ORGANIC AND URBAN FARMING (HRT508)

Course Lecturers:

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Course Synopsis

Definition of organic and urban farming Major types of horticultural crops grown under organic and urban farming Organic and urban farming production system. Importance of organic farming and protected crop cultivation. Peculiarities of organic and urban farming. Concept of home gardening, market gardening and commercial gardening. Certification of organic horticultural products. Materials used in organic crop production. Sources of organic fertilizer materials. Environmental and earthy implications of organic and urban farming. Influence of urbanization and environmental factors. Problems of organic, urban/dry season horticultural farming. Maintenance of soil fertility and crop protection and irrigation. Prospects of organic and urban/dry season horticultural farming.

Definition of Organic and Urban Farming

The term organic defines a substance as a living materials as a living material whether of plant or animal origin. Organic is therefore any chemical compound containing carbon or any substance derived from living organisms, be they plants or animals. Organic farming is a production system which avoids or largely excludes the use of synthetic compound such as fertilizer, pesticides, growth regulators, and livestock feed derivatives. Organic farming system recently rely on crop rotations, crop residues, animal manure, legumes, green manures, off-farm organic wastes and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrient and to control insects, diseases, weeds and other pests.

Urban farming refers to farming activities in a city where particular crops are grown or animals are raised for home consumption and for commercial purposes.

Distnction between Organic and Conventional Agriculture

	Conventional Agriculture	**Organic Agriculture**
1. **Quality**:	Size, Colour	Taste, nutrient content
2. **Plant nutrition**:	Urea, NPK, SSP	Fallow planting, leguminous cover
3. **Pest Control:**	Synthetic	Biological
4. **Weed Control:**	Herbicides	Cover crop| Mulching

The driving force in organic agriculture are:

Health Consideration: Poisonous residues from synthetic agrochemicals, fertilizers, growth regulators are harmful to man.

Sustainable environment: Guaranteeing the future safety of the environment/

Conservation of Bio-Diversity: Existence of different form of flora in the environment

Basic terms in Organic Agriculture

1**. Certification:** The process of certification is the compliance to agreed set of specification or procedure in handling of organic produce. It is an agreed standard that is transparent and well known to everybody.

2. **Treaceability:** This is the process| ability to track every activity that has gone on the production and handling of food and fibre.

3.. **Eutrophication:** Is a process by which plant growth increases in a pond or lake. It generally promotes excessive plant growth, decay, favour certain weed specie over others and is likely to cause severe reduction in water quality.

4. **Conversion:** is a process by which an enterprice that have been running on a conventional principle moves into organic agriculture.

Major types of Horticultural Crops Grown

These include fruit tree e.g Mango, Coconut, Citrus, Cashew, Pear, apple; Vegetables e.g Leafy vegetables, fruit vegetables, spices; flowers and shade trees.

Home gardening: This is the principal source of fresh vegetable supplies for most home. Home gardeners grow various types of local vegetables that supply an important part of family needs.

Market Gardening: Its operation goes beyond family needs. It takes care of home consumption and city market. Market gardeners no longer grow local varieties of vegetables, but those which can be most profitably grown. There are competition in production and sales.

Commercial Production: This is the principal source of vegetables for big city markets for fresh consumption and seed processing. It is more extensive and specialized than market gardening and area of production is determined primarily by climatic and edaphic factors.

Production Systems

Mixed Farming: The practice of mixing crops and animals together on the same piece of land.

Multiple Cropping: It is the practice of growing two or more crops simultaneously on the same piece of land. Depending on crop intensification and arrangement, multiple cropping can be divided into mixed cropping or intercropping relay intercropping, strip intercropping sequential cropping and crop rotation.

Environmental Factors Influencing Organic Agriculture

These can be classified into Human environmental factor and Material Environmental factor. The two factors operate separately or dependently.

Human environmental factors: are made up of economic, institutional and social elements.

Economic Factors: Include policy which determine quantities, qualities and distribution of inputs and outputs. It influences the physical infrastructures such as transportation and roads, water and light supply, marketing, e.t.c

Institutional Factors: Include the laws of the land, credit and marketing conditions, contractual agreement, property right to land and water, distribution of fertilizer, planting material, grading and taxation.

Social factors: It deals with the culture and custom within a community. It determine the types of commodities grown which depends on the taste of the people.

Material environmental factors: consist of physical elements such as climate (rainfall, temperature, relative humidity, light etc), soil, topography and biological elements (Vegetation, weeds, plants, pests and diseases).

Urbanization|Socio-ecological factors: These factors are associated with the demographic growth i.e human population, availability of water, land etc.

Problems:Associated with Organic Agriculture

There are several problems confronting organic and urban farming. These include soil fertility maintenance, weed control strategies, insect pest control strategies, disease control strategies, availability of fertile land in urban areas, source of planting materials processing and storage facilities e.t.c.

SOIL FERTILITY MANAGEMENT IN ORGANIC FARMING

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Organic farming: This is a mode of farming which excludes all chemical inputs. To a large extent it is a self sustaining system, when problem arise solution are sought from within the system and external seepages are often avoided. So that the system can be optimally efficient, mixed farming with components of crops, animals and trees is often encouraged.

Soil fertility management: A deliberate and careful management of soil fertility is crucial in organic farming. An accurate knowledge of the fertility status of the soil is extremely important and adoption of the appropriate management strategies capable of sustaining the fertility and productivity of the soil is necessary. Adoption of farming practices which can sustain and even increase the level of soil organic matter can be achieved by:

a. Selecting and implementing tillage and cultivation practices that maintain or improve the physical, chemical and biological condition of the soil and minimize soil erosion. In a lay mans language soil physical condition describes the softness, mellowness, workability or tilth of the soil. However in technical term it describes the bulk density, water retention penetrability, water infiltration rate, water holding capacity and porosity of the soil. A soil in good physical condition provides several benefits for crop growth and these include; (i) Plant roots can grow through the soil without restriction (ii) Air, water and nutrients needed by plant and soil organism can move through the soil with ease. (iii) Water from rainfall or irrigation seeps into the soil rather than flow over the soil as run off. (iv) Soil organisms involved in decomposition and mineralization of plant and animal residues are able to thrive and disperse throughout the soil.

Soil chemical properties include the fertility, salinity, acidity and alkalinity of the soil. A soil in good chemical condition has the following characteristics: (i) A near neutral pH. (ii) Sufficient nutrients are available for productive crop growth. (iii) Soil nutrients are in available form for plant uptake but they are held sufficiently not to be easily leached or carried away by run off. (iv) The availability of plant nutrient is sufficiently balanced to promote crop growth and microbial activity. (v) Soil do not contain toxins or heavy metal in concentrations high enough to inhibit the growth of plant and beneficial organisms. (vi) Soil contains enough moisture to facilitate nutrient movement to plant root. (vii) Soil contains sufficient oxygen for the growth of plant and soil organism, (viii) Soil contains relatively high level of organic matter which help them to hold water and nutrient.

Improving soil chemical and physical condition is important for both conventional and organic production, improvement of biological condition of soil is particularly important under organic production system. In lay man's language soil biological conditions is described as earthy smell, soil crumbliness, greasy soil etc. Scientists measure it as microbial biomass, microbial community and rate of decomposition of organic matter. Organic production relies on nutrient release through the decomposition of plant and animal residues. Decomposition is a biological process involving a variety of soil organisms, including beetles and other insects, worms, nematodes, fungi, bacteria, and algae. The following characteristics are indices to the biological health of the soil. (i) The soil is readily broken down and decomposed so that plant nutrients become available. (ii) The soil has a good structure provided by stable organic compounds and decomposed plant and animal remains. (iii) The soil is well aggregated because clumps are held together with fungal threads and bacterial gel. (iv) Legumes form healthy nodules and fix abundant nitrogen. (v) Plants have a relatively high resistance to soil-borne diseases.

b. Soil erosion is the loss of surface soil to forces of wind and water it reduces soil productivity and cause water and air pollution. Minimizing soil erosion is critical for sustainable agricultural production this is because the top layer of soil has physical, chemical and biological properties that are much more favorable for crop production than the lower layers. The top soil contain organic matter than lower layers and this organic matter can both protect the soil against erosion and can be easily lost to it. Tillage is the preparation of land for seeding and transplanting and cultivation practices manage weeds and improve soil erosion and water infiltration. Clean tillage disrupts soil organisms, reducing their numbers and often their diversity. Organic producers must use tillage practices that maintain or improve the physical, chemical and biological properties of soil. These practices will have the following general characteristics. (i) Promote water infiltration. (ii) Minimize soil compaction. (iii) Minimize degradation of soil (iv) Protect soil from the erosive forces of wind and water (v) Minimally disrupt the habitat of beneficial soil organisms. (vi). Return or add plant and animal residue to soil to serve as food and energy sources to soil organisms. Practices that can be used to reduce soil disturbance, provide residue cover and protect the soil surface from erosion and organic matter loss include (a) Minimum tillage (b) Undercutter or roll-chopper tillage (c) Mulch tillage or mulching with organic materials (d) Promoting rapid growth of crop canopy (e) Flame weeding. Choice of the appropriate tillage and cultivation implements depends on the location of farm, the soil type the crop, time of the year, weather conditions in a particular year.

According to national organic program rule of United States, Section 205. 203. the physical, chemical and biological properties of soil can be improved or maintained by using cover crops, green manures, compost mulch, high residue crops and perennial crops.

Crop rotation and cover cropping

In a well managed cropping system, crop rotations and cover crops can provide the benefits of cultivation and compensate for many of its negative impacts. When legumes are included in the rotation and/or used as cover crops added benefits are derived from legume nitrogen fixation. Rotating crops can suppress weeds and when crops with different planting dates, rooting habits, length of production, cultivation and harvesting requirements are planted the crops are better equipped to compete with weeds. Cover crops effectively reduce weed pressure by occupying the space and using the light, water and nutrients that would otherwise be available to weeds. Cover crops can be cut or incorporated to soil prior to planting main crop. The residue left after cutting provides a cover over soil surface that suppresses germination of weed seeds and increases soil organic matter. Plant and animal materials must be used to manage crop nutrients and soil fertility and water quality is protected by growing crops that immobilize excess nutrients. Thereby reducing the potential for nutrient to be leached beyond the root zone into ground water or carried away by runoff into streams or lakes. For example rye can tie up large quantity of nitrate. The use of cover crop is particularly important in sandy soil. Plant available nutrients in organic systems include mineral nutrients, mineralized nutrients from plant and animal residues, nutrients held in microbial biomass, and nutrients that are being mineralized.

Crop rotation is the planting of different crops in sequence, sometime the crops are together for part of their life cycle. The benefit of crop rotation is determined by the choice of crops. Growing the same crop continuously on the same field depletes the soil of nutrients required by that crop due to nutrient mining. Usually a high nutrient demanding crop is followed by a crop with low nutrient requirement or a legume, which by its nitrogen fixing ability is able to replenish some of the nutrients taken up by the previous crop. In addition to this, crop with different rooting system can also be combined so that soil nutrients at different depths are efficiently utilized.

Moreover, crop rotation is a cultural system used to control pest and diseases that can become established in the soil over time. Changing of crop in a sequence tend to reduce the population level of the pest. This is because plants within the same taxonomic family tend to have similar pests and pathogen, by regularly changing the planting location the pest cycle can be broken or limited. For example root knot nematode can be greatly reduced by growing a crop that is not a host to it thus making it possible to grow a crop that is susceptible to it the following season. Also crop rotation also help to brake the cycle of weed, this is because some weeds are associated with particular crops and when a different crop is planted the incidence of that weed is reduced or eliminated. This is useful to the principle of organic agriculture that does not permit the use of synthetic pesticides. A general effect of crop rotation is that there is geographic mixture of crop which can slow down the build up of pest and disease during the cropping season. The different crop can also reduce the adverse effect of weather for the individual farmer, by requiring crops to be planted and harvested at different times and more land can be cultivated with the same amount of machinery and labor. The choice and sequence of rotation depends on the soil, climate and precipitation which also determine the type of crop that may be cultivated. Other aspects of farming such as marketing and economics of production must also be considered.

Soil management practices such as zero or reduced tillage can be supplemented by specific crop rotation methods to reduce rain drop impact, sediment detachment, sediment transport and soil loss (Unger and McCalla, 1980.). Protection against soil loss is however maximized with the rotation method that leaves the greatest mass of stubble on the surface of the soil (Ross and Freebain, 1985). The additional residue added by rotation with crops with substantial biomass will enhance soil structure, stubble cover prevent detachment and disruption of soil aggregates that cause macropores to block, infiltration to decrease and runoff to increase (Loch and Foley, 1994). This significantly improves resilience of soil when subjected to periods of erosion and stress.

Crop rotation also affects the timing and length of period that a field is subjected to fallow (Huang, 2003). This is very important because depending on the region climate, a field could be very vulnerable to erosion when under fallow. Therefore efficient fallow management is essential in reducing erosion in a cropping system. Zero tillage is a fundamental management that promotes stubble retention under longer unplanned fallow when crop cannot be planted (Carrol et al 1997).

Green Manures

A green manure is a type of cover crop grown primarily to add nutrient to the soil. It is grown for a specific period then plowed under and incorporated into the soil. Green manure usually performs multiple functions that include soil improvement and protection. Legume green manures contain nitrogen fixing bacteria in their root nodules that can fix atmospheric nitrogen into forms that plant can use. Green manure increases the organic matter in the soil thereby improving water retention, infiltration, aeration and other soil characteristics. The root systems of some green manure grow deep into the soil and bring up nutrients unavailable to shallow rooted crops. Common cover crop functions of weed suppression and prevention of erosion are often considered when selecting crop for green manuring.

Agroforestry

Agroforestry is a collective name for land-use systems in which woody perennials such as trees and shrubs are grown in association with herbaceous plants such as crops and pastures and or livestock in a spatial arrangement, a rotation or both. In which there are both ecological and economic interactions between the tree and the non-tree component of the system. This is the cultivation of trees and crops together. The term suggests a deliberate cultivation of trees within an agricultural setting rather than a forestry simply for wood production. This system evolved as a replacement to shifting cultivation for the regeneration of soil fertility and the slash and burn practice. Although agroforestry is not restricted to the use of nitrogen fixing trees, these however have a special role particularly on degraded lands. Nodulating legumes such as members of the family of Papilonoideae, (Flemingia, Gliricidia and Sesbania) and mimosoideae (eg Acacia, Calliandra, Faidherbia, Leucaena and Prosopis), non nodulating legume trees such as Caesalpinioideae (eg Cassia and Senna) and actinorhizal (eg Alnus and Casaurina) are used in agroforestry.

Compost

Composting is the biological decomposition and stabilization of organic material. The process produces a final product that is stable, free of pathogens and viable plant seeds and can be applied to the soil. As the product stabilizes, odours are reduced and pathogens eliminated. Composting is necessary for reducing bulkiness of material and maintaining the integrity of the pile, it enhances the usefulness of by-products as fertilizer privately and commercially. It is receiving attention as an alternative manure management practice due to increase pressures to reduce impact on the environment. Benefits derived from compost include; reduces mass and volume thereby lowering hauling costs, reduces odour, pathogens are destroyed, kills weed seeds, improves transportability, it is a soil conditioner, improves nutrient qualities, nutrients from compost are released slowly and steadily, decrease pollutants, stabilizes the volatile nitrogen into large protein particles thereby reducing losses, applied to soil when convenient, saleable product and increases water retention of soil.

Compost has numerous agronomic and horticultural uses which include, as a soil amendment, fertilizer supplement, top dressing for pastures and hay crops, mulch for homes and gardens and a potting mix in potted plants. In these examples, the compost increases the water and nutrient retention of soil, provides a porous soil structure for roots to grow in, increases the organic matter and decreases the bulk density or penetration resistance of soil.

Composting:

This is the deliberate biological and chemical decomposition and conversion of organic or plant residues for the purpose of producing humus. This process takes place under controlled conditions in heaps or pits. Composting is a method of recycling organic matter it helps to improve the chemical, physical and biological conditions of the soil. Depending on the situations and site, composting can also solve various problems associated with the management of plant residues, eg (a) disease and pests including weed seeds are destroyed by the high temperatures that develop in good compost during the composting process. (b) Viruses are also destroyed provided a sufficiently high temperature is attained in the compost heap. (c) Nesting and breeding of rodents in scattered heaps of plant litter can be prevented by composting such residues. (d) Plowing fresh material into the soil as green manure in wet season on soil where water tend to stagnate leading to substantial nitrogen loss under the semi-anaerobic condition or constant leaching, composting such biomass help to prevent this. (e) When plant residues with high C/N or C/P ratio eg grain straw is plowed into the soil it temporarily fixes N or P in the soil thereby inhibiting plant growth. This can be avoided by composting the residues preferably with other green, N-rich materials. This reduces the C/N ratio and breaks down inhibitors to produce humus which can be easily applied as fertilizer. The alternative solution of burning the plant residues would entail losing valuable organic matter and nitrogen.

The end product of the composting process is a fertilizer with valuable properties and multiple functions including:

(i) Nutrient function: nutrients are stored by being adsorbed into the organic matter into the tissues of the microorganisms, into their waste products and into the humus compounds themselves. Therefore compost is a slow release fertilizer, the nutrient content of which varies according to the raw material and composting method used.

(ii) Improving soil structure: The soil structure improves due to increase in the percentage organic matter. This leads to improvement in the physical properties of the soil eg bulk density is reduced, aeration is improved, water holding capacity also increases.

(iii) Stimulation of soil organisms: Adding humus increases the biological activity of the soil. It improves water holding capacity and crumb formation, promotes infiltration, protects soil against erosion and facilitates the spread and penetration of plant roots.

(iv) Strengthening resistance: It has been frequently observed that crops fertilized with compost are more resistant to pests than those which have either been given mineral fertilizer or with no fertilizer at all.

(v) Compost is a fertilizer made from renewable resources which can be produced by farmers themselves.

(vi) Composting offers a means of ensuring long-term soil fertility without the need for external inputs. Unlike other fertilizers which have only short-term effects, if applied regularly over many years it can improve the long-term productivity of the soil.

Principles of Composting:

Organisms:

The composting process may be seen as a series of attacks on original structure of organic materials by different groups of microorganisms. Bacterial, fungi, earthworms, isopods, millipedes and snails are usually the early arrivals these gradually give way to protozoa, springtails, mites etc. At the final stages beetles, centipedes, ants and predator mites increase in numbers. Microorganisms play leading role in the decomposition process the larger organisms are particularly active in physical decomposition i.e breaking down the material into smaller particles. To ensure the success of the composting process optimal conditions must be created for the microorganisms. The food supply, air, moisture, warmth and pH of the environment should be as favourable as possible.

Materials:

All organic matter (plants, refuse, paper etc) is suitable for composting, however, human excreta and feaces from carnivores require separate treatment as extra precautions must be taken to ensure adequate sanitation. Organic matter is food for microorganisms providing them with energy and nutrients for growth and reproduction. Starches, soluble sugars, carbohydrates and amino acids are readily available and can be processed rapidly microbiologically by oxidation to CO_2 while producing heat. On the other hand, cellulose and lignin are highly resistant to decomposition and must first be broken down by enzymes. The higher the proportion of such non-readily available matter, the slower the decomposition process. Nitrogen is the most important nutrient in the composting process. If the material to be composted contains enough nitrogen, sufficient amounts of other nutrients needed by microorganisms are usually present. The C/N ratio of compost mixture should ideally be around 30:1. Composting plant residues with animal dung help to achieve a composition with low C/N ratio, accelerates the composting process and improves the quality of compost. Different types of materials from various sources compost better than homogenous materials. The better the materials are mixed, the better the compost. All materials must be chopped into 5-12cm lengths to increase the surface area.

Water:

For a compost to flourish, it must contain water to enable its fungi and bacteria population to develop. The process of decay stops if the water content falls to 12-15% and in some cases water content as high as 40-45% may limit the compost's development, ideally, compost should contain between 50 and 60% water. Higher moisture content will produce anaerobic condition. As a practical indicator the compost should look like a squeezed sponge. Therefore composting material should be thoroughly watered at the onset, this is best done while adding the materials, after adding it and the next morning.

Ventilation:

The compost needs good ventilation so that oxygen can enter and $C0_2$ can escape. If the compost does not get enough air it will revert to rot or silage while too much ventilation may cause it to dry out. Steps are usually taken to improve ventilation around and within the compost. To allow for good air circulation within the compost, it is turned at frequent intervals.

Temperature:

A satisfactory temperature is the best indication of a successful composting. If a compost heap has been correctly built it goes through several temperature phases. The temperature climbs sharply at first reaching a temperature of $60\text{-}70^{oC}$ in 1-3 days. The temperature continues at this level for about a day and drops slowly. The conversion processes are most efficient during the hot phase. Most agents of disease and weed seeds are destroyed during this hot phase. To ensure a temperature increase compost heap should consist of several layers, the size of the compost should measure at least 1 cubic meter. The composting material should be turned when the compost is cold then round of temperature rise occur.

pH:

It has been suggested that ashes, gypsum or lime should be worked into each layer. If used this materials should be sprinkled very thinly over each layer.

Indicators of a successful composting:

(i) Temperature rise should occur between 24-48 hrs into the composting process, the temperature peaks by 42-72 hrs and remain constant for a few days before a gradual reduction up to 14-21days.

(ii) Reduction in size of the composting materials, at the end of the process there is at least 1/3 reduction of the initial biomass.

(iii) Drops of water will be observed under the covering polythene indicating that the organisms involved are metabolically active.

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ORGANIC PEST MANAEMENT

Organic pest management discourages the use of chemicals in controlling pest. Anything done on organic agriculture helps in the management of pests and diseases control.

Organic agriculture saves the use of money for health reasons. Organic agriculture don't destroy, they keep anything that mimic the natural system e.g Wall gecko, toad, spider etc are very useful in organic system. The populations of this organism are enhanced for their better growth and productivity.

Organic system is supposed to give better yield, while it is not so traditional farming. Soil fertility is destroyed in traditional system while organic systems enhance soil fertility. Organic system is not conscious about pests and disease management but what to do to enhance them. Organic pest management (OPM) emphasizes on improved biodiversity.

In organic crop production system, Organic Pest and Disease Management is essentially concerned with the knowledge and understanding of the reason why plants are threatened by pest organism. On this basis, a local organic pest method or strategy are embarked upon to correct or minimize the underlying factor towards reducing the overall effect of organisms on the crop.

In organic system, it is important to look at pests and diseases in a balanced way, i.e, you must accept or recognise that you have to share your crop with some of these organisms. You must not think about the pests alone but also the condition of the grain.

OPM is not just about excluding or avoiding the use of synthetic pesticide and chemicals, it is not just about botanical or plant extracts but rather, it is a wholistic approach and ecological concept that ensures that nothing is wasted on the farm. The implication here is that OPM is based on waste recycling that enhanced bio-diversity. Consequently, in a standard organic farm, pest control is not a priority. Organic farmers do not bother themselves about pests and diseases because organic pesticides are effective against them since organic crop appears to be:

- More resistant or tolerant
- Vigorous
- Low insoluble N and AA
- Thicker cell wall

Practical Tips

1. In organic system, we tolerate higher densities of weeds because:

   a. Conserve/encourage rare species

   b. Encourage host to beneficial organism or natural organisms

   c. Serve as trap for pests and diseases

2. **Tolerant**: You can also tolerate a few pest because it is an essential part of organic system that serve as natural means that pest and crop of other organisms exist harmoniously in a healthy ecosystem. Therefore, in a well established farm, pest exists but not at a disastrous magnitude. Pest must be allowed to take a little of our crop but the rule of thumb is to grow healthy and vigorous plant that cannot be completely destroyed by the pest.

3**. Survival of fittest**: The practical thing to do to a particular plot where plants continued to be plagued by pest is to leave it, if it survives, it is good for us and if not, replace with another crop. For instance, in a plot of tomato, if it is observed that all but some plants are being destroyed by pests and diseases, just allow the survivor to get to seeds and use such seeds to grow, and next season, crop. This is a natural way of allowing better and well adapted varieties to evolve and will at the long run enhance population of plants that are the fittest.

4. **Planting Pattern**: This is important to pest and diseases management. Cop diversity through mixture should be encouraged rather than monoculture that will enhance easy spread. Staggered planting should also be embarked upon to confuse or kill the pests and to support predators.

Bio-diversity will mimic natural ecosystem. Different foliage system of the crop makes it difficult for the pest to zero on susceptible crops..