Index

Lecture No.1

General status and trend in population and food production, agricultural growth, fertilizer and pesticide consumption (in pre and post green revolution period) and negative impacts of their excess application.

CONTENTS

1.1 GENERAL STATUS AND TREND IN POPULATION AND FOOD PRODUCTION

Current Indian population: 116 crores, it will reach to 130 and 166 crores by 2025 and 2050 AD, respectively.

We need to produce food grain of 320 and 350 m t by 2025 and 2050 A D, respectively. Current food grain production is 210 m t.

India has 17 % of the world's population and 15 % of livestock but, has only 2.4 %of the geographical area, 4 % of the fresh water, 1 % of rainfall, 0.5 % of forest and 0.5 % of grazing land of the world

17 % more water is required by 2020 AD.

By 2050 AD global population will be 9.4 billion (42 % increase)

Growth rate of agriculture (1.5 %) is much lower than population growth (2%).

Net cultivated area in India: 142.8 m ha. It will decline to 137 m ha by 2050 AD.

65 % of the population still relies on agriculture for employment and livelihood Agriculture support 58 % of the total working force.

Agriculture contributes 18 % to GDP.

973 million people are undernourished in the world

800 m people living below the poverty line in the world and half of them in South Asia and majority of them in India (FAO).

270 m ha area in the world is irrigated area, which consumes 70 % of the world's total human-induced water consumption.

Before 1970's –ship to mouth stage (PL-480: wheat import during 1960)

Annual agril. Production, which was 0.3 % during 1900 to 1950, jumped to 3.3 % during 1960-70 but the growth became reduced to 1.43 % during 1990-98 compared to the population growth of 18 % during the same period. India became the 4th largest fertilizer producing country

Fertilizer consumption increased from 0.52 kg/ha during 1950-51 to 94.72 kg/ha during 1999-2000.

During 2001-02: 18 m t fertilizer was used but the crop removed 28 m t.

During 2006 total fertilizer consumption from chemical fertilizer was 20.4 m t

Country's nutrient requirement will be 45 m t by 2020 AD to produce the food grain required by the population.

Before 1960 none of the micronutrient (MN) deficiencies were found.

During 1960: Only Fe was found defiant

During 1999: Five MN (Mo, Bo, Mn, Zn and Fe) noticed deficient

During 2003: Eight MN's were found deficient

Now : Ten MN's are found deficient

Karnataka stood first in Zn (78%), Fe (39%) and Bo (32%) deficiencies.

Combined effect of high yielding var., fertilizers, irrigation and monocropping mined more nutrients from the soil.

In the beginning of the green revolution a kilo of chemical fertilizer yielded 15-16 kg of grains. The same is now declined to 4-5 kg.

Nations wealth is measured based on the fertility of its soil.

According to Indian standards nitrates in soil should not exceed 45 mg/litre (carcinogenic & affects central nervous system, methaemoglobinaemia: blue baby disease).

Phosphates concentration in the water encourages weed growth (Eutrophication). Consumption of pesticide: 1954 =434 tonnes

1984=64,290 tonnes

But, pests and diseases multiplied four fold.

- The problem of pests and diseases became ten times more severe compared to 1950, after the synthetic pesticides became in use.

- In 1990, cotton crop occupied only 5% of the area but consumed 54% of the total pesticides. Rice received highest pesticide next only to cotton.
- Use of pesticide was more popular in agriculture with the invention of DDT (Paul Muller who got Noble prize in 1939).
- Each year 25 million people in developing countries suffer from pesticide poisoning.

"Green Revolution provided food for millions of hungry people but left many unseen miseries of fauna and flora on the land and in water"

- Eutrophication: It is the process of enrichment of surface water bodies like lakes, reservoirs and streams with nutrients. Nutrient enrichment of water bodies results in intense proliferation and accumulation of algae and higher aquatic plants in excessive quantities that can result in detrimental changes in water quality and can significantly interfere with the use of water resources.

About 60 % of our agricultural land currently under cultivation suffers from indiscriminate use of irrigation water and chemical fertilizers. The gravity of environmental degradation resulting from faulty agricultural practices has caused alarming concern among the farmers, scientists and conservationists.

Dr.Norman Borlaug in field

Dr.Norman Borlaug

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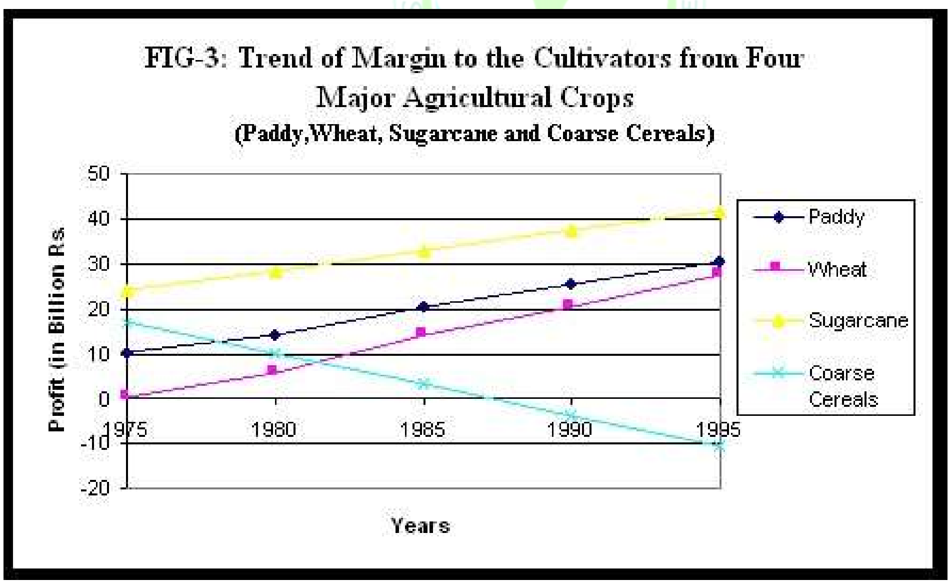

FIG-3: Trend of Margin to the Cultivators from Four Major Agricultural Crops
(Paddy,Wheat, Sugarcane and Coarse Cereals)

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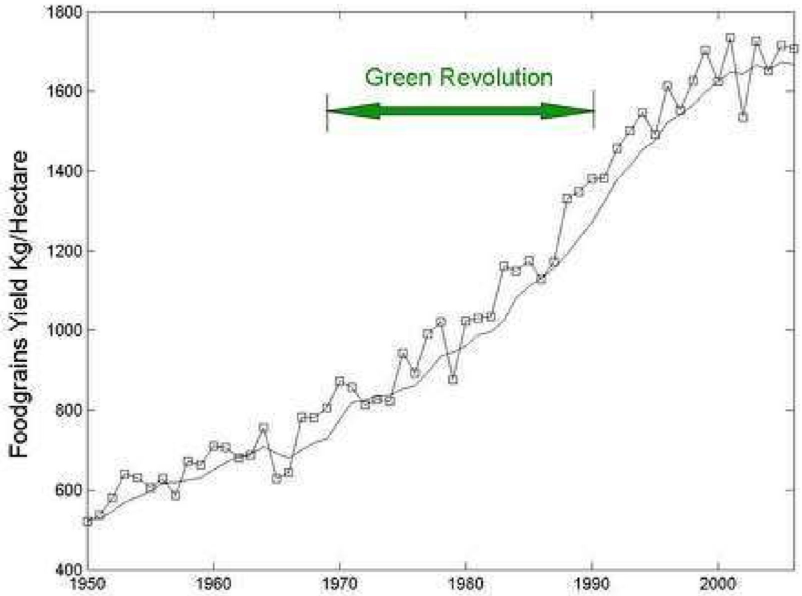


Lecture No.2

RELEVANCE OF ORGANIC FARMING

CONTENTS

2.1 Introduction

25% of the India's population can't get three square meal a day

Green revolution (GR) was only concentrated in areas having fertile soil and adequate water supply. This 30% of the GR area contributed 60% of the food production while, 70% of the area contributed only 40%.

In intensive farming systems, organic agriculture (OA) decreases yield. In the GR areas (irrigated land and well endowed water regions), conversion to organic usually leads to almost identical yields. In traditional rainfed areas (with low external inputs) OA has shown the potential to increase the yields. Under restricted water availability or rainfed condition, difference in crop yield between organic and conventional production narrow down to between 10 to 15%.

In earlier period, farmers used to choose crops depending on the climate and soil conditions. Alexander Walker (at Baroda) (1829) –Green fodder was being grown throughout the year; intercropping, crop rotation, fallowing, composting and maturing were practiced.

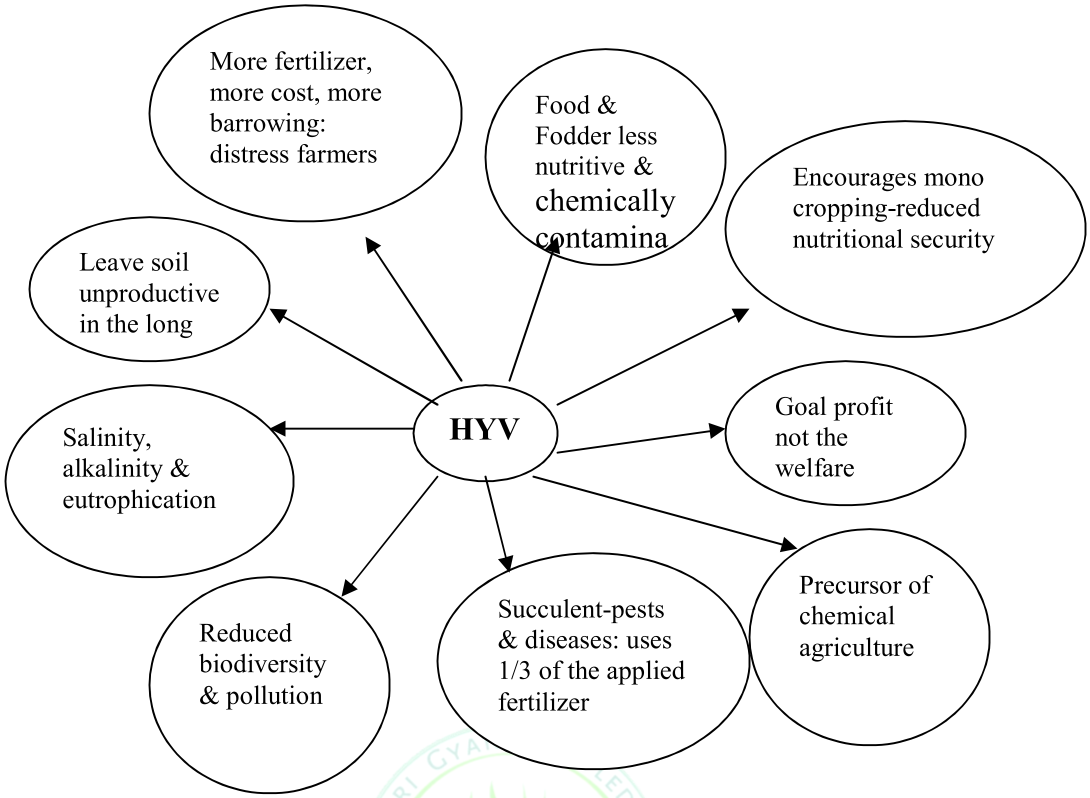
Technical team constituted by the ministry of Agriculture made the following observations.

i) The country at present is not in a position to completely eliminate the use of chemicals especially the fertilizer.

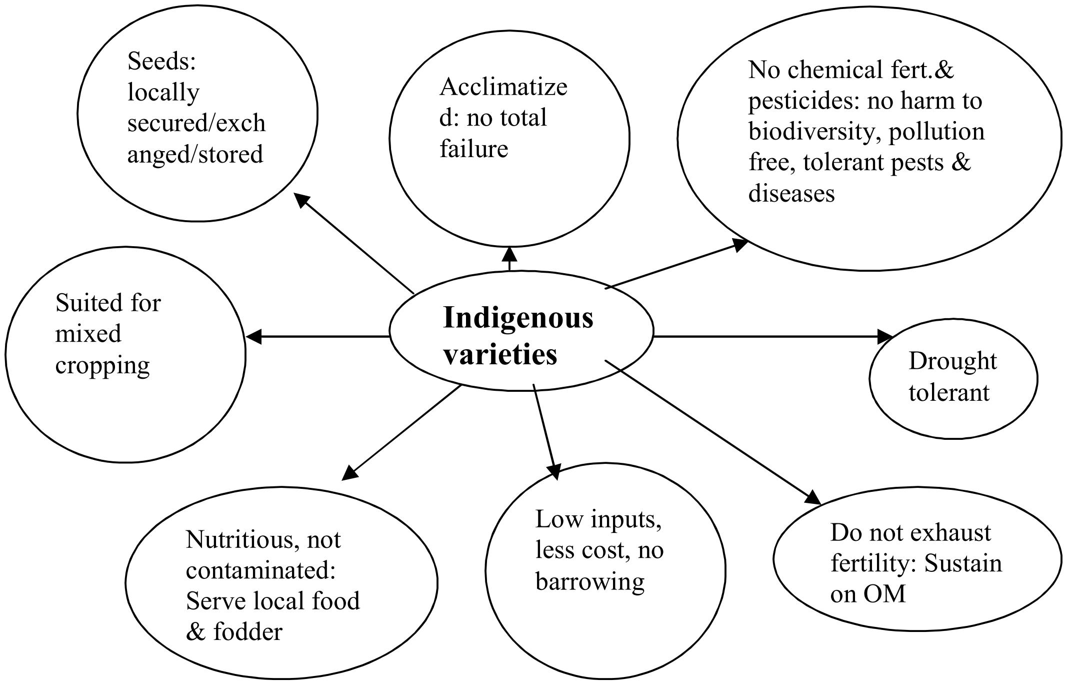
ii) Fertilizers can gradually be reduced iii) Control on commercial sale of organic manures iv) IPM is the solution.

The task force on Organic Farming (OF) set up the Union Ministry of Agriculture during 2001 brought out the status of OF in the country. In its report it is stated "Organic farming is being practiced by thousands of farmers in the country in an unorganized way".

2.2 Consequences of the use of High Yielding Varieties (HYV)



2.3 Characteristics of indigenous varieties



2.4 Ill effects of Green Revolution

Chemical companies that developed highly toxic life damaging chemicals for the purpose of warfare, decided to turn their attention on the chemical control of insects, diseases and unwanted plants.

Reduction in natural fertility of soil

Destruction of soil structure, aeration and water holding capacity of soil.

Susceptibility of soil to water and wind erosion: In US 15 t/ha topsoil is lost; in India it is even more.

Silting of reservoir

Diminishing return on inputs

Indiscriminate killing of useful insects, microorganisms and predators that naturally check excess crop damage by insect pests.

Breeding more virulent and resistant species of pests.

Reducing genetic diversity of plant species.

Pollution with toxic chemicals. (In Europe 25% of the people drinking water with nitrate above safe limit: 25 mg/lit).

Endangering the health of the farmers and workers who produce them (workers handling pesticide for more than 20 years have increased the risk of developing certain type of cancers.

Poisoning the food with highly toxic pesticide residues.

Cash crops replacing nutritious food crops.

Chemical changing the natural taste of the food.

High inputs increasing the agricultural expenses

Increasing the farmers work burden and tension.

Depleting the fossil fuel resources.

Increasing the irrigation needs of the land.

Depleting the ground water reserves.

Lowering the drought tolerance of crops.

Appearance of problematic weeds.

Heightening the socio-economic disparities and land holding concentration.

High input subsidies leading to inflationary spirals.

Increasing the political and bureaucratic corruption.

Destroying the local culture.

Thronging financial institution into disarray.

Agricultural and economic problems sparking off social and political turmoil resulting in violence.

Effects of excess use of endosulfan on health in Kasaragod

Thus, the need arose for an alternative to conventional agriculture, to save the soil from degradation, to increase the fertility and productivity, to avoid synthetic pesticides, to prevent pollution and increase biodiversity, to reduce the dependence on costly external inputs and to reverse the trend of barrowing, to make the farmers to rely more on local natural resources to inculcate self reliance and self respect.

Lecture No.3 & 4

CONCEPT OF ORGANIC FARMING


CONTENTS

3.1 Often debated issues

1. Can OF produce enough food for every body?
2. Is it possible to meet nutrient requirement of crops entirely from organic sources.
3. Are there any significant benefits of OF
4. Is the food produced by OF is superior in quality
5. Is OF economically feasible
6. Is it possible to manage pests and diseases in OF

3.2 Significance of OF for Indian farmer

Varied agro climatic regions and diversified cropping situations, all crops are grown

Potential for on-farm input management viz., crop residues, organic manures, green manures, biopesticides etc.., which are store house of nutrients.

700 mt of rural and urban biomass, 2000 mt of animal and human excreta (800 mt of animal dung annually), 600 to 700 mt of agricultural waste is available in India annually.

Even if 2/3 of the dung is used for biogas generation, it is expected to yield about 440 mt of manure/year, which is equivalent to 2.0 mt N, 2.75 mt P_2O_5 and 1.8 mt K_2O/year.

Small holdings: prevailing farming systems which combine agriculture, livestock, horticulture, forestry, poultry, fisheries etc.,

Indigenous technical knowledge (ITK) and skills, and availability of trained manpower.

Scientific thinking, approach and Govt. policy support towards OF is increasing Greater domestic market for organic foods.

3.3 Size of Organic Food Market/area under OF

18 mha in N-E India –default OF

Roots of OF in English speaking word can be found in India.

Albert Woward(1873-19470-a agricultural scientist

Robert Mc Carrison (1878-1960)

In Pusa, New Delhi, Howard worked on plant breeding and plant protection. At the agricultural research at Indore, he developed an aerobic composting techniques known as "Indore process".

Until 2001 there were only 304 organic farms in India. According to IFOAM-survey in 2005, India has about 76, 326 ha area under OF managed by 5147 certified organic farms which is only 0.05% of total agricultural land.

Demand for organic products from India: Basmati rice, Spices, Tea, Coffee, Mango, Pineapple, Banana, Vanilla, and Cashew nuts, Protein grains.

Export of organic products from India to other countries:

Europe: Netherlands, UK, Germany, Belgium, Sweden, Switzerland, France, Italy and Spain.

Americas: USA and Canada

Middle East: Saudi Arabia and UAE

Asia: Japan and Singapore

Africa: South Africa

Australia: Australia

World

There were only few organic farmers in 1980. Now in 2006, as many as 6,23,000 organic farms with some 31.5 mha area managed organically, it is practiced in about >130 countries.

Market for organic products is growing not only in Europe and North America but also in many other countries.

Growing health and environmental concern creating huge domestic and export market.

International market for organic food products

19.73 billion US $ during 2000

26.00 billion US $ during 2002 (Indian share is 20 million US $)

Demand for organic food is steadily increasing both in developed and developing countries with annual growth rate of 20-25%.

Australia, Argentina, Italy, Canada and USA are the countries having largest area under OF

Some of the countries like Sweden, Australia,Switzerland, Finland and Italy have substantial area (10%) under OF.

Leading organic food consumers: Swiss, Denmark, Sweden, Australia, In Asia, Japan is the major consumer. Malaysia, Taiwan, Singapore and to some extent Korea.

IFOAM (International Federation of Organic Agriculture Movement) in 1972. Its first conference was held at Switzerland.

Market

Current market: 23-25 billion US $

Annual growth rate: 15-20%

USA: 11-13 billion US $

Japan: 350-450 million US $

Europe: 10-11 billion US $

3.4 Status of OF in India

The task force of GOI under the chairmanship of Shri Kunwarji Bhai suggested need for alternative to modern conventional agriculture.

Ministry of Commerce, GOI, has launched national programme for organic production in March, 2000

National Standards for organic products (NSOP) have been standardized during May, 2001 and all the products sold under the logo "India Organic"

Natioanal Accreditation Policy Programme (NAPP) has been formulated with the accreditation regulations announced in May, 2001.

This made it mandatory that all certification bodies engaged in inspection and certification of organic crops and products should be accredited by an accreditation agency.

Accreditation agencies: APEDA, Coffee Board, Tea Board, Spice Board etc.,

Certification and inspection agencies: Institute of Marketology (IMO), SKAL India, INDOCERT, ECOCERT International, SGS India Pvt. Ltd, APOF Bangalore etc., National Institute of Organic Farming (NIOF) established at Ghaziabad. The purpose of this institute is to formulate rules, regulations and certification of organic farm products in conformity with International standards.

Govt of Karnataka also formulated policy on OF during Feb, 2004.

The organic food production costs are higher in the developed countries as organic farming is labour intensive and labour is costly in these countries. However, in country like India, where labouris abundant and is cheap. OF is seen as a good cost effective solution to the increasing costs involved in chemical farming. Currently most of the organic farmers in India are still in the transition phase and hence, their costs are high. As these farmers continue with OF, the production costs are expected to reduce, making India as one of the most important producers of organic food.

<u>**Lecture 4**</u> **CONCEPT OF ORGANIC FARMING**

contents

4.1 Export of organic food from India (2002)

4.2 Concept of Organic Farming

4.3 Ethics of OF:

4.4 Objectives of OF (as per IFOAM)

4.5 Characteristics of OF

4.1 Export of organic food from India (2002)

Organic food items	Sales (Tones)
Tea	3000
Coffee	550

Spices	700
Rice	2500
Wheat	1150
Pulses	300
Oil seed	100
Fruits and Vegetables	1800
Cashew nut	375
Cotton	1200
Herbal products	250
Total	**11,925**

Exports

No. of products exported: 18 items

Total quantity of exports: 63452 mt

Total agril. exports: Rs. 27720 crore

Organic exports: 0.32%

4.2 Concept of Organic Farming

Modern agriculture largely depends on the use of fossil fuels based inputs such as chemical fertilizers, pesticides, herbicides and labour saving but energy intensive farm machinery while, application of such high input technologies has undoubtedly increased production and labour efficiency, there is a growing concern about the adverse effects on soil productivity and environmental quality.

The generally accepted organic rules prohibit the use of synthetic fertilizers, pesticides, growth regulators, livestock feed additives and stress on long term soil management. Use local resources for nutrient supply and control of pests and diseases restricting external inputs to the bare minimum.

It is soil-building mechanisms to keep soil alive. Keeping soil alive is the primary concern of organic farming. In OF, soil and not the crop are fed. It is conversion of soil from non-living to living.

Plants can absorb nutrients only in the form of minerals irrespective of the source of manure. OF seeks to avoid direct use of readily soluble chemicals Eg-Muriate of potash is a natural rock and is not permitted because it is readily soluble. On the other hand, basic slag which is a product of iron ore is insoluble in water and hence, it is allowed.

4.3 Ethics of OF: Chemicalisation, excess irrigation, depletion of soil moisture, depletion of organic carbon and organic matter content in soil, burning/wasting of biomass, soil erosion or allowing the soil to dry etc., are all against the ethics of OF. OF is not a goal to be attained. It is an ongoing process. It is a journey rather than a destination.

According Lampkin (1990): Organic agriculture is a production system, which avoids or largely excludes the use of synthetic compounded fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent feasible, organic farming system relies on crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and to control insects, weeds and other pests.

According to IFOAM: The role of organic agriculture whether in farming, processing, distribution or consumption is to sustain and enhance the health of ecosystem and organisms from the smallest of the soil to human beings.

The primary goal of OA is to optimize the health and production of inter dependent communities of soil life, plant, animals and people.

According to Codex Alimentarius (Food code) Commission (CAC), OA is a holistic food production management system, which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity.

OA is often termed as knowledge based rather than input based.

India needs nutritional security besides food security.

India stands 124th in the developmental index because of poor nutrition.

Organic foods and vegetables contain 40% antioxidants and beneficial compounds and 90 % more of these compounds are in organic milk. Organic foods are more nutritious than other foods.

Albert Howard sited several examples of good nutritive values of organic food in his book"**An Agricultural Testament**"

OA is farming system devoid of chemical inputs, in which the biological potential of the soil and underground water resources are conserved and protected from the natural and human induced degradation or depletion by adapting suitable cropping models including agro forestry and methods of organic replenishment; besides natural and biological means are used for pest and disease management by which the soil life and beneficial interactions are stimulated and sustained.

OF is a matter of giving back to nature what we tale from it (Fantilanan, 1990). It is safe, inexpensive, profitable and sensible. OF does not totally excludes the elements of modern agriculture.

Different terms by diff people: i) Ecofriendly farming (farming in relation to ecosystem) ii) Biological farming (farming in relation to biological diversity), iii) Biodyanamic farming (biologically dynamic and ecologically sound and sustainable), iv) Macrobiotic agriculture (agriculture in relation to macro fauna), v) Natural farming etc., (based on natural farming which alone are sustainable).

OA has three principles, It must be

a) Ecologically sound, b) Economically feasible and c) Socially acceptable.

Till 20 th century OF was not alternative, it was a way of life. Till today in many of the poor nations, OF is a way of life as much as it is a method of farming.

OF is not a philosophy but a means of achieving sustainability in agriculture.

4.4 Objectives of OF (as per IFOAM)

To produce food of high nutritional quality in sufficient quantity

To work with natural system rather than seeking to dominate them.

To encourage and enhance biological cycles within farming system-involving microorganisms, soil flora and fauna, plants and animals. To maintain and increase long term fertility of soil

To use, as far as possible, the renewable resources. To work as much as possible, within a closed system, wit regard to organic matter and nutrient elements

To give all livestocks, conditions of life that allow them to perform all aspects of their innate behavior

To avoid all forms of pollution that may result from agricultural techniques

To maintain the genetic diversity of agricultural system and its surroundings, including the plants and wild life habitats

To allow agricultural producers an adequate returns and satisfaction from their work including safe drinking water

4.5 Characteristics of OF

Maximum but sustainable use of resources

Minimal use of purchased inputs, only as complementary to local resources

Ensuring the basic biological functions of soil-water-nutrients-human continuum

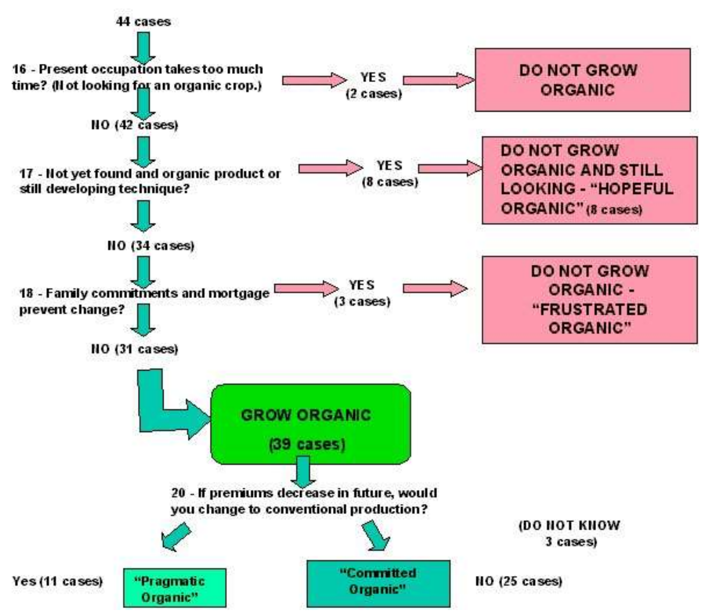
Maintaining the diversity of plant and animal species as a basis for ecological balance and economic stability

Creating an alternative overall landscape which give satisfaction to the local people

Increasing crop and animal diversity in the form of polycultures, agroforestry systems, integrated crop-livestock systems etc.., to minimize the risk

Figure 3.3: Constraints to the Organic Farming Decision

(Given you have decided to grow organic products)



Lecture No. 5

ORGANIC PRODUCTION REQUIREMENTS

CONTENTS

5.1 Components of OF:

i. Organic manures

Organic manures such as FUM, biogas slurry, compost, straw or other crop residues, biofertilizers, green manures and cover crops can substitute for inorganic fertilizers to maintain the environmental quality. Organic farmers may also use the see weeds, fish manures and some permitted fertilizers like basic slag and rock phosphate.

ii Non-chemical weed control measures

Mechanical weed control, especially in row crops. No herbicides are used. Cultural, biological and physical methods are resorted to. Botanical herbicides, mycoherbicides and bioagents are employed to control weeds.

ii. Biological pest management

Non-chemical, biological pest management is encouraged. Natural enemies of pests are encouraged. Botanical pesticides such as those derived from neem could be used. Microbial pesticides like *Bacillus thuringiensis* is used.

5.2 Nutrient management in OF

The first task in OF is to protect the soil fertility and health. Use of organic manures, crop rotation, use of crop residues, green manures, intercropping with legumes, use of biofertilizers etc., are resorted to.

5.3 Limiting nutrient losses

Better recycling of wastes

Handling of organic wastes

Application of organic matter at right time, method and quantity

Reducing run off by following conservation practices

Conservation of organic matter by decreasing burning of crop residues

In wet land, deceasing denitrification losses of nutrients

Nutrient release and time of uptake must be synchronized

Cropping pattern

Pumping of nutrient by hedge row planting

Minimizing the exports of nutrients from the farm

5.4 Organic manures

The organic manures are derived from biological sources like plant, animal and human residues. These organic manures contain loa amounts of plant nutrients but, organic matter, other than nutrients, present in large quantity hence, they are also called as bulky organic manures. Among various bulky organic manures, FYM, compost, green manure, concentrated manures, vermicompost, oil cakes are most widely used.

5.5 Farm Yard Manure (FYM)

Farmyard manure (FYM) is decomposed mixture of cattle dung and urine with straw and litter used as bedding material and residues from the fodder fed to cattle. The waste material of cattle consisting of dung and urine soaked in the refuse of the shed is collected daily and placed in trenches of about 6 m long, 2 m wide and 1 m deep. A section of 2-3' from one end of the trench is first selected for filling. The trench is filled up to a height of about 50 cm above ground level and plastered over with slurry of cow dung and earth. The material is allowed to decompose undisturbed for 3-4 months for anaerobic micro organisms to complete fermentation.

FYM become ready to apply after 3-4 months. It is spread evenly over 3-4 weeks before sowing, mixed with soil by hand hoe or cultivator. Well-decomposed FYM contains 0.5% N, 0.2% P_2O_5 and 0.5 % K_2O. Cow dung from biogas plant is also utilized in similar manner.

5.5.1 Factors influencing the quality of FYM

- Kind of animal species
- Kind of bedding material
- Kind of fodder fed to cattle
- Age of the animal
- Manner of collection in the shed
- Storage in the pit etc.,

5.5.2 Enrichment of FYM

The recommended dose of P and K_2O for the crops is mixed with 750 kg of sieved FYM. The mixture is spread in the form of heap and plastering is done with red earth paste. This anaerobic process is maintained for 30 days. Then the N fertilizer recommended for the crop is mixed and applied immediately before sowing.

Lecture No. 6

COMPOST

CONTENTS

Compost

Composting is a process by which organic wastes are converted into organic fertilizers by means of biological activity under controlled conditions. It is an important technique for recycling organic (agricultural and industrial) wastes and for improving the quality and quantity of organic fertilizers.

Composting is a self heating, thermophilic and aerobic biological process occurs naturally in heaps of biodegradable process and is carried out by different kinds of heterophyllic microorganisms, bacteria, fungi, actinomyctes and protozoa, which derive their energy and carbon requirements from the decomposition of carbonaceous materials.

6.1 Principles of composting

Compost making includes three important principles

i. Narrowing down of C: N ratio to a satisfactory level (10:1 to 2:1)

ii. Total destruction of harmful pathogens and iii. Destruction of weed seeds by high temperature (60-65° C)

6.2 Organic resources available for composting

i. Livestock and human wastes ii. Crop residues, tree litter and weeds iii. Green manure

iv. Urban and rural wastes

iv. Agro industrial by-products

v. Marine wastes

In India, it is estimated that the annual production of dung and urine of livestock and human beings amounts to about 2000 mt with the potential to supply 6.4, 2.0 and 2.7 mt of N, P_2O and K_2O, respectively.

6.3 Essential requirements for composting

i. **Bulky organic refuse:** stubbles, cotton stalks, tur stalks, ground nut shell, weeds, leaves, dust bin refuse etc. ii. **Starter material:** Cattle dung, urine, night soil, sewage, urea, rockphosphate or any other readily available nitrogenous substance and microbial cultures. iii. **Water:** to keep the moisture content of the material at a level of 50%.

iv. **Air:** especially in initial stages of decomposition.

6.4 Methods of composting

a) Indore method, b) Activated compost, c) Bangalore method, d) NADEP method,

e) Coimbatore method, f) Synthetic compost, g) Windrow composting (leaf compost),

h) Accelerated composting and enrichment, i) Phospho-compost, j) Reinforced compost from sugarcane trash and press mud and k) Japanese method of composting.

6.4.1 Bangalore method of composting

Dr. Acharya developed this method for the utilization of town residues and night soil. It is hot fermentation method. The compost production depot is located on the city outskirts. First, refuse is filled in the trench to about 15 cm height. The night soil is

spread over this to a layer of 5 cm. After filling the pit with refuse and night soil in alternate layers, the pit is filled to 15 cm above the ground level with a final layer of 15 cm on the top. This may be made dome-shaped and converted with thin layer of soil with red earth or mud to prevent moisture loss and breeding of flies. The materials are allowed to remain as such without any turning and pot watering for about three months. The compost obtained by this method contains 1.5% N, 1.0% P_2O and 1.5 % K_2O, respectively.

6.4.2 Indore method

Waste materials are chopped into 5-10 cm pieces and dried to 40-50 % moisture level. They are spread in layers of 10-15 cm thickness either in pits or in heaps of 1 m width, 4-5 m length and 1 m depth. The heap is properly moistened with dung using earth or night soil. Sufficient quantity of water is sprinkled over the heap to wet the composting materials to the level of 50 % moisture. Periodical turnings (15, 30 and 60 days) are given to aerate and material is covered with a thin layer of soil (2-3 thickness). The average composition of manure: 0.8% N, 0.3% P_2O and 1.5 % K_2O, respectively.

Disadvantages: a) Requires labour for turning, b) Not practicable if large quantity of material is there, c) Site should be at elevated level, near a cattle shed and water source.

6.4.3 NADEP Method

The Nadep method of making miracle compost was first invented by afarmer named N.D. andharipande (also popularly known as "Nadepkaka")living in Maharashtra (India). The method, which has become quite popularamong the farmers in Western India, now bears his name. The Nadep method of making compost **is** unique not because it is successful in making good compost, which other methods can also lay claim to;its real secret lies in the large quantities of compost the process can deliverwith a minimum of human effort within a specific period of time. The process basically involves placing select layers of different types of compostible materials in a simple, mud-sealed structure designed with brick and mud water. The system permits conversion of approximately 1 kg of animal dung into 40 kg of rich compost which can then be applied directly to the field. The multiplication factor is significant in view of the fact that in the

tropics, there **is** rapid decomposition of organic materials in the soil. This organic matter must be replaced and replenished if agricultural fertility is not to go on declining. The problem is there is a scarcity of compostible materials, particularly animal dung, prevailing within the country. **(A** good proportion of animal dung is dried and used as fuel in many rural areas.) Thus, even if all available organic materials, including dung, were religiously and scrupulously collected, they would still not be sufficient to replace the organic constituents of the vast quantities of India's fast-degrading soils. The Nadep method of composting actually enables the farmer to get around the difficulty of generation of mass and to increase the quantity of compost rapidly within a given frame of time and without any significant additional expense.

Name of person or institution responsible for the practice or experience is Dr. Kumarappa Gowardhan Kendra

The NADEP method of organic composting was developed by a Gandhian worker called Narayan Deotao Pandharipande of Maharastra (Pusad). Compost can be prepared from a wide range of organic materials including dead plant material such as crop residues, weeds, forest litter and kitchen waste. Compost making is an efficient way of converting all kinds biomass into high value fertilizer that serves as a good alternative to farmyard manure, especially for cropgrowing households without livestock.

Description

This method of making compost involves the construction of a simple, rectangular brick tank with enough spaces maintained between the bricks for necessary aeration. The recommended size of the tank is 10 ft (length) x 5 ft (breadth) x 3 ft (height). All the four walls of NADEP tank are provided with 6// vents by removing every alternate brick after the height of 1ft. from bottom for aeration. Tank can be constructed in mud mortar or cement mortar.

6.5 ESTABLISHMENT ACTIVITIES

_ Raw materials required for filling NADEP tank:
_ Agricultural waste (Dry & green) – 1350-1400 kgs.
_ Cattle dung or biogas slurry – 98 – 100 kgs.
_ fine sieved soil – 1675 kgs.

_ Water – 1350-1400 litres.
_ The important technique in the manufacture of Nadep compost is that the entire tank should be filled in one go, within 24 hours and should not go beyond 48 hours, as this would affect the quality of the compost. Thatched roof BRICKW ALL Flooring Air vents Green-farm technologies for small and marginal farms Resources Center for Sustainable Development_ Before filling; the tank is plastered by dilute cattle dung slurry to facilitate bacterial activity from all four sides. It is also filled in definite layers each layer consisting of the following sub layers.

Sub-layer-1

4 to 6// thick layer of fine sticks, stems, (To facilitate aeration) followed by 4 to 6// layer ofdry and green biomass.

Sub-layer-2

4 kgs. Cow dung is mixed with 100 litres of water and sprinkled thoroughly on the agricultural waste to facilitate microbial activity.

Sub-layer-3

60 kgs. of fine dry soil is spread uniformly over the soaked biomass for moisture retention and acts as a buffer during biodegradation. Thus the proportion of organic materials for each layer is 100 kgs. Organic biomass: 4kgs.cowdung + 100 litres water+60 kgs soil. In this way, approximately 10 -12 layers are filled in each tank. After filling the tank, biomass is covered with 3// thick layer of soil and sealed with cow dung +mud plaster.

6.6 MAINTENANCE

After 15-30 days of filling the organic biomass in the tank gets automatically pressed down to 2 ft. The tank is refilled by giving 2-3 layers over it and is resealed. After this filling the tank is not disturbed for 3 months except that it is moistened at intervals of every 6-15 days. The entire tank is covered with a thatched roof to prevent excessive evaporation of moisture. Under no circumstances should any cracks be allowed to develop. If they do, they should be promptly filled up with slurry.

6.7 BENEFITS

Reduced cash expenses on chemical fertilizer, improved soil fertility, increased crop yield_ Supports organic crop production, reduced dependence on outside inputs_ From each NADEP tank approximately 2.5 tons of compost is prepared with in 90-120 days._ The use of compost reduced the need for mineral fertilizer thus reducing production costs and outside dependence.

<u>Lecture No.7</u>

GREEN MANURING

<u>CONTENTS</u>

Legume effect has been successfully utilised in green manuring. The amount of nitrogen fixed by ordinary green manure crop like Dhaincha, Sunhamp, etc. may average about 60 kg/ha. However, the amount of nitrogen accumulated by green manure crop is not likely to be able to provide to the level of nitrogen currently needed by high yielding varieties. Therefore, integrated use of both chemical fertilizer and green manuring is best solution.

Green manuring

The practice of ploughing or turning into the soil undecomposed green plant tissue for the purpose of improving physical condition as well as fertility of soil is referred to as green manuring and the manures obtained by this method is known as green manures. The use of green manure in crop production is recorded in China as early as 1134 BC.

8.1 Types of green manuring

1) Green manuring *in situ*: Any crop or palnt (generally leguminous) grown and ploughed *in situ* is called green manuring *in situ*.

E. g.: Sesbania (*Sesbania speciosa*), dhaindia (*Sesbania aculeate*), sunhemp (*Crotolaria juncea*), Phillipesara (*Phaseolus trilobus*), cowpea (*Vigna anguiculata*), greengram (Mungbean) (*Vigna radiata*), black gram (*Vigna mungo*), berseem (*Trifolium alexandrium*) etc.

2) Green leaf manuring: Consists of gathering green biomass (tender leaves and twigs) from nearby location (bunds, field boundaries) and adding it to the soil.

E. g.: *Cassia auriculata,* neem (*Azadiracta indica*), Glyricidia (*Glyricidia maculate*), *Leucaena leucocephala, Cassia tora, Tephrosia purpurea, Vitex nigundo,* karanj (*Pongamia glabra*), calotropis (*Calotropis gigantea*) etc,.

Green manuring

- Legumes
  - Green manures
    E.g.-Dhaincha, sunhemp,
    Green gram, cowpea, soybeam
  - Green leaf manures
    E.g. Glyricidia, cassia,
    Pongamia glabra, subabul
- Non-legumes
  - Green manure
    E.g. Sunflower, sesbania,
    Buck wheat, desmodium
    Centroseme, crotolaria
  - Green leaf manure
    E.g.: Calotropis, adathoda
    thespesia

8.2 Advantages of green manuring

1. Helps in improving physical and chemical properties of soil. E.g. Builds up soil structure, improves tilth, formation of crumbs in heavy soil, increases water holding capacity

2. Green manure crops absorb nutrients from the lower layer of soils and leave them in the soil surface layer when ploughed in for use by the succeeding crops.

3. Helps to maintain OM status of soil.

4. Acts as source of food and energy to soil microbes and increases their population.

5. Helps in release of nutrients in available form for use by the crops. E.g. GM crop increases the solubility of lime phosphate because of increase in microbial activity.

6. Prevents leaching of nutrients to lower layers.

7. Increases aeration of rice soils by stimulating the activities of surface films of algae and bacteria.

8. It reduces soil temperature and protects the soil from the erosion action of water as it forms canopy cover on the soil.

9. Leguminous green manure plants helps in N-fixation and adds the same to the soil. E.g. 60-100 kg N/ha in single season.

Green manures 60 to 200 kg N/ha

Crotolaria juncea (sun hemp) 17 t/ha biomass, 160 kg N/ha

Dhainchia (*Sesbania aculeata*) 25-26 t/ha biomass, 18.5 kg N/ha

10. Helps in soil amelioration. E.g. *Sesbania aculcata* (Dhaincha) in soil – when applied continuously for 4-5 seasons, green leaf manuring crops like *Argenone maxicana* and *Tamarindus indicus* has buffering effect in sodic soils.

11. Certain green manure like pongamia and neem leaves are reported to control insects.

12. Increases yield to the extent of 15-20 per cent compared to no green manuring.

8.3 Desirable characteristics for legume green manure crops

1. Multipurpose use

2. Short duration, fast growing, high nutrient accumulation ability

3. Tolerance to shade, flood, drought and adverse temperatures.
4. Wide ecological adaptability
5. Efficiency in use of water
6. Early onset of biological N-fixation
7. High N accumulation rates
8. Timely release of nutrients
9. Photoperiod insensitivity
10. High seed production, high seed viability
11. Ease in incorporation
12. Ability to cross inoculate or responsive to inoculation
13. Pest and disease resistance
14. High N sinks in underground plant parts

Lecture No.8

VERMICOMPOSTING

CONTENTS

Vermicomposting

Darwin (1881) was the first to show that earthworms affect soil formation and development.

9.1 Commonly used species: *Eisenia foetida, Perionyx excavatus, Eudrilus eugeniae, Lumbricus rubellus, L. terrestris*.

Eudrilus eugenia – African night crawler

Eisenia foetida – Tiger worm

Perionyx excavatus – Indian blue

Vermiculture is culturing of earthworms: Earthworms effectively harness the beneficial soil microflora, destroy soil pathogens and convert organic wastes into valuable products known as cast which contains biofertilizers, vitamins, enzymes, antibiotics, growth

hormones and proteinaceous worm biomass. Hence earthworms are called as 'artificial fertilizer factories'.

- Earthworm is nocturnal
- Clitellum – adult stage
- Two adults meet and lay egg within a week. Eggs are of coriander seed shape.
- Earthwork take MO through the food. MO multiply in the in intestine of earthworm and they come out with casts. It contains various types of bacteria, actinomycetes, enzymes, vitamins and micronutrients.

9.2 Preparation of vermicompost

Pit size: 10 m x 1 m x 0.3 m

In irrigated area and heavy rainfall areas – above ground.

- Drench with chloropyriphos @ 2 ml/lit of H_2O. Leave for one week and then go for filling the pit in the following manner.

7. Paddy straw / sugarcane trash

6. Black soil

5. Green leaves

4. Dung biogas slurry

3. Crop residue

2. Dung / biogas slurry

1. Coconut coir or any material which is having higher WHC

Crop residues 15 to 10 cm thickness; Black soil 3-5 cm; Other layers 6 to 10 cm

Apply water @ 30 to 60 litres for 16 days. Leave 1000 to 2000 worms of suitable species (*E. eugeniae*) at about 10 cm depth.

Worm multiplication and compost production will be higher if sugarcane trash, sunflower or bajra residues are used.

Keep the pit always moist (30-60% moisture) by daily watering (@ 50 lit) during summer or twice a week during rainy season. Provide shade to the pit.

- Vermicompost production is seen after 45 days of leaving worms to the pit. It will be complete in 80-90 days. Residue will be converted to vermicompost (75%).
- To collect / take vermicompost from the pit, leave the pit without watering for about 3 days. Worm will move to deeper layer due to lack of moisture in the upper layer. Take out the compost from the upper layer and sieve the compost and store it in a gunny bag under shade.
- About 2 to 4 t vermicompost will be produced from one gunta area in 3 months and 6 to 12 t vermicompost will be produced from one gunta in one year.
- Earthworm complete their life cycle within 90 days by which time they multiply about 40 to 50 times. In vermicompost, eggs, nymphs and adults (all forms / stages) are found.

9.3 Enemies of earthworm

Termites, ants, rats, centipedes, frog, birds, pig, etc. Termites and ants are main enemies.

Control

1. Chloropyriphos @ 2 ml/lit
2. Maintain 40-50% moisture in the pit (for controlling termites, ants and rats)
3. Plant turmeric plants around the pit.
4. Open small trench around the pit and put bavistin powder in it.

9.4 Benefits of vermicompost

1. It contains NPK (0.8 : 1.1 : 0.5%)
2. It contains micronutrients (Mg, Fe, Bo, Mo, Zn), growth regulators and beneficial MO.
3. It increases WHC of soil.
4. It increases aeration in soil.
5. Decreases salinity and increases availability of nutrients.
6. Reduces soil erosion.
7. Decreases cost of cultivation.
8. Reduction in incidence of diseases and pests
9. Increases yield.

9.5 Use of vermicompost in agriculture

1. For almost all crops, apply vermicompost @ 2.5 t/acre at the time of sowing.

2. Vermiculturing (*in situ*): Leave worms in the field. Maintain sufficient moisture by regular irrigation and lot of crop residues. Crop residues have to be there in the field. Don't apply chemicals or chemical fertilizers to soil but through the leaves.

3. Spray the vermiwash on the crop (it contains micronutrients, growth regulators and MO) (Coelomic fluid-antibacterial)

Primary degradation by microorganisms and secondary degradation by earthworm. All microorganisms multiply several times in earthworm guts. These microorganisms do biogradation than actual earthworms.

9.6 Origin and evolution of earthworm

No such scientific information on origin and evolution of earthworm because of their soft body and decay quickly. So fossils are not found. However,

1. Stepheson (1930) – stated that earthworm originated in around 120 m years ago, after origin of dicot plants.

2. Others – Earthworm originated prior to origin of dicots, *i.e.*, 570 m years agro.

Clitellum: Glandular portion of epidermis associated with cocoon production (cocoon – nothing but eggs or cases). It indicates sexual maturity.

Vermiculture: Only culture of earthworm and multiplication.

Vermicomposting: Management of earthworm to produce compost.

9.7 Basic characteristics of earthworm suitable for vermicomposting

1. Should have high rates of consumption, digestion and assimilation.

2. Should have high adaptability to varying environmental factors (temperature, rainfall, relative humidity, etc.). Soil temperature should not be >35°C. No stagnation of water for > 45 days.

3. Should have feeding preference and adaptability to wide range of organic materials.

4. Should have high growth rate.

5. Should have compatibility with other worms.

6. Should have disease resistance.

7. Should have least inactivity period (time taken for earthworm for feeding after introduction).

9.8 Maintenance of base culture

For initial multiplication, best substrate is cow dung. Base culture should be multiplied on this substrate. For any commercial venture, maintenance of seed culture is a must. Mixing of cow dung + pieces of banana pseudostem in 1 : 1 ratio gives more number of worms due to more multiplication rate. One year old semi-decomposed rice straw makes the worm to lay as many cocoons as possible.

9.9 Methods of vermicomposting

1. Indoor (small scale production)

2. Outdoor (large scale production)

    a. Pit system

    b. Heap system

    c. Brick system

    d. Kadapa slab method

Lecture No. 9

Recycling of organic residues

CONTENTS

10.1 INTRODUCTION

10.2 CLASSIFICATION OF ORGANIC RESIDUES

10.1 INTRODUCTION

Agricultural wastes can be considered to include crop after harvest and primary processing, tree residues, organic / plant residues from social forestry, animal excreta and processing left over from the slaughter. Lower and agro-industrial wastes. Thus, agricultural wastes comprise all organic wastes produced and disposed off or used in primary agricultural production. It is estimated that these organic wastes available in India can supply about 7.1, 3.0 and 7.6 mt of N, P_2O_5 and K_2O, respectively. The important organic wastes potential in India:

Animal wastes	2018 mt
Crop residue	407 mt
Municipal wastes	29 mt
Rice husk	15 mt
Rice bran	2.5 mt
Bagasse	5.3 mt
Press mud	2.0 mt
Saw dust	2.2 mt

Conversion of all the available organic wastes in India can yield 2014 mt of solid organic manure.

700 mt of plant biomass

2000 mt animal excreta including humans.

Chinese are most efficient in recycling all organic wastes.

10.2 Classification of organic residues (sources of organic residues)

1. Livestock and human wastes: Human excreta, livestock dung and urine, byproduct of slaughter houses and animal carcases, blood, bones, horns, hooves, leather, hair, bonemeal, horn and hoof meal.
2. Crop residues, tree wastes and aequatic weeds
3. Green manures
4. Urban and rural wastes. E.g. rural and urban solid wastes, sewage and sullage
5. Agro-industrial byproducts: E.g. Oil cakes, paddy husk and bran, bagasse and pressmud, saw dust, fruit and vegetable wastes, tea and tobacco wastes, etc.
6. Marine wastes. E.g. Fish mean and sea weeds.
7. Tank silts.

1. 80 to 90% of inorganic nutrients ingested by animals in their feed is excreted in faeces and urine. The nutrients in the animal manure depends on the age and type of animal, nature of work, the feed fed to the cattle, the bedding material used, etc. The proportion of organic matter excreted is equivalent to about 40 per cent of organic matter intake. Urine is normally low in phosphorus and high in potassium, whereas equal parts of nitrogen is excreted in the faeces and urine of cattle.

a) Sheep and goat manure : 3% N, 1 P_2O_5 and 2% K_2O

b) Poultry manure : 3.03% N, 2.63% P_2O_5 and 1.4% K_2O

c) Blood meal : 10 to 12 % N, 1 to 2% P_2O_5 and 1% K_2O

d) Fish manure : 4 to 10% N, 3 to 9% P_2O_5 and 0.3 to 1.5% K_2O

e) Bone meal : 4% N, 20% P_2O_5 (raw bone mean), 1 to 2% N, 22 to 24% P_2O_5 (steamed bone meal)

Human excreta

Night soil: 5.5% N, 4% P_2O_5 and 2% K_2O

2. Crop residue

Cereal straw and residues : 0.5% N, 0.6% P_2O_5 and 1.5% K_2O

Availability of crop residues : Rice (118.9 mt), wheat (57.5 mt), maize (21.0 mt), millets (40.0 mt), sorghum (41.0 mt) and sugarcane (43.0 mt).

Cotton : Stalks, leaves, flowers, roots and bark, stems, press wood, cotton dust.

Tobacco : Leaf scrap, stalks

Rice milling : Rice bran, rice husk, straw

Sugarcane : Trash, bagasse, molasses, pressmud (1-1.5% N, 4-5% P_2O_5 and 2-7% K_2O – pressmud)

Cereals : Leaves, stalks, etc.

Weeds : Water hyacinth, Ipomoea, lantana, cassia, etc.

3. Green manure

4. Urban and rural wastes

Sewage

5. Farm residues

Fruit and vegetable wastes

Mango (peels and kernel), pineapple (peels, cores, trimmings), citrus fruits (peels, pomace, cull fruits and seeds), guava (peels, pomace and seeds), peach (peels and cores), plum (stone), grape (stalks, pomace, seed, and rottens), banana (peels), tomato (seeds and pomace), potato (peels, rottons from cold storage), mushroom (stalks, cuttings, trimmings)

Plantation industry

Coconut (coir dust), arecanut (husk, leaf sheath and leaves), cashewnuts (cashew apple, testa, shell liquid), tea (tea wastes), coffee (husk or pulpy mass), rubber (rubber sticks, leaves, mill wastes).

Oil seed industry:

Ground nut is important crop followed by rape seed and mustard, sesamum, linseed and castor. Oil seeds- (i) Edible. E.g. Groundnut, safflower, sesamum, cotton, coconut, (ii) Non-edible: E.g. pongamia, mahua and neem cake.

Non-edible cakes are used as manures especially for horticultural crops. Nutrients present in cakes are made available to crops 7 to 10 days after application.

Sugar milling industry

Bagasse: 33% is bagasse. Apart, it is used in producing pulp, paper board, etc., a portion of bagasse could be utilised as both for fuel and manure if it is processed through biogas plants. 0.25% N, 0.12% P_2O_5, after composting: 1.4% N, 0.4% P_2O_5.

Pressmud: 1.25% N, 2% P_2O_5 and 20-25% organic matter. After composting: 1.4% N and 1.0-1.5% P_2O_5. It is very high in lime (45%). It is good to apply in acidic soil.

Sawdust: It is wide in C/N ratio (400 : 1). It absorbs 2-4 times more moisture than straw / cereal residues. It can be used as a good absorbatn for soaking urine in cattlesheds and bedding materials for cattle. Can be used as mulching material.

6. Fishery and marine industry

Sea food and canning industry is an important industry. Prawn shell and head fish and frog legs are the main byproducts of this industry (4 to 10% N, 3 to 9% P_2O_5 and 0.3 to 0.5% K_2O).

Marine algae and sea weeds: 1 to 2% P_2O_5 and 2 to 7% K_2O and a number of trace elements.

7. Tank silts

It consists of a large proportion of finer soil particles of silt and clay and organic matter carried by run-off water from the surrounding soil to the tanks during heavy rains.

It contains 0.3% N, 0.3% P_2O_5 and p.3% K_2O. It is an active culture of microorganisms, especially the N-fixers.

Lecture 10

INTRODUCTION TO BIOFERTILIZERS

CONTENTS

11.1 INTRODUCTION

According to an estimate 240 million tonnes of food grains will be required to feed about one billion expected populations by 2000 AD in India and to achieve this milestone, a sizable quantity of mineral fertilizers will be required. The total fertilizer requirements of our country would be 23 million tonnes as against the present consumption level of 13 million tonnes per annum. The problem is so acute that it is beyond any single type of nutrient source to accept the challenge of appropriate nutrient supply. Integrated use of all the sources such as mineral fertilizers, organic manures, biofertilizers, etc. is the only alternate for improving soil fertility. The use of organic manures and mineral fertilizers is in practice but use of biofertilizer in agriculture is not very popular. Hence, there is a need to make its use popular. The increased cost of fertilizer production coupled with progressively increasing use of chemical fertilizers particularly needed by HYV (High Yielding Varieties) are adding to the cost of cultivation of crops and causing nutritional enhancement in Indian agriculture. Recent energy crisis, rapid depletion of non renewable energy sources like naptha, natural gas, sulphur, etc. their production also releases pollutants, nutrient potential from all organic sources in India is over 19 million tonne/year which is adequate requirement to meet 70 per cent of the projected nutrient requirement for the decade ending 2000 A.D

Nutrient need of growing plant can be met through a number of sources. The major sources of plant nutrient are minerals fertilizer, organic manure, recycled waste and byproduct, biological nitrogen fixation (BNF), natural minerals and to lesser extent nutrient recycled through irrigation water and precipitation. These supplement major plant nutrients and the plant productivity for sustainable agriculture. They are important and cost effective inputs in agriculture, plantation and

commercial crops. Microbial inoculants/biofertilizers on their application multiplies in rhizosphere soil and benefits the growing crops. If the soil conditions are favorable, the populations of added microorganism are built up in the rhizosphere of plants and frequent application of microbial inoculants can be avoided. They are inexpensive and help in reducing the consumption of chemical fertilizers. The cost of production of biofertilizer is low and so is the selling price. On nutrient basis, one tonne of Rhizobium inoculants is equivalent to 100 tonnes of inorganic fertilizer

It has now become possible to meet a large part of our total nitrogen demand through proper husbandry of BNF (Biological Nitrogen Fixation) by micro-organism (bio-fertilizers) in crop production systems. Bio-fertilizers are capable of providing an economically viable level for achieving the ultimate goal of enhanced productivity.

11.2 DEFINITION

'Biofertilizer' is a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant.

Biofertilizers (BF) (microbial nutrients) are the products containing living cells of different types of microorganisms which have an ability to mobilize nutritionally important elements from non usable to usable form through biological process. Although the advent of the phenomena is as old as a century, the need of its commercial exploitation was not felt in traditional agriculture. In recent years, biofertilizers have emerged as an important component of INSS (Integrated Nutrient Supply System) and hold a promise to improve the crop yields and nutrient supplies.

Biofertilizers are not fertilizers. Fertilizers directly increase soil fertility by adding nutrients. Biofertilizer, a term which refer to all such microorganism which add, fix, mobilize or solubilize the nutrient in simpler form which is easily used by plants. There significance lies in their ability to supplement/mobilize soil nutrient with minimal use of non-renewable resources and as components of integrated plants nutrient systems. Biofertilizers are more aptly termed as Microbial/Bacterial or Fungal inoculants. Biofertilizers add nutrients through the natural processes of fixing atmospheric nitrogen, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances. Biofertilizers can be expected to reduce

the use of chemical fertilizers and pesticides. The microorganisms in biofertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of biofertilizers, healthy plants can be grown while enhancing the sustainability and the health of soil. Biofertilizers are very similar to compost tea. They can be thought of as an engineered compost tea where only the microorganisms that are most beneficial are used.

11.3 Importance

The increase in the productivity during the green revolution period is accompanied by an exponential increase in consumption of non-renewable sources of energy. In view of the fast diminishing energy sources comined with their escaling cast.

11.4 Benefits

1) Germination increase up to 20 percent. Improved seedling emergence and growth.

2) Increase yield from 10 to 40 percent.

3) Improve the quality of fruit and keeping quality.

4) Saving of 25 to 35 percent inorganic fertilizers.

5) Increase the availability and up take of N and P in plants.

6) Improve the status of soil fertility maintain good soil health and crop productivity.

Lecture No. 11

SOIL IMPROVEMENTS AND SOIL AMENDMENTS

CONTENTS

12.1 Saline and alkali soils

When the chloride (Cl^-), sulphate ($SO_4^=$), carbonate ($CO_3^=$) and bicarbonate ($HCO_3^=$) salts of sodium (Na^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}) are increased in soil, the soil becomes saline and alkali. On the basis of amount of salts, average quantity of exchangeable sodium and pH, such soils are classified as saline, alkali and salinealkali soils.

12.2 Saline soil (white alkali)

Characteristics

High toxic concentration of soluble salts in the rootzone. Soluble salts are Cl^- and SO_4^{2-} of Na, Ca and Mg. Electrical conductivity (EC) of soil solution saturated extract is more than 4.0 dS/m at 25°C, ESP is <15% and pH is <8.5.

Formation of saline soil

Common in arid and semi-arid regions having rainfall less than 55 cm. Lots of salts are deposited on soil surface in saline soils and saline soil layer shines white in dry season.

Favourable conditions

i) High water table with a fairly high salt concentration

ii) High temperature iii) Low rainfall

Sources of salts: Soil, ground water, irrigation water, canal and sea.

Reclamation

i) Remove excess salt to a desired level in the rootzone

ii) Leach with good quality water iii) Give adequate drainage iv) Intermittent ponding of water.

Salt tolerant crops are grown during initial period.

12.3 Sodic soil (black alkali/non-saline alkali)

High exchangeable sodium percentage interferes with plant growth.

Characteristics

a) EC < 4.0 dS/m at 25°C b) ESP > 15%

c) pH > 8.5 (8.5-10.0) d) Low infiltration rate

Occurrence: Indo-Gangetic plains of UP, Punjab and Haryana.

Reclamation

Replace exchangeable Na^+ by Ca^{++} and thus released Na^+ salt be leached out of rootzone.

Amendments

i) Gypsum ($CaSO_4.2H_2O$) ii)

Phosphogypsum

iii) Iron pyrite (FeS_2) iv) Calcium salts, acids,

acid formation materials

v) Bulky organic manures, green manures, crop residues. These are applied in conjunction with gymsum.

vi) Leaching with water of good quality.

Management practices

i) Cropping with green manure ii) Apply high dose of N

(because of volatilisation, N loss) iii) Apply zinc during

initial years of reclamation iv) Frequent irrigation with

small quantities of water

12.4 Saline-alkali land

Characteristics

a) EC > 4 dS/m at 25°C

b) ESP > 15%

c) pH < 8.5

Favourable factors

(i) Aridity, (ii) Poor external or internal drainage, (iii) Irrigation by saltish water, (iv) Permanent water course, (v) Rise in water table by excess irrigation (vi) Erratic use of irrigation water (*i.e.*, flooding followed by intense drought).

Salike-alkali land is difficult to manage because of its poor physical condition.

12.5 Effects of soil salinity and alkalinity

i) In alkali condition, soil is dispersed and becomes compact.

ii) Less water permeability due to compactness iii) Low aeration iv) Low microbial activities

v) Unavailability of nutrients like P, Ca, N vi) Nutritional disturbances at pH 8.5 and more vii) Hindrance in water absorption viii) Increase in osmotic pressure of soil solution badly affects the plants growth ix) In alkali soil highly toxic Na_2CO_3 is present.

12.6 Acid soils

Acid soils are those having pH less than 5.5.

Processes in acid soil formation

1. Laterisation of varying degrees
2. Podzolisation with sub-temperate to temperate climate.
3. Intense leaching of light alluvial soils.

4. Marshy conditions with significant amount of partly decomposed organic matter.

Characteristics of acid soils

1. **Physical**: a) light texture, b) high permeability, c) poor water holding capacity, d) poor cation exchange capacity, e) poor organic matter content.

2. **Chemical**: a) Base unsaturated soil, more anions than cations, b) Active and potential soil acidity, c) Availability of nutrients (Al, Fe, Mn, Zn, Co). Toxic effects on plants Al^{3+} concentration is more.

3. **Biological**

    1. There is no effect of pH on the population of fungi. Hence, fungi population is more than bacteria.

    2. Fungi cause diseases

    3. Rate of decomposition of biological materials and rate of mineralization and nitrification, etc., are reduced when acidity is increased.

Management of acidic soils

1. By growing crops suitable for particular soil pH.

2. Ameliorating the soils through the application of amendments.

Liming

Application of lime raises the soil pH to a desirable level. The quantity of liming material to be applied depends on soil pH, soil texture, capacity and type of liming material. On an average, hydrated lime $Ca(OH)_2$ at the rate of 5 t/ha is applied in the field and is thoroughly mixed in soil. The gap between lime application and crop sowing is atleast two or three months.

Liming materials

1. Calcium limestone ($CaCO_3$) (more than 90% use in India)
2. Dolomite (rich in Mg)
3. Quick lime (CaCO)
4. Slaked lime $Ca(OH)_2$
5. Coral shell lime
6. Chalk $CaCO_3$
7. Blast furnace slag $CaSiO_3$ and Ca_2SiO_4
8. Miscellaneous sources like wood ashes, etc.

Biological reclamation

Use of organic materials and crops

Soil amendments

Soil amendments are substances that influence plant growth favourably by changing the soil pH, increasing the nutrient availability, improving the physical conditions of the soil and counteracting the effects of injurious substances. There are three types of soil amendments.

There are three types of amendments

1. Materials used for amending acidic soils. E.g. Lime
2. Materials used for ameliorating alkali soils. E.g. Gypsum and phosphogypsum.
3. Soil aggregating agents or soil conditioners to stabilise soil aggregates and to form granular structures. E.g. Poly-electrolytes, including polyvinylites, polyacrylates, cellulose gums, lignin derivatives and silicates.

1. **Gypsum**: Gypsum is dehydrated calcium sulphate ($CaSO_4.2H_2O$) and used as a popular amendment for the reclamation of alkali soils. Pure gypsum contains 18.6% S and 23.2% Ca. Commercial agricultural grades (70-80%) contain 13-15% S and 16-19% Ca. The sulphur in gypsum is in plant available sulphate form and its solubility is comparable to that of SSP. Most of the gypsum mines are located in Rajasthan.

2. **Phosphogypsum**: It is a byproduct of phosphoric acid production. The $CaSO_4$ in phosphogypsum is available as dehydrate ($CaSO_4.2H_2O$), hemihydrate ($CaSO_4.1/2\ H_2O$) and anlydrate ($CaSO_4$) or in combination of dehydrate and hemihydrate. Phosphogypsum is high grade gypsum with 80-90% purity. It may also contain traces of iron, manganese, zinc and copper. This fertilizer is of great importance in alkali soils as a source of S.

3. **Lime and liming materials**: Calcium oxide (CaO) is the only material to which the term lime may be correctly applied. It is also called as unslaked lime, burned lime or quick lime (CaO). It is most effective with high neutralising value or calcium carbonate equivalent (CCE) of 179% compared to pure $CaCO_3$. Complete mixing of this material into the soil is very difficult. Calcium hydroxide [$Ca(OH)_2$] is a white powder and called slaked lime or hydrate lime [$Ca(OH)_2$]. The other common liming materials are calcium carbonate ($CaCO_3$), calcite or calcium-magnesium carbonate [$CaMg\ (CO_3)_2$] or

dolomite. Limestone is mined by open pit method. Most of the agricultural limestones have the CCE value of 90-98% because of impurities present.

12.7 More About Saline Soils

Introduction

Soil salinity has caused heavy loss of national wealth in India. Out of 329 million hectares of land in the country, about 175 million ha. (53 %) is suffering from degradation in some form or the other. There are 7.61 M ha of salt affected soils in

India as per the Ministry of Agriculture, GOI. The extent of this problem area as given by different sources varys from 8.56 M ha to 10.9 M ha. Water logging affects another 8.52 M ha mainly in the irrigation commands, which includes some of the saline-alkali soils also. In Haryana, parts of Punjab, Rajasthan, Uttar Pradesh, Gujarat, Maharashtra, Madhya Pradesh, Karnataka, Andhra Pradesh and Tamil Nadu, substantial areas of good irrigated lands are affected by saline - alkali and water-logging problems. There are several reasons for development of salinity in the soils, such as:

- Excessive and uncontrolled irrigation
- Accumulation of salts in the top layer due to evapo-transpiration in arid conditions
- Water logging conditions in perennial river basins/ irrigation sources due to seepage
- Excessive use of chemical fertilizers containing chlorides, sulfates etc.
- Poor drainage conditions.

The problem of salinity, alkalinity and water logging deserve special treatments based on the local conditions and soil texture, structure and topography. When water is used for agricultural purposes, in most cases more than 50 percent goes waste. It seeps out of unlined channels, pipes, ditches, runoff fields or percolates in to the soil and accumulate in uneven depressions. Water dissolves naturally occurring salts in the rocks and soils

and carries them to the surface of the soil, where the water molecules evaporate, leaving the salts to accumulate near the surface. Excess salts, eventually will lead to alkali problem.

The growing problem of salinity-alkalinity should be minimised or eliminated as early as possible since it is growing at the rate of 10% every year. Soil salinity has become an acute problem rendering crop productivity to decline or making the soil unfit for cultivation. Irrigation has both sides of bane and boon. Unscientific irrigation has endangered many favorable environmental conditions and human health. The Government / people have now realised the seriousness of the problem. In the absence of adequate drainage provisions, with the introduction of new irrigation projects and also the faulty water management practices on the farms, additional area will turn salty each year.

Saline soils contain soluble salts which impair the soil productivity. Such soils can normally be identified by the presence of white crusts of salts on the surface of the land area and poor crop growth. Internal drainage of such soils will not be bad. By opening adequate drains, such soils can be improved.

Drainage becomes a problem when the soil is water logged. In such soils, the aeration will be a limiting factor and microbial activities will be hindered and hence the removal of excess water from such water logged areas becomes very essential.

On the other hand, sodic soils containing excess sodium become extremely waterlogged as the soil porosity is lost and water do not percolate down easily / quickly. In case of excess Sodium contents of the soil, it has to be treated with soil amendments such as gypsum, sulfur etc., and then the salts have to be drained. In summary, the basic requirement is provision of adequate and appropriate drainage system. Black soils are worst affected as they have poor drainage due to high clay content.

2. Visual Effects of Saline - Alkali soil

The Harmful effects of saline water irrigation are mainly associated with accumulation of salts in the soil and are manifested through reduced availability of water to plants, delayed germination and slow growth rate.

- Excessive salts in the soil can induce early wilting and the effects are almost similar to those of drought.

- Some of the visual symptoms are that the plants look stunted; leaves are smaller but thicker and have often dark green colour as compared to plants growing in a salt free area irrigated with good quality water.
- Alkali soils become extremely hard on drying and slushy on wetting. Black incrustation is seen on the surface.
- All useful microbial activity is completely lost making the soil unhealthy for crops.

3. <u>Management of Saline soils</u>

The farmers are aware of soil salinity and its bad effects. The yields of various crops have drastically reduced due to salinity. The problem is more pronounced in recent years. The farmers are shifting to other activities like dairying and there is growing tendency towards crop rotation. The farmers are following measures like green manuring, crop rotation, sub-soiling, open drainages, mulching etc. to a limited extent. The practice of application of amendments like Gypsum is not popular in many parts of the country due to non availability in the local markets.

The problem of saline soils was studied from various angles and concluded that unless corrective measures are adopted at appropriate time, vast tracts of so called fertile soils will become barren leading to unproductivity and under production. It is the ultimate responsibility of every one involved in rural development to save the soil from the bad effects to sustain the growing population. The importance of soil management will have to be given top most priority in the years to come. Otherwise, viability of crop production will be eroded.

4. <u>Provision of subsurface drainage</u>

In the areas of high salinity, it is essential to bring down the salinity by leaching the salts. It is also necessary to lower the water table if it is shallow and saline and maintain it below the critical depth to prevent resalinisation. Drainage of agricultural lands can be achieved through a package of the following measures :

- Intercept the flood and seepage water from above by opening sufficiently large drain (called interceptor drain) and divert the same from affecting the holding.
- Construct a good feeder drain (called vertical disposal drain) in the field, along the slope and connect it with the common drain or natural drains such as nallas.
- Construct adequate drains in the plots and crop fields and connect them to the vertical disposal drain.
- Provide drop pits and stone pitching in erodable spots.
- If the soils are alkali in nature, apply sufficient quantities of chemical and organic amendments, based on soil test results.

Traditionally drainage is provided by means of open ditches, dug out either by human labour or by earth moving equipment. The width and depth depends on the quantity of water to be removed and root system of the crop. Though, they can be opened without much skills, they have several limitations such as :

L The sides collapse and silt up fast.
L Weeds and grasses grow up and clog the drain and also spread weed seed.
L Harbor pests like rats.
L Become water-logging and breed mosquitoes.
L Occupy 15-20 % of land area.
L Obstruct cultivation and movement of machinery.
L All lateral drains have to be ploughed up and re-laid after each cropping.

Out of the various methods of drainage systems and reclamation of saline soils, subsurface drainage system will be most effective and long lasting particularly in heavy soils. This system includes laying of perforated PVC pipes under ground and draining the accumulated salts along with water to a common outlets/well. The drained water will be tested for its quality and if found suitable, the same water will be recycled to the crop. There are different dimensions of perforated and unperforated pipes (blind pipes) available with reputed plastic manufacturing companies , with BIS specification. It is an excellent system for all irrigated agriculture crops like sugarcane, yielding orchards, plantations and sensitive crops like turmeric.

The steps involved in laying a successful sub-surface drainage system :

- Investigation and diagnosis of the water-logging problem, soil physical and chemical properties, availability of natural outlet and fall etc.
- Drawing a perfect design, which includes decisions on dia of the pipe, distance between laterals, depth and manholes for maintenance.
- Sellection of proper materials - pipes, fittings, filter material, outlets etc.
- Proper laying of the system to ensure smooth flow.

4. Benefits of drainage

Flooding and loss of seeds and fertilizers are largely eliminated Dries up the fields quickly soon after rains and thus making the land ready for cultivation. It avoids permanently ponded areas and swamps etc. It removes excess water, salinity and alkalinity from the soils It keeps the soil pores open and thus increase both infiltration and permeability rates of the soil Where underground drainage is practiced, there will be a better physical condition of the soil that permits vigorous and deeper root growth and as a result drought tolerance. Improves earthworms, soil microbes etc. and thus better health of soil. Reduces certain crop diseases.

6. Difficulties in financing for soil reclamation

Besides ignorance of bad effects of soil salinity and subsequentreduction in crop yields, the bankers are reluctant to finance for reclamation of saline soils. In certain case, the local bankers are not aware that NABARD provides refinance assistance for reclamation of saline soils under land development activity. There are certain difficulties in financing for reclamation activities as discussed below :

- Desalinisation is a long term process; and simultaneously protection to safeguard land area is also essential.
- Desalinisation is not limited to the individual efforts. It should be scientifically managed on the basis of land slope and command areas. Individual farmer's efforts goes futile if other neighboring farmers do not follow the amelioration programmes. Collective efforts are essential for more effectiveness.
- Desalinisation is a scientific process. On the contrary, farmers do not know scientific processes and their results. Farmers ignorance in this respect results in waste of time and money. Lack of demonstration farms is a serious limitation.
- UGP drainage system is a skill oriented one and needs proper guidance.
- The farmers are not submitting schemes for amelioration of salinity. Similarly farmers are not aware of the scheme of financing for desalinisation. Lack of knowledge among farmers and many officials is a serious limitation. Farmers are restless due to the growing problem of salinity, but helpless due to lack of knowledge and lethargy of the farmers institutions in solving the problem of soil salinity. Sugar factories and NGOs should take initiative in this regard and work out for repayment through tie-up and extension support.
- Government initiation plays a significant role in the scheme of desalinisation. In fact the problem of salinity is an out come of hurried efforts of irrigation development. Government is not having any well-drawn out scheme for this problem.
- Cooperative credit structure is much worried of the salinity, because of its high exposure to cooperative sugar factories. Other financial agencies are not so worried of the problem.
- Construction of drainage systems to channelise the saline water to flow towards slopes is the major effort required to be implemented. The use of excavators is essential. Similarly drainage should be constructed as per the slopes, which covers farm units owned by many farmers. So group action needs to be

promoted. Simultaneously proper maintenance of the drainages is also essential. All these activities can only be made through collective efforts. Banking agencies consider that it would be difficult to coordinate.

In order to adopt permanent and cost effective saline soil treatment methods, it has been suggested to take up the subsoil drainage system rather than following temporary cultural practices like green manuring, open drains, crop rotation, mulching etc. A simple model of laying underground drainage system with PVC pipes to drain out excess water in waterlogged areas and soluble salts in salt affected areas is explained below.

7. Potential Benefits and high Returns:

The subsurface drainage system is perceived as costly. The initial cost varys from Rs. 60,000 to Rs.75,000 per ha. However, considering the huge loss to yield and income, the investment is highly viable and prudential. It has been observed in many sugarcane growing areas of Maharashtra that there has been a drastic reduction of cane yields, from as high as 120 to135 tons per ha to as low as 50 to 60 tons per ha now. For example the average cane productivity in many sugar factory command areas in Ahmed Nagar District has come down to 60 to 75 tons per ha. The value of this loss is substantial to take such high investment to restore the soil productivity. It amounts to a loss of income of over Rs. 50,000 per ha per year. One of the innovative farmers who had installed such an under ground system near Rahuri of Maharashtra started getting an yield level of about 150 tons of cane per ha. From this it is evident that even if Rs. 25,000/- has to be spent per acre, the entire investment can be recovered with 2-3 years. Similarly, those of the farmers who have laid under ground tile drains in coastal Karnataka in Areca gardens have started realizing very high yields of areca nut, as also inter crops of pepper. Since such areas have assured irrigation, this item should be taken up on high priority. The investment is highly viable. However, the high initial cost warrants credit support to many farmers. The sugar factories which will be highly benefited from the increased availability of cane with in their command area, should help the farmers in arranging the credit, pipes, earth moving machinery etc. to the farmers. The command area banks should come forward to formulate suitable location specific schemes. To provide guidance in this regard a model scheme is given below.

Lecture 12

Organic Weed Management

CONTENTS

13.1 Introduction

Weeds can be considered a significant problem because they tend to decrease crop yields by increasing competition for water, sunlight, and nutrients while serving as host plants for pests and diseases. Since the invention of herbicides, farmers have used these chemicals to eradicate weeds from their fields. Today, some farmers have a renewed interest in organic methods of managing weeds since the widespread use of agrochemicals has resulted in purported environmental and health problems. It has also been found that in some cases herbicide use can cause some weed species to dominate fields because the weeds develop resistance to herbicides. In addition, some herbicides are capable of destroying weeds that are harmless to crops, resulting in a potential decrease in biodiversity on farms. It is important to understand that under an organic system of weed control, weeds will never be eliminated but only managed.

Organic weed management is a holistic system involving an entirely different approach to managing a farming system. The organic farmer is not interested in eliminating all weeds but wants to keep the weeds at a threshold that is both economical and manageable. A farmer who manages weeds organically must be intimately familiar with the type of weeds and their growth habits to determine which control methods to employ.

Optimizing the biological terrain of the soil for the crop will create an unfavorable environment for many weeds, effectively reducing weed numbers and vigor. This concept forms the core of effective weed control in an organic production system. Contrast to this the weed-control strategies of conventional farming, with heavy use of salt fertilizers, herbicides, monoculture and imbalanced cation saturations. Indeed, that

environment could accurately be described as one of cultural weed *enhancement.* The conventional field environment presents heavy pressure to select for herbicide-resistant weeds that thrive under these conditions. Each year, these highly adapted weeds find the same favorable conditions and reproduce abundantly. It is really no wonder that most herbicides are only effective for a few years before a newer, stronger (and more expensive) chemical is needed to control weeds sufficiently. It is important to know your enemy. All weed species have their weaknesses and their strengths, usually occurring at distinct stages of their life cycles or resulting from specific growth patterns. Different weeds present problems at different times of year, or with different crops. Some weedcontrol strategies, such as disking a field infested with quackgrass, may even increase the prevalence of certain species of weeds under specific conditions. Grassy weeds often require different control measures than do broad-leafed weeds. Correctly identifying the species of weeds that are causing major problems in your fields is critical to choosing and timing effective control measures

13.2 Organic Methods of Weed Management

1. **Thermal weed control**

Thermal weed control involves the use of flaming equipment to create direct contact between the flame and the plant. This technique works by rupturing plant cells when the sap rapidly expands in the cells. Sometimes thermal control involves the outright burning down of the weeds. Flaming can be used either before crop emergence to give the crop a competitive advantage or after the crop has emerged. However, flaming at this point in the crop production cycle may damage the crop. Although the initial equipment cost may be high, flaming for weed control may prove cheaper than hand weeding.

2. **Soil solarization:** During summer and fall, organic farmers sometimes sterilize their soil through solarization. During this process, a clear plastic film is placed over an area after it has been tilled. Solarization works when the heat created under

the plastic film, which is tightly sealed at the edges, becomes intense enough to kill weed seeds.

3. **Mulch:** Mulching or covering the soil surface can prevent weed seed germination by blocking light transmission preventing seed germination. Allelopathic chemicals in the

mulch also can physically suppress seedling emergence. There are many forms of mulches available. Listed are three common ones:

i. **Living mulch: L**iving mulch is usually a plant species that grows densely and low to the ground, such as clover. Living mulches can be planted before or after a crop is established. It is important to kill, till in, or otherwise manage the living mulch so that it does not compete with the actual crop.

ii. **Organic mulches:** Such materials as straw, bark, and composted material can provide effective weed control. Producing the material on the farm is recommended since the cost of purchased mulches can be prohibitive, depending on the amount needed to suppress weed emergence. An effective but labor-intensive system uses newspaper and straw. Two layers of newspaper are placed on the ground, followed by a layer of hay. It is important to make sure the hay does not contain any weed seeds.

iii. **Inorganic mulches:** Materials such as black polyethylene have been used for weed control in a range of crops in organic production systems.

4. Mechanical weed management

Managing weeds mechanically is both time consuming and labor-intensive but it is also one of the most effective methods for managing weeds. The choice of implementation, timing, and frequency will depend on the structure and form of the crop and the type and number of weeds. Cultivation involves killing emerging weeds or burying freshly shed weed seeds below the depth from which they will germinate. It is important to remember that any ecological approach to weed management begins and ends in the soil seed bank. The soil seed bank is the reserve of weed seeds present in the soil. Observing the composition of the seed bank can help a farmer make practical weed management decisions. **5. Stale seedbed**

The stale or false seedbed technique of flushing out weed seeds from the soil works by depleting the seed bank. After the soil is cultivated two to three weeks before sowing, emerging weeds are killed by flaming or light cultivation. By helping to reduce the seed bank. This technique reduces subsequent emergences of weeds.

6. Crop rotation

Crop rotation has been at the heart of the organic weed management system since medieval times and has persisted well into the 20th century due to its proven effects on weed populations. The goal of a crop rotation is to create an unstable environment that discourages weeds from becoming established in the field. Deciding on the sequence of crops, a farmer must take into account the type of soil he or she is working with, the climate, and the crop. Diverse crop rotations are essential to build a healthy, sustainable organic system and break pest and weed cycles. In general, it is best to alternate legumes with grasses, spring-planted crops with fall-planted crops, row crops with close-planted crops, heavy feeders with light feeders. Careful use of cover crops during times when the ground would be bare adds valuable nutrients (especially nitrogen), adds organic matter, improves soil microbial diversity, and prevents erosion. Maintain a long-term balance of diverse crops on a farm, taking into account any necessary soil conservation practices, livestock requirements, time constraints and market profitability.

7. Crop establishment and competition

Make sure crops emerge first to give them a head start in their competition with weeds. Transplanting helps increase a crop's competitive ability since the plants are larger and easier to establish. Sow crops close together by reducing the row spacing. Since the crop will take up more space, it shades the weeds, reducing the weeds' ability to compete. Another technique involves increasing the seeding rate of a crop. This increases the competitive ability of the crop by increasing the odds that the crop will survive in greater numbers than the weeds. The most effective way to control weed growth is to have highly competitive crops. A vigorously growing crop is less likely to be adversely affected by weed pressure. It is imperative to create conditions where the intended crop can establish dominance quickly. Using high-quality, vigorous seed, well adjusted planting equipment, adapted varieties, optimal soil fertility, good soil drainage and tilth, and proper soil preparation will usually result in rapid, vigorous crop growth.

8. Sanitation. Using clean seed will prevent the introduction of new weed problems and will avoid planting a generous crop of weeds with your desired crop. Mowing weeds around the edges of fields or after harvest prevents weeds from going to seed. Handroguing weeds in problem areas, and thoroughly composting manure can reduce the spread of weed seeds and difficult weed species. Thorough cleaning of any machinery

that has been used in weedy fields is a good idea, as is establishing hedgerows to limit wind-blown seeds. Common sense, yes — and it works! Cultural practices won't prevent all weed growth, and some mechanical follow- up will usually be necessary, but cultural practices can improve soil conditions, permitting more effective mechanical control, they can adjust weed species to ones that are easier to control, and, most importantly, cultural weed-control practices can produce high-quality, vigorous, high-yielding organic crops.

It is important to maintain proper sanitation on the farm to reduce the introduction and spread of weed seeds. There are several ways to keep weeds and weed seeds from entering the farm. First, any animal manure that will be used on the farm should be composted because weed seeds can pass through an animal's digestive system unharmed, it is important to compost the manure. Composting results in temperatures that become high enough to kill many weed seeds. Second, purchase certified seed that is guaranteed to be free of weed seeds. If you are a farmer interested in saving your own seed, be diligent about collecting clean seed so you do not contaminate your collections. Also make sure to remove weeds before they set seed. Once a weed is allowed to set seed, the number of weed seeds in the seed bank is increased. Last, keep tillage and other equipment clean when moving between fields to reduce the spread of weed seeds.

9. Allelopathy

Allelopathy is an alternative and organic approach to weed control that uses chemicals that are excreted from a plant to cause either direct or indirect harm to weeds by negatively affecting their germination, growth, or development. Nearby weeds can be affected by allelopathic chemicals entering the rhizophere from the roots or the aerial parts of the crop plant. Crop residues from cover crops, such as fall rye, or other organic mulches can also be used to suppress weeds through such allelopathic interactions. This "allelopathy" is one of nature's most effective techniques of establishing plant dominance. Allelopathic crops include barley, rye, annual ryegrass, buckwheat, oats, sorghum, sudan-sorghum hybrids, alfalfa, wheat, red clover and sunflower. Selecting allelopathic crops can be useful in particularly weedy fields with reducing overall weed pressure.

9. **Soil Fertility & Condition.** In an organic system, it is important to rely on the biological activity of the soil as the main source of fertility and favorable soil physical

structure. An active and diverse soil microbial population is the key to growing healthy, high-yielding organic crops. Successful organic fertility management should primarily feed the soil microbial life in a long-term manner, rather than simply feeding the plants. Soil organic matter is a tremendous source of plant nutrients and water holding capacity. Soil tests can be useful, but only if the results are interpreted appropriately for an organic system. Careful attention to the balance of key nutrients can often reduce weed problems and enhance crop plant growth. One common mistake made by many organic farmers is the improper application of manure or improperly finished compost. This can throw off the balance of certain soil nutrients and microbial life and can often increase weed growth. Some soil fertility amendments, such as gypsum, can increase the looseness and tilth of the soil. This improves success for mechanical-cultivation operations, but it also seems to reduce the pressure from certain weed species that are favored by hard, tight soils.

10. **Variety Selection.** Careful selection of crop varieties is essential to limit weeds and pathogen problems and satisfy market *Lely weeder.* needs. It is important to consider planting disease-resistant varieties if certain pathogens are prevalent in the area. Any crop variety that is able to quickly shade the soil between the rows and is able to grow more rapidly than the weeds will have an advantage. Deep shading crops, which intercept most of the sunlight that strikes the field and keeps the ground dark,

will prevent the growth of many weed species. Alfalfa, clover and grasses are particularly good shading crops because any weeds that grow in them will usually be cut when hay is harvested, thereby preventing weed seed production.

11. Mycoherbicides

Herbicides especially soil applied, have harmful effects on both human and animal health. In this context, fungal pathogens control specific weeds and continue to survive on the weeds year after year unlike herbicides that are to be applied every year. Fungal pathogens as a bioagent in controlling weeds are more popular than bacterial, viral or nematodes because, most of the plant pathogens are fungi, which are destructive and widely prevalent, and they can be safely used in organic farming. Phytopathogens normally initiate diseases in specific weeds and produce phytotoxins killing the weeds within 3-5 weeks.

Characteristics of mycoherbicides

a. They should be culturable in artificial media
b. They should produce abundant spores
c. They should be stable in storage
d. Should be genetically stable
e. Effective under field condition
f. Tolerant to variation in temperature
g. These herbicides should be compatible with other chemicals/culturable practices For controlling water hyacinth: *Alternaria eichhornea, Cercospora piaropi, C.*

rodmanii, Uredo eichhornea and Rhizoctonia solani.

For controlling weeds in rice and soybean field: *Colletotrichum gloeosporoids*.

For controlling *Eupatorium reparium* : Rust fungus

List of fungicides used to control specific weeds

Mycoherbicides	**Weeds to control**	**Trade name**

Colletotrichum gloeosporoids	Aeschynomene	Collego
C. furarioides	*Aslepias seriacea*	-
Cercospora rodmanii	*Eichornea crassipes*	ABG 5003
Puccinia chandrillus	*Chandrillana juncea*	-
P. abrupta	*Parthenium hysterophorus*	-
Phytophthora palmivora	*Morrenia odorata*	Devine
Alternaria sp	*Crisium avense*	-
A. cassia	*Cassia abistifolia*	Caset
A. crassa	*Datura stramonium*	-
A. helianthi	*Xanthium stromarium*	-
Phomopsis convolvulus	*Convolvulus arvensis*	-
Bipolaris halepense	*Sorghum halepense*	-

Mycoherbicides under the trade name Collego are popular in USA. Devine is a liquid formulation of pathotype *Phytophthora palmivora* . Colego is wettable

formulations of *Colletotrichum gloeosporoids.* The skeleton weed (*Chandrillana juncea*) was a problematic weed in wheat belt of Australia and has been successfully controlled by rust fungi.

Lecture No. 13

ORGANIC FOOD QUALITY

CONTENTS

15.1 INTRODUCTION

Consumers expect their food to be enjoyable, nutritious and safe. Quality attributes include (a) Nutritional value, (b) Organoleptic properties (appearance, colour, texture and taste), (c) Functional properties.

15.2 Chemical food contaminants: Synthetic pesticides, herbicides, fertilizers, fungicides, veterinary drugs (i.e., antibiotics, growth hormones), synthetic preservatives and additives and irradiation.

(a) Pesticide residue: Organically produced foods contain less residues than conventionally produced foods. Organic certification schemes specify that land must be free from chemical inputs for 2 or 3 years prior to organic production. Low levels of pesticides due to previous land use and pesticides drifts from conventionally managed farms may be present. It should be below the maximum residue limits (MRL). In organic management, biological control is the preferred method of pest management.

(b) Nitrates from fertilizers: Nitrates content of organically-grown crops, particularly nitrophilic leaf, root and tuber crops, is reported to be significantly lower than in conventionally grown products.

E.g.

- Methaemoglobinaema (a disease that interferes with oxygen carrying capacity of blood)
- Nitrosomine illness is caused by presence of secondary amines, which causes cancer in human beings.
- Feroxyl nitrates, alkyl nitrates, vapours of HNO_3 and nitrate aerosols causes respiratory illness
- Entrophication

Under certain conditions, nitrates may be converted to nitrosamines which are carcinogenic.

c) Environmental contaminants

Due to industrial activity (mining, smelting activities), the energy sector, agricultural practices or disposal of hazardous and municipal wastes. The use of biosolids (sludge) leads to contamination of food with heavy metals, toxic organic compounds (such as dioxin, PCB) and persistent microbial pathogens. The codex and EU organic standards prohibit the use of sewage sludge.

d) Veterinary drugs and contaminants in animal feeds

According to EC regulations, the livestocks are to be fed on organically-produced feed stuffs, the potential for contamination with pesticide residues and other agricultural chemicals is greatly reduced compared to conventional farming methods.

Contaminants in animal feeds such as pesticide residues, agricultural and industrial chemicals, heavy metals and radioactive nuclides may pose problems.

In Denmark, organic milk currently account for 20 per cent of total milk production.

15.3 Microbial food contaminants

a) Contamination from natural fertilizers

Untreated or improperly treated manure or biosolids used as fertilizers or soil nutrient agents, whether in organic or non-organic agriculture, can lead to contamination of products and/or water resources. Animal and human faeces known to contain a range of human pathogens. Properly treated manure or biosolids are effective and safe fertilizers. Pathogenic organisms can survive upto 60 days under compost.

b) *E. coli* contamination

Virulent strains of *E. coli* develop in the digestive tract of cattle which is mainly fed with starchy grains. Cows mainly fed with hay generate less than one per cent of *E. coli* found in faeces of grain fed animals. Therefore, ruminants (cattle and sheep) are fed with diets with a high proportion of grass, silage and hay. Organic farming potentially reduces the risk of *E. coli* contamination.

c) Mycotoxins

Mycotoxins are toxic by-products of certain moulds that can grow on certain food products under suitable conditions. Aflotoxins are the most toxic of these compounds and can cause liver cancer at low doses if ingested over a prolonged period of time. Organic farming may lead to increased risk of mycotoxic contamination since fungicides are not allowed in OF. Therefore, good agricultural, handling and storage practices are required in organic agriculture to minimise the risk of mould growth and mycotoxins contamination.

15.4 Food irradiation

Irradiation of food assists in the control of insects, parasites, pathogenic bacteria and various deteriorative changes that occur in same foods. When food irradiation is carried out according to internationally accepted guidelines, there is no associated food safety risk. Genetically engineered organism (GMD): International guidelines ban the use of GMOs.

15.5 Aims of organic production and processing

- To produce sufficient quantities of high quality food, fibre and other products.
- To work compatibly with natural cycles and living systems through the soil, plants and animals in the entire production system.
- To recognise the wider social and ecological impact of and within the organic production and processing systems.
- To maintain and increase long-term fertility and biological activity of soils using locally adopted cultural, biological and mechanical methods as opposed to reliance on inputs.
- To maintain and encourage agricultural and natural biodiversity on the farm and surroundings through the use of sustainable production systems and protection of plant and wildlife habitats.
- To maintain and conserve genetic diversity through attention to on-farm management of genetic resources.
- To promote the responsible use and conservation of water and all life therein.
- To use, as far as possible, renewable resources in production and processing systems and avoid pollution and wastes.
- To foster local and regional production and distribution.

- To create a harmonious balance between crop production and animal husbandry.
- To provide living conditions that allow animals to express the basic aspects of their innate behaviour.
- To utilize biodegradable, recyclable and cycled packaging materials.
- To provide everyone involved in organic farming and processing with a quality of life that satisfies their basic needs within a safe, secure and healthy working environment.
- To support the establishment of an entire production, processing and distribution chain which is both socially and ecologically responsible.
- To recognize the importance of, and protect and learn from, indigenous knowledge and traditional farming systems.

Lecture No. 14

QUALITY CONTROL STANDARDS

CONTENTS

16.1 Introduction

In order to assure the consumer that a product is produced organically, a kind of quality control is needed. The organic quality is based on standards, inspection, certification and accreditation. All organic food is produced and handled according to strict rules called 'organic standards'. These standards cover all aspects of food production from animal welfare and wildlife conservation, to not allowing artificial food additives. All organic forms are visited at least once a year by a certifying inspector to check that standards are met. Organic standards do not define a quality status which can be measured in the final product (E.g. quality of pesticide residues, heavy metals, etc.). They define the way of production (E.g. that no chemical pesticides and fertilizers are used). There are organic standards at the national as well as international level.

16.2 IFOAM (International Federation of Organic Agriculture Movement) Basic standards

IFOAM started during 1970, which now has more than 750 member organisations in over 100 countries. Took the lead in setting standards for organic agriculture. Several countries and organisations have their own standards but largely follow IFOAM standards. Meanwhile, the FAO and WHO jointly brought out guidelines during 1999, known as Codex Alimentarius Commission' guidelines for production, processing, labelling and marketing of organically produced food (ACIGL-32-1999).

India – NPOP (National programme for organic production) during 2000.

IFOAM basic standards are most important organic standards which also describes the principle of organic farming. These are the mother or organic standards. They are standards for standard setting on the national of international level. They are not for certification. It provides framework for certification bodies and standard setting organisations to develop their own certification standards. They are regularly reviewed and updated by the IFOAM members from all over the world.

16.2.1 Aims and activities of IFOAM

- Information exchange about all facts or organic agriculture.
- Promotion of the worldwide development of organic agriculture.
- Exchange of knowledge and experience among members and the organic movement as a whole.
- Representing the organic movement in international institutions.
- Continuously revising the IFOAM basic standards and the norms for accreditation.
- Developing a harmonised international organic guarantee system from the basic standards to the IFOAM accreditation programme.

16.2.2 Standards

Standards are rules of production for organic agriculture. They determine the production process within the ecological and social environment through which the product emerges. There are standards at various levels.

1. **International standards**: International standards are those standards for organic agriculture approved by international bodies and recognised by legal authorities. E.g. Codex Alimentarius Commission guidelines.

IFOAM basic standards: They were first published in 1980. Since then they have been subjected to biennial review and publication. These basic standards define organic products grown, produced and handled. They reflect the current state of organic production and processing methods.

Codex alimentarius: The codex guidelines for organically produced food will be regularly reviewed at least every four years based on given codex procedure.

2. **Regional / supranational standards**

Different regions in the world are involving regional or supranational standards for organic agriculture. E.g. European Union Council's regulations.

European Union Council's regulations: The European Union regulation on organic production lays down minimum rules governing the production, processing and import of organic products, including inspection procedures, labelling and marketing for the whole of Europe. Each European country is responsible for enforcement and for its own monitoring and inspection system. Applications, supervision and sanctions are dealt with at regional levels.

3. **National standards**

National standards are basic organic agriculture standards prepared by respective countries on the basis of which detailed standards are prepared by certification agencies and statutory boards for the development of crops.

Some of the national standards are

1. USDA standards
2. Canadian organic standards
3. Australian organic standards

Organic standards

The use of synthetic pesticides, weedicides and agro-chemicals led to contamination of products and the quality of the produce is under question. Thus, pesticide residue laboratories were set up to test the pesticide contamination in food and drink, but it did not prevent terrestrial and aquatic ecosystem on land and water. Thus, the clean and uncontaminated food can only be obtained by growing than in places, which is not contaminated and not applied with toxic chemicals. The standards are set which makes the food products to be grown under specified conditions, using only permissible inputs, following organic principles during growing, harvesting, processing, packing and transportation and the same came to be known as 'organic standards'.

Organic standards are sets of definitions, requirements, recommendations and restrictions regarding the practices and materials that can be used within certified organic production and processing systems. Organic standards also cover such aspects as the transport, storage and marketing of organic products. Organic standards typically contain lists of materials that are permitted as farm and processing inputs, such as fertilizers, pesticides and food additives. All other materials should be considered as prohibited unless the relevant certification programme approves their use. Organic standards generally emphasis the use of good management practices to minimise the need for inputs wherever possible. Organic standards address such broader aspects as biodiversity, native vegetation retention, waterway management, animal husbandry, ethics and waste management.

16.3 The four IFOAM main principles of organic production

- **The principle of health**: Organic agriculture should sustain and enhance the health of soil, plant, animal and human as one and indivisible.

- **The principle of ecology**: Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

- **The principles of fairness**: Organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.

- **The principle of care**: Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well being of current and future generations and the environment.

16.4 Codex alimentarious guidelines

In 1991, the Codex Alimentarius Commission, a joint FAO / WHO food standards programme began developing guidelines for the production, processing, labelling and marketing of organically produced foods. The guidelines include general sections describing the organic production concept and the scope of the text, description and definitions, labelling and claims (including, products in transition/conversion), rules of production and preparation including criteria for the substances allowed in organic production; inspection and certification systems; and import control. Guidelines for the production, processing, labelling and marketing of organically-produced foods adopted during 1999. During 2001, it included sections ensuring livestock and livestock products and bee keeping and bee products. In earlier guidelines (IFOAM), only organic farming and processing were included, but in codex labelling and marketing are included codex guidelines are widely adopted throughout the world.

16.5 Codex guidelines for organic production system 1.

Enhance the biological diversity within the whole system

2. Increase the soil biological activity. E.g. flora, fauna,

etc.

3. Maintain long-term soil fertility.

4. Recycle wastes of plant and animal origin in order to return nutrients to the land.

   Thus, minimising the use of non-renewable resources.

5. Rely on renewable resources in locally organised agricultural ecosystems.

6. Promote the healthy use of soil, water and air as well as minimise all forms of pollution that may result from agricultural practices.

7. Handle agricultural products with emphasis on careful processing methods in order to maintain the organic integrity and vital qualities of the products at all stages.

8. Become established on any existing farm through a period of conversion the appropriate length of which is determined by site specific factors, such as history of land, type of crops and livestocks to be produced.

16.6 European Union regulations

The European Union was one of the first to set up a policy on organic farming by adopting EU Council regulation. With this regulation, the council created a community frame work defining in detail the requirements for agricultural products or food stuffs bearing a reference to organic production methods. The regulation is set up primarily as a labelling regulation, meant to regulate the internal market for organic products but it also describes the organic production standards and inspection and supervision requirements. It virtually deals with all agricultural products and with all aspects of primary food production and food processing.

16.7 National Standards for Organic Production (NSOP)

In India, standards for organic agriculture were announced in May, 2001 and the National Programme on Organic Production (NPOP) is administered by Agricultural and Processed food products Export Development Authority (APEDA) using the IFOAM basic standards under the Ministry of Commerce. It includes definite principles, basic standards of production, documentation, inspection and certification guidelines. The Government has set the frame conditions in which the organic sector of a country operator which include content and legal status of organic standards, the regulations concerning the use of organic claims and labels, the legislation on consumer protection and the accreditation system. As per the national accreditation policy, all certifying agencies operating in India are to obtain accreditation from any one of the accrediting agency appointed by the Government of India (E.g. Spice Board, Coffee Board, Tea Board, APEDA, etc.).

5. Plant protection

Natural methods are to be adopted. Preventive, cultural thermophysical, etc., promote natural predators and bioagents.

Prohibited: Synthetic products, GM products.

Restricted: Most of the plant products. Even neem oil, biopesticides (NPV, fugae, bacterial, etc.)

Not allowed: Alcoholic product based plant pesticides, soft soap based pesticides even sterilised insects

Allowed: Most of homeopathic, herbal and BD preparation, pheromone traps and mechanical traps-allowed / permitted.

Until now, the Indian standards are only compulsory for products to be exported. It is planned to apply the same standards also for the domestic market.

NSOP guidelines

1. **Formation of organic farmers group**: Farmers with similar farming and production should be brought together preferably in the same village in contiguous areas.

2. **Conversion period in organic farming**: It is the time between the start of organic management and certification of crops. Conversion period varies from 1 to 3 years depending on the current usage of chemical fertilizers, pesticides and false usage of lands. It is determined by certification agencies, while deciding the period, ecological regions are considered.

3. **Plant and planting material**: All seed and planting material essentially used from the same farm or other organic farming farms which are adopted to local soil and climatic conditions.

4. **Fertilisation policy in organic farming**: Biodegradable materials are encouraged. Poultry manure, if it is produced outside the farm, is avoided. They set limitations for use of biodegradable material. Excess use of it also pollute environment. Manures containing human excreta should not be directly used on crops which are used for direct consumption. Carbon based materials should form the basis for nutrition. Some of the mineral fertilizers have restricted use and can be used as supplementary to manures. E.g. Lime, gypsum, rock phosphate, KNO_3 are permitted.

Permitted FYM, urine, crop residues, mulches, cover crops, poultry manure, biofertilizers, BD preparation, vermicompost, botanical extracts, etc.

Restricted use Blood meal, bone meal, compost, city waste, FYM from other farm.

Restricted minerals NaCl, KSO_4, gypsum, $MgSO_4$, lime, rock phosphate.

16.8 Common issues in various standards

1. Maintenance of organic management

The standards requirements should be met during the conversion period. If the whole farm is not converted, the certification programme should ensure that the organic and conventional parts of the farm are separate and inspectable. Converted land and animals should not get switched back and forth between organic and conventional management.

2. Soil healths and water quality

- Enhancement of biodiversity
- No burning of vegetation
- Recycling, generation and addition of OM and nutrients
- Measures to be taken to avoid land degradation and pollution of water resources and should not exploit it.
- Manures to avoid salanisation.
- Rain water recycling where possible
- No clearing of forest
- Measures to prevent soil and water erosion.

3. Biodiversity

- Minimum crop rotation requirements / variety
- Should manage weeds, insects, diseases and other pests while maintaining soil fertility, OM and microbial activity.
- Standards for orchards / plantation floor cover and/or diversity or refuse plantings in the orchard should be set.

4. **Soil productivity**

- Compost prepared from agricultural products produced in the field. Native soil MO are to be utilised.
- Legumes, GM or deep rooting plants in rotation programme
- Use mineral fertilizer (ground rock, lime, dolomite, etc.) microbial fertilizers, biodynamic preparations and botanical preparations
- No synthetic / chemical fertilizers are permitted.
- Use of fertilizers and soil improvement materials noted only in the organic standards. Maximum amount of manures may not exceed 170 kg N/year/ha.

5. **Pest, disease and weed management**

Noxious animal, insects, pests, disease, weed, etc., are to be controlled by

1. Cultivation methods (suitable crop / varieties, time of planting and other cultural management)
2. Physical method (using light, heat, sound, etc., or manual or mechanical methods)
3. Biological method (predators, parasites, etc.)
4. In case of critical agricultural chemicals noted in the standards are to be used.

Ionising radiation should not be executed for the disease and pest control, preservation of foods, removal of pathogens and sanitation. Products which can be used under the supervision are biopesticides (Bt, trichoderma, NPV, pseudomonas, etc.), Bordeaux mixture, sulphur, soft soap and most plant based products (neem, rotenone, pyrethrum, etc.). Maximum use of copper under NPDP 8 kg/ha/year.

Lecture 15

CERTIFICATION PROCESS AND PROCEDURE

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18.1 Certification: Certification means the farm and the farmer's methods inspected by an organic certifying group to ensure that they comply with guidelines on organic farming. Each certifying group has a code of standards, which is available to interested people. Certification is a procedure by which a third party gives written assurance that a product, process or services is in conformity with certain standards. Certification is the key to the National Organic Programme. The certification process focuses on the methods and materials used in production.

A third party- an organic certifying agent evaluates producers, processors and handlers to determine whether they conform to an established set of operating guidelines called organic standards. Those who conform are certified by the agent and allowed to use a logo, product statement or certificate to document their product as certified organic.

18.2 Accreditation

In March 2000, the Ministry of Commerce launched NPOP (National Programme for Organic Production) design to establish National Standards for

Organic Products, which could then be sold under the logo 'India Organic'. For proper implementation of NPOP, NAPP (National Accreditation Policy and Programme) has been formulated with Accreditation regulation announced in May

2001. These make it mandatory that all certification bodies whether internal or foreign operating in the country must be accredited by an Accreditation agency.

An agricultural product can only be exported as organic product if a certification body duly accredited by APEDA certifies it.

18.3 Types of certification

1. **Foreign certification**: The inspection and certification of export oriented organic projects in developing countries are certified by the certification bodies based in importing countries. The main disadvantage is that costs of certification are high due to frequent plane trips and Western salaries.

2. **Co-certification**: Local branch officers of Western Certification programmes conduct inspection along with local inspection staff who speak local languages and familiar with local conditions. However, inspection work is supervised by the Head Office. This reduces number of plane trips.

3. **Indigenous certification**: Indigenous certification bodies can usually offer cheaper inspection fees as less traveling is required and only local salaries have to be covered. They support the development of domestic markets.

For export to the European Union (EU) market, a certificate from a certification body, which is accepted by EU competent authorities is essential. To regulate the export of certified organic products, the Director General of Foreign Trade, Government of India has issued a public notice according to which no certified organic products may be exported unless they are certified by an inspection and certifying agency duly accredited by one of the accreditation agencies designated by Government of India.

18.4 Steps in certification

1. Identification of a suitable certifier: The producer or farmer makes contact with certifying agency. Certifying agency gives information on standards fees application, inspection, certification and appeal procedures.

2. Submission of an application: Submit application along with field history, farm map, record keeping system, etc.

3. Review of application

4. On-farm inspection

5. Final review

The outcome of the review may be a) approval for organic certification, b) request for additional information, c) Notification of non-compliance, d) Denial of certification.

If certification is granted, the producer can begin marketing his or her products as organic. The producer is free to use the seal of certifier.

Examples of non-compliance may include

1. In adequate records of manure application, equipment clearing on-farms where conventional production is also done and compost preparation.

2. A farm that has had chemicals used on it and is in its 1st or 2nd year of transition to organic production cannot be granted certification because the land must be free from prohibited pesticides and fertilizer for a minimum of three years.

3. The contract indicating scope, obligation, inspection and certification, sanction and appeals, duration, fee structure is executed. The costs of certification depends on size of farm, type of production system, group of farmers, location of unit, travel time to reach the inspection site and costs for travel, food and accommodation during inspection.

4. The farm has to undergo inspection at least once a year. Inspectors verify that organic practices such as long-term soil management, buffering between organic farms and neighbouring conventional farms and record keeping are being followed. Processing inspections include review of the facilities of clearing and pest control methods, ingredient transportation and storage and record keeping and audit control. The inspector evaluates the performance of the farm activities with the help of farmers statements and records and by viewing the fields, animals and farm buildings. He can take samples for laboratory testing and may conduct unannounced inspections.

The inspector transmits his/her findings to the certification body as a written report.

5. Final review and certification

The certification body compares the results of the inspection with the requirements of the organic standards. A certification committee decides whether certification may be granted or not and then the agency issues approval or denial of certificate. The certificate is given for current years harvest only and hence annual certification is required. The operator can request for reconsideration of decisions of denial of certificate if has valid reason.

18.5 Group certification

Majority of agriculture practitioners worldwide are small holders and are often located in remote areas with long travel times from one place to another. Furthermore, the overall revenue from their agricultural production is usually too small to allow a viable farm inspection by external inspection body for each farmer.

Based on these observations, an idea was generated to develop Grower Group Certification (CGC) where group certification refers to the certification of a group of producers who are in close proximity to one another, whose farms are uniform in most ways and who are organized under one management and marketing system (IFOAM).

According to NPOP, certification of an organized group of producers, processors and exports with similar farming and production systems and which are in geographical proximity.

18.6 Internal control system (ICS)

As per IFOAM and NPOP definition, Internal Control System (ICS) is a documented quality assurance system that allows the external certification bodies to delegate the inspection of individual group members to a body identified from within the operators of the group. This can be legally recognised farmers association, cooperatives, NGOs or exporters, project or a farmer group. This means, in practice that a growers group basically controls all farmers for compliance with organic production rules according to defined procedures. The organic certification body then mainly evaluates whether the ICS is working well and efficiently. The ICS guards the integrity of the organic quality of the products particularly in smallholder projects. It is a system in which all persons dealing with products (grower, buyers and store keepers) are identified, registered, instructed on the requirement of organic certification and where large number of farmers are to be inspected by a foreign certification body, the involved cost can be very high. In such cases, smallholder group certification can be done. It is done for defined groups (may be upto 900 to

1000 farmers) with similar farming and production system located in geographical proximity. Only one application is required to certify the entire farms of such small holder group and the certification and inspection fee is shared by each individual farmer / operator.

Contracted to ensure compliance. The activities of these persons are monitored by regular visits and documentary control. Besides this, the persons involved are made aware of their common responsibilities for the products, which imply certain social control.

Developing countries are increasingly looking for ways to reduce certification costs and procedures in order to make certification more feasible for small farmers. ICS is an alternative scheme, which help group of small farmers to reduce costs and simplify procedures of internal inspection and certification.

The external auditor can invariably insists on physical inspection of all individual holdings extending up to and above four hectares. It may also be noted that the number of units above four hectares should not exceed 50 per cent of the total area under the group certification.

Marginal farmers	< 1 ha
Small farmers	1 to 1.99 ha
Semi-medium farmers	2 to 3.99 ha
Medium farmers	4 to 9.99 ha
Large farmers	> 10 ha

Lecture No. 16

CERTIFICATION AGENCIES

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19.1 International inspection and certification agencies

1. Soil Association Inspection Scheme, UK
2. SKAL, The Netherlands
3. ECOCERT, France / Belgium / Germany
4. IMO, Switzerland
5. Organic Crop Improvement Association, USA
6. Demeter Association, USA

19.2 Certification agencies in India

- ECOCERT: International (Based in France and Germany branch office in Aurangabad, Maharashtra).

- IMO Control Pvt. Ltd. – Institute for Marketology (based in Switzerland, office in Bengaluru, Karnataka).
- LACON GmbH (based in Germany, office in Aluva, Kerala).

- SGS India Pvt. Ltd. (based in Switzerland, office in Delhi and other cities)
- BIOINSPECTA (based in Switzerland, branch office in Cochin, Kerala)
- SGS India Pvt. Ltd. (based in India, office in Bengaluru)
- APOF Organic Certification Agency (AOCA) (based in India, office in Gurgaon, Haryana)
- SKAL International (based in Netherlands, branch office in Mumbai)
- INDOCERT (based in India, office in Aluva, Kerala)
- India Society for certification (ISCOP) (based in India, office in Coimbatore)

All the above certification bodies are accredited under NPOP.

Ministry of Commerce, Government of India- apex body for NSPO, Ministry of Agriculture, Horticulture, APEDA, Coffee Board, Tea Board, Spice Board, Coconut Development Board, Cocoa and Cashewnut Board are members in steering committee.

They will be administering and developing National Accreditation Policy and programmes to implement national organic programme.

19.3 Accreditation agencies

1. APEDA
2. Coffee Board
3. Tea Board

4. Spice Board
5. Coconut Board
6. Cocoa and Cashewnut Development Board

In turn, these accreditation agencies have inspection and certification agencies. These agencies directly contact farmers, organic input producers, processors and marketing agencies.

19.4 Organic market

The organic food production costs are higher in the developed countries as organic farming is labour intensive and labour is costly in these countries. However, in country like India, where labour is abundant and is relatively cheap, organic farming is seen as a good cost effective solution to the increasing costs involved in chemical farming. Currently most of the organic farmers in India are still in the transition phase and hence their costs are still high. As these farmers continue with organic farming, the production costs are expected to reduce, making India as one of the most important producers of organic food.

19.5 Organic food products exported from India

- Organic cereals: Wheat, rice, maize or corn
- Pulses: Redgram, black gram
- Fruits: Banana, mango, orange, pineapple, passion fruits, cashewnut, walnut.
- Oilseeds and oils: Soybean, sunflower, mustard, cotton seed, groundnut, castor
- Vegetables: Brinjal, garlic, potato, tomato, onion.
- Herbs and spices: Chilli, peppermint, cardamom, turmeric, black pepper, white pepper, amla, tamarind, ginger, vanilla, cloves, cinnamon, nutmeg, mace. • Others: Jaggery, sugar, tea, coffee, cotton, textiles

19.6 Export of organic food products from India (2002)

Organic food items	**Sales (tones)**
Tea	3,000
Coffee	550
Spices	700
Rice	2,500
Wheat	1,150
Pulses	300
Oil seeds	100
Fruits and vegetables	1,800
Cashewnut	375
Cotton	1,200
Herbal products	250
Total:	11,925

Exports

Products exported : 18 items

Total exports (2002-03)	:	63,452 mt.
Approx. value	:	Rs. 89.42 crore
Total agricultural exports	:	Rs. 27,720 crore
Organic export	:	0.32%

Market

Current market	:	23-25 billion US $
Annual growth	:	15-20%
USA	:	11-13 billion US $
Japan	:	350-450 m US $
Europe	:	10-11 billion US $

Potential products

Rice, cereals products, pulses, honey, canesugar, jaggery, fruits (juices, concentrates and nectars), herbs and spices and peanuts.

19.7 Advantage India

- Conducive agro-climatic conditions
- Prevailing traditional farming
- Many areas are not yet exposed to chemicals
- Progressive farmers
- Availability of manpower
- Government initiatives