs to be replenished with the application of organic manure etc.

6. Organic vegetable garden

The concept of organic farming is to feed the soil and not the plant. Organic farming, therefore, is a production system that avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators etc. To the maximum extent feasible, organic farming systems rely upon crop rotation, crop residues, animal manure, green manure, legumes, off farm organic waste, mechanical cultivation, mineral bearing rocks and aspects of biological control to maintain soil productivity and tilth, to supply nutrients and to control insects, diseases and weeds.

The crops and the crop varieties are selected carefully as some crops are less prone to the attack of insects and diseases and thus can be grown easily without any chemical sprays. These crops include beet, carrot, onion, garlic and leafy vegetables. However, some losses/ damages caused by insects, diseases and weeds are expected in Organic Vegetable Gardens. There are many techniques that will reduce the need for synthetic pesticides and improve soils without chemical fertilizers.

7. Commercial farms

A commercial farm is typical urban agricultural operations that operate on fewer than 25 acres. Urban farmers create direct access to food through farm stands and farmers' markets, increasing the amount of food dollar going into their own pocket and helping the local economy. Many urban commercial farms tend to be located in the suburbs and help create strong community connections through pick-your-own operations, corn mazes, petting zoos, school tours, and farm stands (Brown and Carter 2003). There are three categories of metropolitan farms:

1. Recreational farms which sell less than $10,000 annually in less than 100 acres;
2. Adaptive farms which sell $10,000 or more annually of high-value products and are 100 to 200 acres in size; and
3. Traditional farms which sell greater than $10,000 annually of high-value products and are greater than 200 acres.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- Know importance and benefits of urban agriculture.
- List the problems with urban farming system.
- Understand the concept and types of gardens in organic and urban farming system.

4.0 CONCLUSION

This unit taught us that urban agriculture involves the production of food and the rearing of domestic livestock within or immediately adjacent to built-up settlements. It informs us that urban agriculture supplies certain foodstuffs to growing urban population and it is a critical factor in poor households' nutrition. We also learnt that urban agriculture assists in: managing open spaces; reduce the disposal and treatment of urban wastes; generates supplemental income and/or affording cash savings and provides employment.

We were made to know that urban agriculture represents an opportunity for improving food supply, health conditions, local economy, social integration, and environmental sustainability altogether. The unit stated that urban agriculture contributes to ecological restoration through the restoration of degraded land and reduced storm water runoff. It also made us to understand urban agriculture increases local biodiversity and provide green space micro-climate benefits such as mitigation of the urban heat island effect, humidity regulation, wind reduction, and shade provision.

The unit educated us that apart from the benefits of urban agriculture stated above, the farming system carries health and environmental risks that includes: – potential use of contaminated water, land pollution, bad odor and smells, noise pollution, inappropriate use of pesticides and raw organic manure that can leak into water sources.

This unit defines a garden as a land available within the compound of the residential building or an open space in private or public space that is utilized for the cultivation of plants. It further stated that within the confines of a garden proper care, harvesting, irrigation and other plant cultural operations are carried out. We also know that there are different types of gardens that include: Home gardens, Community gardens, Rooftop gardens, Kitchen garden, Market garden, Organic vegetable garden and Commercial farms.

5.0 SUMMARY

Urban Agriculture involves the production of food and the rearing of domestic livestock within or immediately adjacent to built-up settlements. Urban Agriculture supply farm produce to the urban food systems as it also serves as a: food security option for households; tool for using productive urban open spaces; means of treating and recovering urban solid and liquid wastes; way of saving or generating income and

employment and means of managing freshwater resources more effectively.

In practice Urban Agriculture not only supplies certain foodstuffs to growing urban population, it is a critical factor in poor households' nutrition. Additionally, it assists in: managing open spaces; reducing disposal and treatment of urban wastes; generating supplemental income and/or affording cash savings and providing employment. Urban agriculture represents an opportunity for improving food supply, health conditions, local economy, social integration, and environmental sustainability altogether.

Urban agriculture contributes to ecological restoration through the restoration of degraded land and reduced storm water runoff. Urban agriculture also increases local biodiversity and provide green space micro-climate benefits such as mitigation of the urban heat island effect, humidity regulation, wind reduction, and shade provision. Apart from the benefits of urban agriculture stated above, the farming system carries health and environmental risks that includes: – potential use of contaminated water, land pollution, bad odor and smells, noise pollution, inappropriate use of pesticides and raw organic manure that can leak into water sources.

A garden is a land available within the compound of the residential building or an open space in private or public space that is utilized for the cultivation of plants. Within the confines of a garden proper care, harvesting, irrigation and other plant cultural operations are carried out. There are different types of gardens that include: Home gardens, Community gardens, Rooftop gardens, Kitchen garden, Market garden, Organic vegetable garden and Commercial farms.

6.0 TUTOR-MARKED ASSIGNMENT

- State the importance and benefits of urban agriculture
- Explain the problems with urban farming system.
- Discuss the concept and types of gardens in organic and urban farming system.

7.0 REFERENCES/FURTHER READING

Food and Agriculture Organization, United Nations. (1981). *Agriculture: Toward 2000*. Rome, Italy. Food and Agriculture Organization, United Nations. 1983**.** *Protect and produce. Soil conservation for dlvelopmient.* Rome, Italy.

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UNIT 4 CERTIFICATION OF ORGANIC PRODUCTS

CONTENTS

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3.0 Main Content
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1.0 INTRODUCTION

Organic farming is a production system in which farmers are expected to comply with certain guidelines and standards therefore, a certification system is necessary. The need to market organic products separately and to make a clear distinction between organic and conventional products throughout the organic distribution and processing chain necessitates the establishment of a certification system that will ensuring that organic products have been produced according to organic standards.

The main objective of such a certification system is to assure consumers that products genuinely have been produced organically. As there is no obvious way for consumers to distinguish whether a product is organic, a price premium for organic products can only be achieved if confidence in the organic quality is ensured. This makes clear standards, certification and labelling of products important factors for the economic success of organic farming.

A clear and comprehensible system of standards, certification and labelling exist in different parts of the world. A typical example is found in the European Union (EU), where existing council regulations 2092/91 and 1804/1999 (EC 1999a) define the standards to which farmers have to adhere in order to produce organically. While sometimes complicated in detail, these standards provide a clear basis for all organic farmers in Europe.

Anyone who wants to sell products as organic can only do so by sticking to the rules laid out in the European regulations and submitting to an elaborate inspection system that has been set up to make sure that the products have been produced according to the standards. These standards also apply to those who want to import products into the European Union.

2.0 LEARNING OBJECTIVES

By the end of this unit, you should be able to:

- Understand the concept and relevance of standards and regulations in organic farming
- Explain the importance labels to consumers' organic products.
- Know the need and purpose of organic certification for producers of organic food.

3.0 MAIN CONTENT

3.1 Standards and Regulations

Organic farming methods are internationally regulated and legally executed by many countries, based in great part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization for organics established in 1972. The new EU regulation on organic production as well as the Canadian organic standard came in to force in the year 2009. Furthermore, the Australian domestic organic standard was implemented. Canada and the U.S. concluded the world's first fully reciprocal agreement between regulated organic systems, and the EU introduced procedures for approving certification bodies from outside the EU.

The standards and regulations are set in place to ease trade in organic products and foster the future growth of the sector. The standards set by EU can be seen as a minimum level within the Union. These standards explicitly state that stricter rules may be used. A number of stricter standards set out by national farmers' organizations- also belonging to the organic farming sector – exist. From a marketing point of view, stricter standards can be seen as the basis for further market segmentation within organic farming in an attempt to receive an additional premium for being the 'most organic' among the organic farmers. Prior to European regulation of organic farming, most national standards were set by private sector bodies. The common standard introduced by regulation has had a major positive impact on both market transparency and trade opportunities, and clearly counteracts any attempt at fraud.

The number of countries with organic standards has increased to 73, and there are 16 countries that are in the process of drafting legislation. In 2009, FAO, IFOAM and UNCTAD started the Global Organic Market Access (GOMA) project. The aim of GOMA is to facilitate equivalence, harmonization and other types of cooperation in order to simplify the process for trade flow of products among the various organic guarantee systems. There has been modest growth in the number of certification

bodies with the total being 488, up from 481 in 2008. Most certification bodies are in the European Union, the United States, Japan, South Korea, China, Canada, and Brazil.

A growing number of organic producers are certified through Participatory Guarantee Systems (PGS) across the world. PGS are locally focused quality assurance systems. It is estimated that around 10'000 small operators are involved in PGS world-wide. The leading countries with regards to PGS are located in the global South. Several organic standard setters have also developed draft standards for climate "add-ons" for organic certification, and it is expected that the use of carbon labeling by retailers will grow considerably in the future.

3.1.1 Regulatory mechanism

To have quality assurance a country has to have an internationally acclaimed certification process in place for export, import and domestic markets. National Programme on Organic Production (NPOP) defines the regulatory mechanism and is regulated under two different acts for export and domestic markets. NPOP notified under Foreign Trade Development and Regulation Act (FTDR) looks after the export requirement. The NPOP notified under this act has already been granted equivalence by European Union and Sweden. USDA has also accepted the conformity assessment system of NPOP. Due to this, the product certified by any Indian accredited certification agency under NPOP can be exported to Europe, Sweden and USA without the requirement of re-certification.

To look after the requirement of import and domestic market the same NPOP has been notified under Agriculture Produce Grading, Marking and Certification Act (APGMC). Regulatory body of NPOP under FTDR act is Agricultural and Processed Foods Export Development Authority (APEDA) under Ministry of Commerce and of NPOP under APGMC act is Agricultural Marketing Advisor (AMA) under Ministry of Agriculture. Accreditation of Certification and Inspection Agencies is being granted by a common National Accreditation Body (NAB). 18 accredited certification agencies are looking after the requirement of certification process. Out of these 4 agencies are under public sector while remaining 14 are under private management.

3.2 Labeling

Logos, labels and brands help the consumer to recognize organic products. For a long time, this has been of concern only to some national governments and not to European policy. In December 1999, however, a European logo was introduced to communicate the organic character of a product clearly to consumers. Unfortunately, so far this logo has failed to

find wide acceptance in the marketplace. Instead, a multitude of different logos and labels are used throughout Europe. Most of these are supported by farmers' organizations; others are government-supported.

Typically, these logos and labels designate specifics of the country of origin. A few exceptions which try to stress the international transferability of organic products exist, such as the Demeter logo indicating biodynamic production. The existence of too many logos is not only confusing for consumers, but tends to produce an 'information entropy' effect: consumers do not recognize any logo, because no one logo is sufficiently widely known.

A number of super market chains have started specific brands for organic products which are sold only in their supermarkets. In this area, national approaches also predominate. The difference between brands on the one hand and logos and labels on the other is quite important. A brand name is a 'private product' for which cost and benefit are borne by the respective supermarket chain, whereas logos and labels have the character of 'club goods'.

Everybody who joins the club by paying dues and abiding by the club's rules can enjoy the benefits. The bigger the club, the more difficult it becomes to coordinate the diverging interests regarding the logo or label. And as the club gets bigger, individual members become less likely to promote the good of the club good. The more members the club has, the smaller the exclusivity of its benefits.

Thus an organic farmer who wants to use the European logo will only benefit from using it if it is already widely recognized by consumers. Promoting a logo or label to establish it in the market and achieve its wide recognition demands collective action by the 'owners' of the logo. This is very expensive and demands a long – term approach.

The European logo for organic farming has two major advantages:

1. It is free of charge. Anybody who produces certified organic products may use it at no additional cost.
2. It is applicable in all EU countries, thus facilitating trade.

On the other hand, the European logo also has severe drawbacks:

1. It is neither actively promoted nor supported by a marketing campaign.
2. It is very similar to other European logos under the 'designated origin' legislation (Council regulations 2081/92 and 2082/92).

3. It cannot be used for organic products with more than 5 percent imported (to the EU) ingredients. This is a major obstacle to the use of the logo in many cases.

   The widespread adoption of the European organic logo and its acceptance among consumers would most likely have positive effects on market transparency and consumer demand for organic products.

3.3 Organic Certification

Organic certification is a certification process for producers of organic food and other organic agricultural products. In general, any business directly involved in food production can be certified, including seed suppliers, farmers, food processors, retailers and restaurants. Requirements vary from country to country, and generally involve a set of production standards for growing, storage, processing, packaging and shipping that include:

1. Avoidance of synthetic chemical inputs (e.g. fertilizer, pesticides, antibiotics, food additives, etc) and genetically modified organisms;
2. Use of farmland that has been free from chemicals for a number of years (often, three or more);
3. Keeping detailed written production and sales records (audit trail);
4. Maintaining strict physical separation of organic products from non-certified products;
5. Undergoing periodic on-site inspections.

3.3.1 Purpose of certification

Organic certification addresses a growing worldwide demand for organic food. It is intended to assure quality and prevent fraud. For organic producers, certification identifies suppliers of products approved for use in certified operations. For consumers, "certified organic" serves as a product assurance, similar to "low fat", "100% whole wheat", or "no artificial preservatives".

Certification is essentially aimed at regulating and facilitating the sale of organic products to consumers. Individual certification bodies have their own service marks, which can act as branding to consumers. Most certification bodies operate organic standards that meet the National government's minimum requirements.

3.3.2 The certification process

In order to certify a farm, the farmer is typically required to engage in a number of new activities, in addition to normal farming operations that includes:

1. Study the organic standards, which cover in specific detail what is and is not allowed for every aspect of farming, including storage, transport and sale.
2. Compliance - farm facilities and production methods must comply with the standards, which may involve modifying facilities, sourcing and changing suppliers, etc.
3. Documentation - extensive paperwork is required, detailed farm history and current set-up, and usually including results of soil and water tests.
4. Planning - a written annual production plan must be submitted, detailing everything from seed to sale: seed sources, field and crop locations, fertilization and pest control activities, harvest methods, storage locations, etc.
5. Inspection - annual on-farm inspections are required, with a physical tour, examination of records, and an oral interview.
6. 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.
7. Record-keeping - written, day-to-day farming and marketing records, covering all activities, must be available for inspection at any time. In addition, short-notice or surprise inspections can be made, and specific tests (e.g. soil, water, plant tissue analysis) may be requested. For first-time farm certification, the soil must meet basic requirements of being free from use of prohibited substances (synthetic chemicals, etc) for a number of years.

A conventional farm must adhere to organic standards for this period, often, three years. This is known as being in *transition*. Transitional crops are not considered fully organic. A farm already growing without chemicals may be certified without this delay. Certification for operations other than farms is similar. The focus is on ingredients and other inputs, and processing and handling conditions. A transport company would be required to detail the use and maintenance of its vehicles, storage facilities, containers, and so forth. A restaurant would have its premises inspected and its suppliers verified as certified organic.

SELF ASSESSMENT EXERCISE

i. Describe the concept and relevance of standards and regulations in organic farming
ii. Highlight the importance labels to consumers' organic products.
iii. Explain the need and purpose of organic certification for producers of organic food.

4.0 CONCLUSION

This unit taught us that organic farming is a production system in which farmers are expected to comply with certain guidelines and standards therefore, a certification system is necessary. The unit explains that the need to market organic products separately and to make a clear distinction between organic and conventional products throughout the organic distribution and processing chain necessitates the establishment of a certification system that will ensuring that organic products have been produced according to organic standards. We learnt that the main objective of such a certification system is to assure consumers that products genuinely have been produced organically.

We now know that clear standards, certification and labeling of products are important factors for the economic success of organic farming and that a clear and comprehensible system of standards, certification and labeling exist in different parts of the world. The unit further explains that organic farming methods are internationally regulated and legally executed by many countries, based in great part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization for organics. The unit stated that to have quality assurance a country has to have an internationally acclaimed certification process in place for export, import and domestic markets.

This unit taught us that Logos, Labels and Brands which helps the consumer to recognize organic products are supported by farmers' organizations; while others are government-supported. We also learnt that organic certification is a certification process for producers of organic food and other organic agricultural products and that any business directly involved in food production can be certified, including seed suppliers, farmers, food processors, retailers and restaurants.

5.0 SUMMARY

Organic farming is a production system in which farmers are expected to comply with certain guidelines and standards therefore, a certification system is necessary. The need to market organic products separately and to make a clear distinction between organic and conventional products

throughout the organic distribution and processing chain necessitates the establishment of a certification system that will ensuring that organic products have been produced according to organic standards.

The main objective of such a certification system is to assure consumers that products genuinely have been produced organically. As there is no obvious way for consumers to distinguish whether a product is organic, a price premium for organic products can only be achieved if confidence in the organic quality is ensured. This makes clear standards, certification and labelling of products important factors for the economic success of organic farming.

Therefore, a clear and comprehensible system of standards, certification and labelling exist in different parts of the world. Organic farming methods are internationally regulated and legally executed by many countries, based in great part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization for organics. To have quality assurance a country has to have an internationally acclaimed certification process in place for export, import and domestic markets.

Logos, labels and brands help the consumer to recognize organic products most of which are supported by farmers' organizations; others are government-supported. Organic certification is a certification process for producers of organic food and other organic agricultural products. In general, any business directly involved in food production can be certified, including seed suppliers, farmers, food processors, retailers and restaurants.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the concept and relevance of standards and regulations in organic farming
2. Describe the importance labels to consumers' organic products.
3. Discuss the need and purpose of organic certification for producers of organic food.

7.0 REFERENCES/FURTHER READING

Food and Agriculture Organization, United Nations. (1981). *Agriculture: Toward 2000*. Rome, Italy. Food and Agriculture Organization, United Nations. 1983**.** *Protect and produce. Soil conservation for dlvelopmient.* Rome, Italy.

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