DEPARTMENT OF PLANT PROTECTION
M.Sc. Ag. (Plant Pathology) CBCS II Semester
Open Elective Course- I: Organic Farming

Introduction, Concept and Relevance in Present Context:
Sustainable development has caught the imagination and action all over the world. Sustainable and tenere, to hold), to keep in existence or maintain, implies long-term support or permanence. As it pertains to agriculture, sustainable describes "farming systems that are capable of maintaining productivity and usefulness to society indefinitely. Such systems must be resource-conserving, socially supportive, commercially competitive, and environmentally sound". According to the Food and Agriculture Organization (FAO), "**sustainable agriculture is the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources**". All definitions of sustainable agriculture lay great emphasis on maintaining an agriculture growth rate, which can meet the demand for food of all living things without draining the basic resources.

Over time, the International Alliance for Sustainable Agriculture and an increasing number of researchers, farmers, policy-makers and organizations worldwide have developed a definition that unifies many diverse elements into a widely adopted, comprehensive, working definition: **A sustainable agriculture is ecologically sound, economically viable, socially just and humane**. **T**hese four goals for sustainability can be applied to all aspects of any agricultural system, from production and marketing to processing and consumption. Rather than dictating what methods can and cannot be used, they establish basic standards by which widely divergent agricultural practices and conditions can be evaluated and modified, if necessary to create sustainable systems. The result is an agriculture designed to last and be passed on to future generations. **C**onceived in this sense, sustainable agriculture presents a positive response to the limits and problems of both traditional and modern agriculture. It is neither a return to the past nor an idolatry of the new. Rather, it seeks to take the best aspects of both traditional wisdom and the latest scientific advances. This result in integrated, nature-based agro-ecosystems designed to be self-reliant, resource-conserving and productive in both the short and long terms.

Organic farming is one of the several approaches found to meet the objectives of sustainable agriculture. Organic farming is often associated directly with, *"Sustainable farming."* However, ‘organic farming’ and ‘sustainable farming’, policy and ethics-wise are t wo different terms. Many techniques used in organic farming like inter-cropping, mulching and integration of crops and livestock are not alien to various agriculture systems including the traditional agriculture practiced in old countries like India. However, organic farming is based on various laws and certification programmes, which prohibit the use of almost all synthetic inputs, and health of the soil is recognized as the central theme of the method. Organic products are grown under a system of agriculture without the use of chemical fertilizers and pesticides with an environmentally and socially responsible approach. This is a method of farming that works at grass root level preserving the reproductive and regenerative capacity of the soil, good plant nutrition, and sound soil management, produces nutritious food rich in vitality which has resistance to diseases.

The farming being practiced for the last five decades in India has increasingly been found non-sustainable. The system is oriented towards high production without much concern for ecology and the very existence of man himself. Adverse effects of modern agricultural practices not only on the farm but also on the health of all living things and thus on the environment have been well documented all over the world. Application of technology, particularly in terms of the use of chemical fertilizers and pesticides all around us has persuaded people to think aloud. Their negative effects on the environment are manifested through soil erosion, water shortages, salination, soil contamination, genetic erosion, etc.

Organic farming is one of the widely used methods, which is thought of as the best alternative to avoid the ill effects of chemical farming. The origin of organic farming goes back, in its recent history, to 1940s. During this period, the path breaking literature on the subject published by J.I. Rodale in the United States, Lady Balfour in England and Sir Albert Howard in India contributed to the cause of organic farming.

In simple words organic agriculture is the production system with the optimum utilization of local resources in such a way so that sustainability of production and wellness of the society and environment can be maintained for fairly long time. Although organic agriculture seems to be just the exclusion of synthetic external inputs but it is the ideological differences with conventional agriculture (Sharma, 2001) that makes organic agriculture friendly to society and environment. These differences are given in table 1.

Table 1: Ideological differences between organic agriculture and conventional agriculture

Organic Agriculture	Conventional (chemical) Agriculture
Holistic approach: Any technology applied considering the system as a whole- No Imbalance	Reductionist approach: Targeted approach for one commodity or one pest or deficiency of nutrient- creates imbalance in system
Decentralize production: Most of the inputs e.g. seed, manure, biopesticides etc. produced at farm/village level- suitable to local environment+ generate employment+ low cost of production	Centralize production: Produced in factories/farms, away from the place of use- no proper use of local resources+ least employment+ increase cost of production

Harmony with NATURE: Harness the benefit of natural resources, flora and fauna by using or giving favorable environment to them- sustained productivity of natural resources	Domination on NATURE: Agriculture system is forced to produce more- Regenerative capacity of natural resources decreased+ decreased productivity in long term.
Diversity: Includes all possible organisms complimentary in a system. Work as mutual service providers for nutrient and pest management. Least cost and time required of system owner.	Specialization: Only one crop or tree or animal. All cost and time of nutrient and pest management has to be borne by system owner/farmer.
Input optimization: best use/recycling of available resources. System regenerative capacity and owners economic capacity maintained/enhanced.	Output maximization: Over use of resources disturbs system and resources productivity in long term- Increasing cost.
Knowledge Intensive: Only few resources but need how timely and best integrated. Least dependency on experts/imported technologies, once farmer trained- possible in remotest area.	Input Intensive: Comprehensive list of chemicals with time and method. Needs experts for timely updating. Only possible in resources sufficient areas.
Preventive, protective and proactive approach: All the actions/ applications are done in anticipation of system requirement-least use of inputs.	Cause and control approach: Most of the actions/applications are done to control the damage to system-heavy use of inputs.
Decreasing input use: As the system reaching at perfection it conserve/generate its own resources e.g. for nutrition and protection- decreasing requirement of inputs	Increasing input use: Target and action approach that rather, deteriorate systems regenerative capacity- increasing requirement of inputs.

History of Organic Farming

Pre-World War II

The first 40 years of the 20th century saw simultaneous advances in biochemistry and engineering that rapidly and profoundly changed farming. The introduction of the gasoline-powered internal combustion engine ushered in the era of the tractor and made possible hundreds of mechanized farm implements. Research in plant breeding led to the commercialization of hybrid seed. And a new manufacturing process made nitrogen fertilizer — first synthesized in the mid-19th century - affordably abundant. These factors changed the labor equation.

Consciously organic agriculture (as opposed to the agriculture of indigenous cultures, which always employs only organic means) began more or less simultaneously in Central Europe and India. The British botanist **Sir Albert Howard** is often referred to as the **father of modern organic agriculture**. From 1905 to 1924, he worked as an agricultural adviser in Pusa, Bengal, where he documented traditional Indian farming practices and came to regard them as superior to his conventional agriculture science. His research and further development of these methods is recorded in his writings, notably, his 1940 book, *An Agricultural Testament*, which influenced many scientists and farmers of the day.

In Germany, Rudolf Steiner's development, biodynamic agriculture, was probably the first comprehensive organic farming system. This began with a lecture series Steiner presented at a farm in Koberwitz (now in Poland) in 1924. Steiner emphasized the farmer's role in guiding and balancing the interaction of the animals, plants and soil. Healthy animals depended upon healthy plants (for their food), healthy plants upon healthy soil, healthy soil upon healthy animals (for the manure).

In 1909, American agronomist F.H. King toured China, Korea, and Japan, studying traditional fertilization, tillage, and general farming practices. He published his findings in *Farmers of Forty Centuries* (1911, Courier Dover Publication). King foresaw a "world movement for the introduction of new and improved methods" of agriculture and in later years his book became an important organic reference.

The term *organic farming* was coined by Lord Northbourne in his book *Look to the Land* (written in 1939, published 1940). From his conception of "the farm as organism," he described a holistic, ecologically balanced approach to farming.
In 1939, influenced by Sir Albert Howard's work, Lady Eve Balfour launched the Haughley Experiment on farmland in England. It was the first scientific, side-by-side comparison of organic and conventional farming. Four years later, she published *The Living Soil*, based on the initial findings of the Haughley Experiment. Widely read, it led to the formation of a key international organic advocacy group, the Soil Association.

In Japan, Masanobu Fukuoka, a microbiologist working in soil science and plant pathology, began to doubt the modern agricultural movement. In 1937, he quit his job as a research scientist, returned to his family's farm in 1938, and devoted the next 60 years to developing a radical no-till organic method for growing grain and many other crops, now known as Nature Farming (Natural Farming), 'do–nothing' farming or Fukuoka farming.

Post-World War II

Technological advances during World War II accelerated post-war innovation in all aspects of agriculture, resulting in large advances in mechanization (including large-scale irrigation), fertilization, and pesticides. In particular, two chemicals that had been produced in quantity for warfare, were repurposed for peace-time agricultural uses. Ammonium nitrate, used in munitions, became an abundantly cheap source of nitrogen. And a range of new pesticides appeared: DDT, which had been used to control disease-carrying insects around troops, became a general insecticide, launching the era of widespread pesticide use.

At the same time, increasingly powerful and sophisticated farm machinery allowed a single farmer to work larger areas of land and fields grew bigger.

In 1944, an international campaign called the Green Revolution was launched in Mexico with private funding from the US. It encouraged the development of hybrid plants, chemical controls, large-scale irrigation, and heavy mechanization in agriculture around the world.

During the 1950s, sustainable agriculture was a topic of scientific interest, but research tended to concentrate on developing the new chemical approaches. In the US, J.I. Rodale began to popularize the term and methods of organic growing, particularly to consumers through promotion of organic gardening.

In 1962, Rachel Carson, a prominent scientist and naturalist, published *Silent Spring*, chronicling the effects of DDT and other pesticides on the environment. A bestseller in many countries, including the US, and widely read around the world, *Silent Spring* is widely considered as being a key factor in the US government's 1972 banning of DDT. The book and its author are often credited with launching the worldwide environmental movement.

In the 1970s, global movements concerned with pollution and the environment increased their focus on organic farming. As the distinction between organic and conventional food became clearer, one goal of the organic movement was to encourage consumption of locally grown food, which was promoted through slogans like "Know Your Farmer, Know Your Food".

In 1972, the International Federation of Organic Agriculture Movements (IFOAM) was founded in Versailles, France and dedicated to the diffusion and exchange of information on the principles and practices of organic agriculture of all schools and across national and linguistic boundaries.

In 1975, Fukuoka released his first book, *The One-Straw Revolution*, with a strong impact in certain areas of the agricultural world. His approach to small-scale grain production emphasized a meticulous balance of the local farming ecosystem, and a minimum of human interference and labor.

In the 1980s, around the world, farming and consumer groups began seriously pressuring for government regulation of organic production. This led to legislation and certification standards being enacted through the 1990s and to date. Since the early 1990s, the retail market for organic farming in developed economies has been growing by about 20% annually due to increasing consumer demand. Concern for the quality and safety of food, and the potential for environmental damage from conventional agriculture, are apparently responsible for this trend.

Twenty-first century

Throughout this history, the focus of agricultural research and the majority of publicized scientific findings have been on chemical, not organic farming. This emphasis has continued to biotechnologies like genetic engineering. One recent survey of the UK's leading government funding agency for bioscience research and training indicated 26 GM crop projects, and only one related to organic agriculture. This imbalance is largely driven by agribusiness in general, which, through research funding and government lobbying, continues to have a predominating effect on agriculture-related science and policy.

Agribusiness is also changing the rules of the organic market. The rise of organic farming was driven by small, independent producers and by consumers. In recent years, explosive organic market growth has encouraged the participation of agribusiness interests. As the volume and variety of "organic" products increases, the viability of the small-scale organic farm is at risk, and the meaning of organic farming as an agricultural method is ever more easily confused with the related but separate areas of organic food and organic certification.

In Havana, Cuba, a unique situation has made organic food production a necessity. Since the collapse of the Soviet Union in 1989 and its economic support, Cuba has had to produce food in creative ways like instituting the world’s only state-supported infrastructure to support urban food production. Called organopónicos, the city i s able to provide an ever increasing amount of its produce organically.

Definitions

There is not one universally accepted definition of organic farming. Most organic farmers and organic consumers expect that organic farming methods should include natural, not chemical growth and production methods such as crop rotation, mechanical cultivation, animal manures, green manure and integrated pest management.

In 1980, the USDA released a landmark report of organic farming. The report defined organic farming as a production system, which avoids or largely excludes the use of synthetic organic fertilizers, pesticides, growth regulators and livestock feed additives. Organic farming systems largely depends on crop rotations, crop residues, animal manures, green manures, off-farm organic wastes, mechanical cultivation, mineral bearing rocks and aspects of biological control to maintain soil productivity, supply plant nutrients and to control insects, pathogens and weeds (Sharma 2002).

According to Codex definition (FAO), organic agriculture is production management system, which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and biological activity. It emphasizes the use of management practices in preferences to the use of off-farm inputs, taking into account that regional conditions require locally adopted systems. This is accomplished by using, where possible, on-farm agronomic, biological and mechanical methods, as opposed to using synthetic materials to fulfill any specific function within the system.

Organic farming is the form of agriculture that relies on crop rotation, green manure, compost, biological pest control, organically approved pesticide application and mechanical cultivation to maintain soil productivity and control pests, excluding or strictly limiting the use of synthetic fertilizers and synthetic pesticides, plant growth regulators, livestock antibiotics, food additives, and genetically modified organisms

Organic agricultural methods are internationally regulated and legally enforced by many nations, based in large part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization for organic organizations established in 1972. IFOAM defines the overarching goal of organic farming as follows:

"Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.." —IFOAM.

Principles

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

The IFOAM definition of Organic agriculture is based on: The principle of **health –** Organic Agriculture should sustain and enhances the health of soil, plant, animal, human and planet as one and indivisible. This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people. Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

The principle of ecology – Organic Agriculture should be based on living ec ological systems and cycles, work with them, emulate them and help sustain them. This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment. Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

The principle of fairness – Organic Agriculture should build on relationship s that ensure fairness with regard to the common environment and life opportunities. Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings. This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products. This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and wellbeing. Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

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. Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken. This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

Concept of organic farming

Organic farming endorses the concept that the soil, plant, animals and human beings are linked. Therefore, its goal is to create an integrated, environmentally sound, safe and economically sustainable agriculture production system. Soil is a living system linked to an organism with different components. Human interact with these natural components (minerals, organic matter, micro-organisms, animals and plants) to achieve harmony with nature and create a sustainable agricultural production. A key feature of organic farming is the primary dependence on natural resource and those developed locally (green manures, crop residues, farm wastes etc.), rather than external inputs (especially synthetics). The farmer manages self-regulating ecological and biological processes for sustainable and economic production of products. Organic farming systems do not use toxic agrochemical inputs (pesticides, fungicides, herbicides and fertilizers). Instead, they are based on development of biological diversity and the maintenance and replenishment of soil productivity.

The concept of organic farming is based on following principles:

- Nature is the best role model for farming, since it does not use any inputs nor demand unreasonable quantities of water.
- The entire system is based on intimate understanding of nature’s ways. The system does not believe in mining of the soil of its nutrients and do not degrade it any way for today’s needs.
- The soil in this system is a living entity.
- The soil’s living population of microbes and other organisms are significant contributors to its fertility on a sustained basis and must be protected and nurtured at all cost.
- The total environment of the soil, from soil structure to soil cover is more important.

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

Organic farming describes two major aspects of alternative agriculture:

- Substitution of manures, farm organic resources and biofertilizers (INM) for inorganic fertilizers.

- Biological and cultural pest, diseases and weed management (IPM, IDM and IWM) instead of chemical control.

The key characterization of organic farming in relation to soil fertility and crop production includes:

- Protecting the long-term fertility of soil by maintaining soil organic matter levels, fostering soil and biological activity and careful mechanical inversion,

- Plant nutrients supply through relatively insoluble nutrient sources (organic sources) made available by the action of soil microbes,

- Meeting crop need of nitrogen through nitrogen fixation by leguminous crops in the cropping systems and recycling of farm organic materials including crop residues and livestock wastes,

- Importance of crop rotation, natural predators, resistance varieties and other agronomic manipulations of plant protection including weed management, and

- Biodiversity management, soil and environmental health.

Organic agriculture is viable alternative to conventional agriculture. It protects the soil from erosion, improves natural resource base and sustains production at levels commensurate with carrying capacity of managed agro-ecosystem because of reduced dependence on fertilizers and plant protection chemicals. It minimizes environmental pollution and aids in regeneration of ecosystem.

Organic farming is one of several to sustainable agriculture and many of the techniques used (intercropping, crop rotation, ploughing, mulching, integration of crops and livestock etc) are practices under various agricultural systems. What makes organic farming unique is that almost all synthetic inputs are prohibited and soil health improving agronomic practices are mandated.

Organic farming is the pathway that leads to live in harmony with nature. Organic agriculture is the key to sound development and sustainable environment. It minimizes environmental pollution and the use of non-conventional natural resources (resources other than traditional resources). It conserves soil fertility and soil erosion through implementation of appropriate conservation practices.

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

Relevance in present context

There are three categories of opinions about the relevance of organic farming for India. The first one simply dismisses it as a fad or craze. The second category, which includes many farmers and scientists, opines that there are merits in the organic farming but we should proceed cautiously considering the national needs and conditions in which Indian agriculture functions. They are fully aware of the environmental problems created by the conventional farming. But many of them believe that yields are lower in organic cultivation during the initial period and also the cost of labour tends to increase therein. The third one is all for organic farming and advocates its adoption wholeheartedly. They think that tomorrow's ecology is more important than today's conventional farm benefits. However, among many a major reservation, the profitability of organic farming vis a vis conventional farming, is the crucial one from the point of view of the Indian farmers, particularly the small and marginal. Organic farming involves management of the agro-eco system as autonomous, based on the capacity of the soil in the given local climatic conditions. In spite of the ridicule poured out on organic farming by many, it has come to stay and is spreading steadily but slowly all over the world. India has been very slow to adopt it but it has made Inroads into our conventional farming system.

The relevance and need for an eco-friendly alternative farming system arose from the ill effects of the chemical farming practices adopted worldwide during the second half of the last century. The methods of farming evolved and adopted by our forefathers for centuries were less injurious to the environment. People began to think of various alternative farming systems based on the protection of environment which in turn would increase the welfare of the humankind by various ways like clean and healthy foods, an ecology which is conducive to the survival of all the living and non-living things, low use of the non-renewable energy sources, etc. Many systems of farming came out of the efforts of many experts and laymen. However, organic farming is considered to be the best among all of them because of its scientific approach and wider acceptance all over the world.

The International Scene

The negative effects of modem chemical based farming system were first experienced by those countries, which introduced it initially. So, naturally, it was in those countries organic farming was adopted in relatively large scales. There are very large number of organizations promoting the organic farming movement in European countries, America, Australia and rest of the world. These organizations, for example, the International Federation of Organic Agriculture Movements (IFOAM) and Greenpeace have studied the problems of the chemical farming methods and compared the benefits accruing to the organic farming with the former. Organic farming movements have since spread to Asia and Africa too.

IFOAM was founded in France in 1972. It spearheads and coordinates organic farming efforts the world over by promoting organic agriculture as an environment friendly and sustaining method. It focuses on organic farming by highlighting the minimum pollution and low use of non-renewable natural resources through this method. It has about 600 organizational members spread over about 120 countries including India. IFOAM undertakes a wide range of activities related to organic farming such as exchanging knowledge and thoughts among its members;

representation of the movement in governmental, administrative and policy making forums in the national and international arena; updating of production, processing and trading standards; formulation and coordination of research projects; and holding of international conferences and seminars. IFOAM participates in the activities related to organic farming under the auspices of the United Nations and keeps active contacts with several international NGOs.

The Food and Agriculture Organization (FAO) of the United Nations provides support to organic farming in the member countries. It also attempts the harmonization of national organic standards, which is absolutely essential to increase international trade in organic products. The FAO has, in association with the World Health Organization (WHO), evolved the Codex Alimentarius for organic products.

Organic farming has several advantages over the conventional one apart from the protection of both the environment and human health. Improved soil fertility, better water quality, prevention of soil erosion, generation of rural employment, etc. are some of them.

The concept of quality food has undergone a drastic change over the past few decades. It does give emphasis on the characteristics of the end product, but the process and method of production and transport are now considered equally important. Not only the importers but also the domestic retailers have their own quality specifications or standards, which in many cases are tougher than those of the government regulations. Consumers have become health conscious and are willing to pay for the clean, healthy and natural food. Many developed countries have various support programmes to help organic farming with financial incentives and technical guidance.

The organic food market in the world has grown rapidly in the past decade. International trade in organic foods showed an annual growth rate of about 20-22 % during this period. Many retail chains and supermarkets in advanced countries are accorded with 'green status'to sell organic foods. The organic food processing industry is considered nature friendly and thus encouraged.

Need for Organic Farming in India

The need for organic farming in India arises from the un-sustainability of agriculture production and the damage caused to ecology through the conventional farming practices.

The present system of agriculture which we call 'conventional' and practiced the world over evolved in the western nations as a product of their socio-economic environment which promoted an over riding quest for accumulation of wealth. This method of farming adopted by other countries is inherently self destructive and unsustainable.

The modern farming is highly perfected by the Americans who dispossessed the natives of their farms right from the early period of the new settlers in US (Wadia, 1996). The large farms appropriated by the immigrants required machines to do the large scale cultural operations. These machines needed large amount of fossil fuels besides forcing the farmers to raise the same crops again and again, in order to utilize these machines to their optimum capacities. The result was the reduction of bio-diversity and labour. The high cost of the machines necessitated high profits, which in turn put pressure to raise productivity. Then, only those crops with high productivity were cultivated which needed increased quantities of fertilizers and pesticides. Increasing use of pesticides resulted in the damage to environment and increased resistance of insects to them. Pesticides harmed useful organisms in the soil.

The monoculture of high yielding seeds required external inputs of chemical fertilizers. The fertilizers also destroy soil organisms. They damage the rhizobia that fix nitrogen and other micro organisms that make phosphates available to plants (Wadia, 1996). The long term effect was reduction of crop yields. The damaged soil was easily eroded by wind and water. The eroding soil needed use of continuously increasing quantities of fertilizers, much of which was washed/leached into surface and underground water sources.

The theme of consumer welfare has become central in the economic activities in the developed countries in the world. Sustainable agriculture based on technologies that combine increased production with improved environmental protection has been accepted as absolutely essential for the maximization of the consumer welfare. The consumers are increasingly concerned about the quality of the products they consume and food safety has become a crucial requirement. Safety, quality and hygienic standards are increasingly being made strict. The mad cow disease and the question of genetically modified food production are the recent instances, which made the countries to tighten the laws. Mycotoxin contamination, unacceptable levels of pesticide residues and environment degradation are the problems on which the attention is centred. Keeping the interests of the consumers, the European Union has taken tough measures including criminal prosecution to ensure food safety. Another area to increase the consumer welfare is promotion of the eco-friendly methods in agriculture. No-till, or conservation agriculture, lower input approaches of integrated pest or nutrient management and organic farming are some of them.

The Indian agriculture switched over to the conventional system of production on the advent of the green revolution in the 1970s. The change was in the national interest which suffered setbacks because of the country's over dependence on the foreign food sources. The national determination was so intense that all the attention was focused on the increase in agriculture production. The agriculture and allied sectors in India provide employment to 65% of the workers and accounts for 30% of the national income. The growth of population and the increase in income will lead to a rise in demand for foodgrains as also for the agricultural raw materials for industry in the future. The area under cultivation, obviously, cannot be increased and the present 140 million hectares will have to meet the future increases in such demands. There is a strong reason for even a decline in the cultivated area because of the urbanization and industrialization, which in turn will exert much pressure on the existing, cropped area.

Science and technology have helped man to increase agricultural production from the natural resources like land. But the realization that this has been achieved at the cost of the nature and environment, which support the human life itself, is becoming clear. It has been fully evident that the present pattern of economic development, which ignores the ecology and environment, cannot sustain the achievement of man without substantial erosion of the factors that support the life system of all living things on the Earth. The evidence of the ill effects of development is well documented. As said earlier, we in India have to be concerned much more than any other nation of the world as agriculture is the source of livelihood of more than 6-7 million of our people and it is the foundation of the economic development of the country.

There were times when people lived close to nature with access to flora and fauna in healthier and cleaner surroundings. One has to look back at our present metropolitan cities or other large towns before the past fifty years as recorded in history/memories of the present elder generation to see the striking differences in the surroundings in which the people lived there. Land, water and air, the most fundamental resources supporting the human life, have degraded into such an extent that they now constitute a threat to the livelihood of millions of people in the country.

Ecological and environmental effects have been highly publicized all over the world. Many times, these analyses have taken the shape of doomsday forecasts. Powerful interests in the developed western countries have also politicized these issues to take advantage of the poor nations of the world. Efforts to impose trade restrictions on the plea of environment protection are a direct result of these campaigns. But we have to recognize that the abysmal level to which we have degraded our resources, requires immediate remedial measures without terming the demand for them as the ploys of the rich nations to exploit the poor.

Another turn of the events has been the blame game for ecological problems stated at the Earth Summit and other international conferences. The developed countries, it is true, are to a great extent instrumental to degrade the environment. However, the poorer countries of the world including India cannot delay or ignore the need for remedial measures, which are to be effectively implemented. We cannot gloss over the fact that we have also contributed to the degradation of ecology; look at the droughts and floods, disappearance of forests, high noise level and air pollution in the cities which are our own creations.

Organically cultivated soils are relatively better attuned to withstand water stress and nutrient loss. Their potential to counter soil degradation is high and several experiments in arid areas reveal that organic farming may help to combat desertification (Alam and Wani, 2003). It is reported that about 70 hectares of desert in Egypt could be converted into fertile soil supporting livestock through organic and biodynamic practices. India, which has some areas of semi-arid and arid nature, can benefit from the experiment.

The organic agriculture movement in India received inspiration and assistance from IFOAM which has about 600 organizational members from 120 countries. All India Federation of Organic Farming (AIFOF) is a member of IFOAM and consists of a number of NGOs, farmers' organizations, promotional bodies and institutions.

The national productivity of many of the cereal crops, millets, oilseeds, pulses and horticultural crops continues to be one of the lowest in the world in spite of the green revolution. The fertilizer and pesticide consumption has increased manifold; but this trend has not been reflected in the crop productivity to that extent. The country's farming sector has started showing indications of reversing the rising productivity as against the increasing trend of input use.

The unsustainability of Indian agriculture is caused by the modern farming methods which have badly affected/damaged production resources and the environment.

In India, the development of organic agriculture is receiving increasing attention among farmers, producers, processors, traders, exporters and consumers. Growing consciousness of health hazards due to the possible contamination of farm produce from the use of synthetic chemicals have immensely contributed to the revival of this form of farming during the last ten years. Agro-climatic conditions in India and our agricultural biodiversity are conducive to organic agriculture and hence offer tremendous scope for cultivation of a wide range of organic products. India is now understood to be a potential supplier of organic products to the international market. Presently, India is exporting these products to Europe, US and Japan and volumes are looking up.

Organic agriculture has grown out of the conscious efforts by inspired people to create the best possible relationship between the earth and men. Since its beginning the sphere surrounding organic agriculture has become considerable more complex. A major challenge today is certainly its entry into the policy making arena, its entry into anonymous global market and the transformation of organic products into commodities. During the last two decades, there has also been a significant sensitization of the global community towards environmental preservation and assuring of food quality. Ardent promoters of organic farming consider that it can meet both these demands and become the mean for complete development of rural areas. After almost a century of development organic agriculture is now being embraced by the mainstream and shows great promise commercially, socially and environmentally. While there is continuum of thought from earlier days to the present, the modern organic movement is radically different from its original form. It now has environmental sustainability at its core in addition to the founders concerns for healthy soil, healthy food and healthy people. To provide a focused and well directed development of organic agriculture and quality products, Ministry of Commerce and Industry, Government of India launched the National Programme on Organic Production (NPOP) in the year 2000, which was formally notified in October 2001 under the Foreign Trade & Development Act (FTDR ACT

ORGANIC PRODUCTION REQUIREMENTS

The important organic production requirements as per national standards for organic production developed by

APEDA are reproduced below:

	·	Genetically engineered cultivars or plant materials are not
		permitted in organic production.
CROP PRODUCTION AND ANIMAL HUSBANDRY IN		The seed for raising a
GENERAL	·	crop should either be organically

Conversion Requirements

Organic agriculture means a process of developing a viable and sustainable agroecosystem. **The time between the start of organic management and certification of crops and/or animal husbandry is known as the conversion period.** The whole farm, including livestock, should be converted according to the standards over a period of **three years**.

For a sustainable agro-ecosystem to function optimally, diversity in crop production and animal husbandry must be arranged in such a way that there is interplay of all the elements of the farming management. Conversion may be accomplished over a period of

produced or if organic seed is not available, conventional seed without any chemical treatment may be used.

- Whole farm including the livestock should be converted to organic in a step by step manner.
- If the whole farm is not converted, the certification programme shall ensure that the organic and conventional parts of the farm are separate and inspectable.
- Before products from a farm/project can be certified as organic, inspection shall be carried out during the conversion period.
- To ensure a clear separation between organic and conventional production, the certification programme (agency) shall inspect, where appropriate, the whole production system.
- Plant products produced can be certified organic when the national standards requirements have been met with during the conversion period of at least two years before sowing for annual crops or in

		the case of perennial crops other than
time. A farm may be converted step by step.		grassland, at least three years before the first harvest of
The totality of the crop production and all animal husbandry		products.
	·	Biodegradable material of microbial plant or animal origin
should be converted to organic management.		shall form the basis of the fertilization programme.
There should be a clear plan of how to proceed with the	·	Manures containing human excreta (faeces and urine)
		cannot be used on vegetation for human consumption.
conversion. This plan shall be updated if necessary and should	·	Mineral fertilizers shall only be used in a supplementary
cover all aspects relevant to these standards.		role to carbon based materials. Permission for use shall
		only be given when other fertility management practices
The certification programme should set standards for different		have been optimized.
farming systems so that they can be clearly separated in	·	Chilean nitrate and all synthetic nitrogenous fertilizers,
		including urea, are prohibited.
production as well as in documentation, and the standards should	·	Mineral fertilizers shall be applied in their natural
determine norms to prevent a mix up of input factors and products.		composition and shall not be rendered more soluble by
		chemical treatment.
	·	Products used for pest, disease and weed management,
The standards requirements shall be met during the conversion		prepared at the farm from local plants,

period. All the standards requirements shall be applied on the relevant aspects from the beginning of the conversion period itself. If the whole farm is not converted, the certification programme shall ensure that the organic and conventional parts of the farm are separate and inspectable. Before products from a farm/project can be certified as organic, inspection shall have been carried out during the conversion period. The start of the conversion period may be calculated from the date of application of the certification programme or from the date of last application of unapproved farm inputs provided it can demonstrate that standards requirements have been met from that date of implementation.

animals and micro-organisms, are allowed.

- The use of synthetic herbicides, fungicides, insecticides and other pesticides is prohibited.
- In case of reasonable suspicion of contamination the certification programme shall make sure that an analysis of the relevant products and possible sources of pollution (soil and water) shall take place to determine the level of contamination.
- For protected structure coverings, plastic mulches, fleeces, insect netting and silage rapping, products based only on polyethylene and polypropylene or other polycarbonates are allowed. These shall be removed from the soil after use and shall not be burnt on the farmland. The use of polychloride based products such as PVC film is prohibited.

Simultaneous production of conventional, organic, in conversion and/or organic crops or animal products which cannot be clearly distinguished from each other, will not be allowed.

To ensure a clear separation between organic and conventional production, a buffer zone or a natural barrier should be maintained. The certification programme shall ensure that the requirements are met.

A full conversion period is not required where de facto full standards requirements have been met for several years and where this can be verified through several means and sources. In such cases inspection shall be carried out with a reasonable time interval before the first harvest.

Maintenance of Organic Management

Organic certification is based on continuance. The certification programme should only certify production which is likely to be maintained on a long-term basis. Converted land and animals shall not get switched back and forth between organic and conventional management.

Landscape

Organic farming should contribute beneficially to the ecosystem.

Areas which should be managed properly and linked to facilitate biodiversity:

- Extensive grassland such as moorlands, reed land or dry land
- In general all areas which are not under rotation and are not heavily manured
- Extensive pastures, meadows, extensive grassland, extensive orchards, hedges, hedgerows, groups of trees and/or bushes and forest lines
- Ecologically rich fallow land or arable land
- Ecologically diversified (extensive) field margins
- Waterways, pools, springs, ditches, wetlands and swamps and other water rich areas which are not used for intensive agriculture or aqua production
- Areas with ruderal flora.

The certification programme shall set standards for a minimum percentage of the farm area to facilitate biodiversity and nature conservation.

The certification programme shall develop landscape and biodiversity standards.

CROP PRODUCTION

Choice of Crops and Varieties

All seeds and plant material should be certified organic.

Species and varieties cultivated should be adapted to the soil and climatic conditions and be resistant to pests and diseases. In the choice of varieties genetic diversity should be taken into consideration.

When organic seed and plant materials are available, they shall be used. The certification programme shall set time limits for the requirement of certified organic seed and other plant material. When certified organic seed and plant materials are not available, chemically untreated conventional materials shall be used. The use of genetically engineered seeds, pollen, transgene plants or plant material is not allowed.

Duration of Conversion Period

The establishment of an organic management system and building of soil fertility requires an interim period, the conversion period. The conversion period may not always be of sufficient duration to improve soil fertility and re-establish the balance of the ecosystem but it is the period in which all the actions required to reach these goals are started.

The duration of the conversion period must be adapted to:

- the past use of the land
- the ecological situation

Plant products produced can be certified organic when the national standards requirements have been met during a conversion period of at least two years before sowing or in the case of perennial crops other than grassland, at least three years (thirty-six months) before the first harvest of products. The accredited inspection and certification agency may decide in certain cases (such as idle use for two years or more) to extend or reduce the conversion period in the light of previous status of the land but the period must equal or exceed twelve months.

The conversion period can be extended by the certification programme depending on, e.g., past use of the land and environmental conditions.

The certification programme may allow plant products to be sold as "produce of organic agriculture in process of conversion" or a similar description during the conversion period of the farm.

For the calculation of inputs for feeding, the feed produced on the farm unit during the first year of organic management, may be classified as organic. This refers only to feed for animals which are themselves being reared within the farm unit and such feed may not be sold or otherwise marketed as organic. Feed produced on the farms in accordance with the national standards is to be preferred over conventionally grown / brought-in feeds.

Diversity in Crop Production: The basis for crop production in gardening, farming and forestry in consideration of the structure and fertility of the soil and surrounding ecosystem and to provide a diversity of species while minimising nutrient losses. Diversity in crop production is achieved by a combination of:

- a versatile crop rotation with legumes
- an appropriate coverage of the soil during the year of production which diverse plant species

Where appropriate, the certification programme shall require that sufficient diversity is obtained in time or place in a manner that takes into account pressure from insects, weeds, diseases and other pests, while maintaining or increasing soil, organic matter, fertility, microbial activity and general soil health. For non perennial crops, this is normally, but not exclusively, achieved by means of crop rotation.

Fertilization Policy

Sufficient quantities of biodegradable material of microbial, plant or animal origin should be returned to the soil to increase or at least maintain its fertility and the biological activity within it. Biodegradable material of microbial, plant or animal origin produced on organic farms should form the basis of the fertilization programme.
Fertilization management should minimize nutrient losses.

Accumulation of heavy metals and other pollutants should be prevented.

Non synthetic mineral fertilizers and brought in fertilizers of biological origin should be regarded as supplementary and not a replacement for nutrient recycling.

Adequate pH levels should be maintained in the soil.

Biodegradable material of microbial, plant or animal origin shall form the basis of the fertilization programme.

The certification programme shall set limitations to the total amount of biodegradable material of microbial, plant or animal origin brought onto the farm unit, taking into account local conditions and the specific nature of the crops.

The certification programme shall set standards which prevent animal runs from becoming over-manured where there is a risk of pollution.

Brought-in material (including potting compost) shall be in accordance with standards.

Manures containing human excreta (faeces and urine) shall not be used.

Mineral fertilizers shall only be used in a supplementary role to carbon based materials. Permission for use shall only be given when other fertility management practices have been optimized.

Mineral fertilizers shall be applied in their natural composition and shall not be rendered more soluble by chemical treatment. The certification programme may grant exceptions which shall be well justified. These exceptions shall not include mineral fertilizers containing nitrogen.

The certification programme shall lay down restrictions for the use of inputs such as mineral potassium, magnesium fertilizers, trace elements, manures and fertilizers with a relatively high heavy metal content and/or other unwanted substances, e.g. basic slag, rock phosphate and sewage sludge.

Chilean nitrate and all synthetic nitrogenous fertilizers, including urea, are prohibited.

Pest, Disease and Weed Management including Growth Regulators

Organic farming systems should be carried out in a way which ensures that losses from pests, diseases and weeds are minimized. Emphasis is placed on the use of a balanced fertilizing programme, use of crops and varieties well-adapted to the environment, fertile soils of high biological activity, adapted rotations, companion planting, green manures, etc. Growth and development should take place in a natural manner.

Weeds, pests and diseases should be controlled by a number of preventive cultural techniques which limit their development, e.g. suitable rotations, green manures, a balanced fertilizing programme, early and pre-drilling seedbed preparations, mulching, mechanical control and the disturbance of pest development cycles. The natural enemies of pests and diseases should be protected and encouraged through proper habitat management of hedges, nesting sites etc. Pest management should be regulated by understanding and disrupting the ecological needs of the pests. An ecological equilibrium should be created to bring about a balance in the pest predator cycle.

Products used for pest, disease and weed management, prepared at the farm from local plants, animals and micro-organisms, are allowed. If the ecosystem or the quality of organic products is likely to be jeopardised, the Procedure to Evaluate Additional Inputs to Organic Agriculture and other relevant criteria shall be used to judge if the product is acceptable. Branded products must always be evaluated.

Thermic weed control and physical methods for pest, disease and weed management are permitted.

Thermic sterilization of soils to combat pests and diseases is restricted to circumstances where a proper rotation or renewal of soil cannot take place. Permission may be given by the certification programme only on a case by case basis.

All equipments from conventional farming systems shall be properly cleaned and free from residues before being used on organically managed areas.

The use of synthetic herbicides, fungicides, insecticides and other pesticides is prohibited.

The use of synthetic growth regulators and synthetic dyes is prohibited.

The use of genetically engineered organisms or products is prohibited.

Accredited certification programmes shall ensure that measures are in place to prevent transmission of pests, parasites and infectious agents.

Contamination Control

All relevant measures should be taken to minimize contamination from outside and from within the farm.

In case of risk or reasonable suspicion of risk of pollution, the certification programme should set limits for the maximum application levels of heavy metals and other pollutants. Accumulation of heavy metals and other pollutants should be limited.

In case of reasonable suspicion of contamination, the certification programme shall make sure that an analysis of the relevant products to detect the possible sources of pollution (soil and water), shall take place to determine the level of contamination.

For protected structure coverings, plastic mulches, fleeces, insect netting and silage rapping, only products based on polyethylene and polypropylene or other polycarbonates are allowed. These shall be removed from the soil after use and shall not be burnt on the farmland. The use of polychloride based products is prohibited.

Soil and Water Conservation

Soil and water resources should be handled in a sustainable manner.

Relevant measures should be taken to prevent erosion, salination of soil, excessive and improper use of water and the pollution of ground and surface water.

Clearing of land through the means of burning organic matter, e.g. slash-and burn, straw burning shall be restricted to the minimum.

The clearing of primary forest is prohibited.

Relevant measures shall be taken to prevent erosion.

Excessive exploitation and depletion of water resources shall not be allowed.

The certification programme shall require appropriate stocking rates which do not lead to land degradation and pollution of ground and surface water.

Relevant measures shall be taken to prevent salination of soil and water.

Collection of Non Cultivated Material of Plant Origin and Honey

The act of collection should positively contribute to the maintenance of natural areas.

When harvesting or gathering the products, attention should be paid to maintenance and sustainability of the ecosystem.

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

Products can only be certified organic if derived from a clearly defined collecting area, which is not exposed to prohibited substances, and which is subject to inspection.

The collection area shall be at an appropriate distance from conventional farming, pollution and contamination.

The operator managing the harvesting or gathering of the products shall be clearly identified and be familiar with the collecting area in question.

ANIMAL HUSBANDRY

Animal Husbandry Management

Management techniques in animal husbandry should be governed by the physiological and ethological needs of the farm animals in question. This includes:

- That animals should be allowed to conduct their basic behavioural needs.
- That all management techniques, including those where production levels and speed of growth should be

  concerned, for the good health and welfare of the animals.

For welfare reasons the herd or flock size should not adversely affect the behavioural patterns of the animal.

The certification programme shall ensure that the management of the animal environment takes into account the behavioural needs of the animals and provides for:

- Sufficient free movement
- Sufficient fresh air and natural daylight according to the needs of the animals
- Protection against excessive sunlight, temperatures, rain and wind according to the needs of the animals

- Enough lying and/or resting area according to the needs of the animal. For all animals requiring bedding, natural materials shall be provided.

- Ample access to fresh water and feed according to the needs of the animals

- Adequate facilities for expressing behaviour in accordance with the biological and ethological needs of the species.

No compounds used for construction materials or production equipment shall be used which might detrimentally affect human or animal health.

All animals shall have access to open air and/or grazing appropriate to the type of animal and season taking into account their age and condition, to be specified by the certification programme.

The certification programme shall allow exceptions in cases where:

- *The specific farm or settlement structure prevents such access provided animal welfare can be guaranteed*

- *Areas where feeding of animals with carried fresh fodder is a more sustainable way to use land resources*

  than grazing, provided animal welfare is not compromised.

Restrictions shall always include a time limit which shall be set for each exception.

Poultry and rabbits shall not be kept in cages.

Landless animal husbandry systems shall not be allowed.

When the natural day length is prolonged by artificial lighting, the certification programme shall prescribe maximum hours respective to species, geographical considerations and general health of animals. Herd animals shall not be kept individually.

The certification programme may allow exceptions, e.g., male animals, smallholdings, sick animals and those about to give birth.

Pest and Disease Control

Pests should be avoided by good manufacturing practices. This includes general cleanliness and hygiene.

Treatments with pest regulating agents must thus be regarded as the last resort.

Recommended treatments are physical barriers, sound, ultra-sound, light, and UV-light, traps (incl. pheromone traps and static bait traps), temperature control, controlled atmosphere and diatomaceous earth. A plan for pest prevention and pest control should be developed.

For pest management and control the following measures shall be used in order of priority:

- Preventive methods such as disruption, elimination of habitat and access to facilities
- Mechanical, physical and biological methods
- Pesticidal substances contained in the Appendices of the national standards
- Other substances used in traps

Irradiation is prohibited.

There shall never be direct or indirect contact between organic products and prohibited substances. (e.g. pesticides).

In case of doubt, it shall be ensured that no residues are present in the organic product.

Persistent or carcinogenic pesticides and disinfectants are not permitted.

The certification programme shall set up rules to determine which protection agents and disinfectants may be used.

Ingredients, Additives and Processing Aids

100% of the ingredients of agriculture origin shall be certified organic.

For the production of enzymes and other micro-biological products the medium shall be composed of organic ingredients.
The certification programme should take into consideration:

- The maintenance of nutritional value
- The existence or possibility of producing similar products.

In cases where an ingredient of organic agriculture origin is not available in sufficient quality or quantity, the certification programme may authorise use of non organic raw materials subject to periodic re-evaluation. Such non-organic raw material shall not be genetically engineered.

The same ingredient within one product shall not be derived both from an organic and non-organic origin.

Water and salt may be used in organic products.

Minerals (including trace elements), vitamins and similar isolated ingredients shall not be used.

The certification programme may, grant exceptions where use is legally required or where severe dietary, or nutritional deficiency can be demonstrated.

Preparations of micro-organisms and enzymes commonly used in food processing may be used, with the exception of genetically engineered micro-organisms and their products. The use of additives and processing aids shall be restricted.

Processing Methods

Processing methods should be based on mechanised, physical and biological processes.

The vital quality of an organic ingredient shall be maintained throughout each step of its processing.

Processing methods shall be chosen to limit the number and quantity of additives and processing aids.

The following kinds of processes are approved:

- Mechanical and physical
- Biological
- Smoking
- Extraction
- Precipitation
- Filtration

Extraction shall only take place with water, ethanol, plant and animal oils, vinegar, carbon dioxide, nitrogen or carboxylic acids. These shall be of food grade quality, appropriate for the purpose. Irradiation is not allowed.

Filtration substances shall not be made of asbestos nor may they be permeated with substances which may negatively affect the product.

Packaging

Ecologically sound materials should be used for the packaging of organic products.

Packaging materials that affect the organic nature of the contents should be avoided. Use of PVC materials is prohibited. Laminates and aluminum should be avoided. Recycling and reusable systems shall be used wherever possible. Biodegradable packaging materials shall be used.

The materials used must not affect the organoleptic character of the product or transmit to it any substances in quantities that may be harmful to human health.

LABELLING

Labelling shall convey clear and accurate information on the organic status of the product.

When the full standards requirements are fulfilled, products shall be sold as "produce of organic agriculture" or a similar description. The name and address of the person or company legally responsible for the production or processing of the product shall be mentioned on the label. Product labels should list processing procedures which influence the product properties in a way not immediately obvious. Additional product information shall be made available on request. All components of additives and processing aids shall be declared. Ingredients or products derived from wild production shall be declared as such.

The person or company legally responsible for the production or processing of the product shall be identifiable.

Single ingredient products may be labelled as "produce of organic agriculture" or a similar description when all

Standards requirements have been met.

Mixed products where not all ingredients, including additives, are of organic origin may be labelled in the following way (raw material weight):

- Where a minimum of 95% of the ingredients are of certified organic origin, products may be labelled "certified organic" or similar and should carry the logo of the certification programme.

- Where less than 95% but not less than 70% of the ingredients are of certified organic origin, products may not be called "organic". The word "organic" may be used on the principal display in statements like "made with organic ingredients" provided there is a clear statement of the proportion of the organic ingredients. An indication that the product is covered by the certification programme may be used, close to the indication of proportion of organic ingredients.

- Where less than 70% of the ingredients are of certified organic origin, the indication that an ingredient is organic may appear in the ingredients list. Such product may not be called "organic".

Added water and salt shall not be included in the percentage calculations of organic ingredients.

The label for in-conversion products shall be clearly distinguishable from the label for organic products.

All raw materials of a multi-ingredient product shall be listed on the product label in order of their weight percentage. It shall be apparent which raw materials are of organic certified origin and which are not. All additives shall be listed with their full name.

If herbs and/or spices constitute less than 2% of the total weight of the product, they may be listed as "spices " or "herbs " without stating the percentage.

Organic products shall not be labelled as GE (genetic engineering) or GM (genetic modification) free in order to avoid potentially misleading claims about the end product. Any reference to genetic engineering on product labels shall be limited to the production method.

STORAGE & TRANSPORT

Product integrity should be maintained during storage and transportation of organic products.

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

Where only part of the unit is certified and other products are non-organic, the organic products should be stored and handled separately to maintain their identity.

Bulk stores for organic product should be separate from conventional product stores and clearly labeled to that effect.

Storage areas and transport containers for organic product should be cleaned using methods and materials permitted in organic production. Measures should be taken to prevent possible contamination from any pesticide or other treatment.

The detailed description of various regulations governing organic production can be obtained from APEDA or downloaded from their website www.apeda.com. These stringent production requirements have been laid down to help produce the food commodities suitable for export. Organic food market is growing worldwide at a fast pace. Therefore, development of production practices in accordance with regional conditions and farmers requirement is need of the hour. India can utilize her economical manpower to produce cost competitive and high quality products for export and for domestic market. Organic production is one area of agriculture which can convert India's 'Green Revolution' into 'Evergreen Revolution'. However, ti will require highest level of commitment from every individual and institution engaged directly or indirectly in promotion of organic farming. Who knows we might be looking at another billion dollar industry in the making similar to information technology."

BIOLOGICAL INTENSIVE NUTRIENT MANAGEMENT

Soil is the important source of plant nutrients. Plant nutrients are lost from the soil in different ways. Large quantities are removed from the soil due to harvest of crops. Weeds remove considerable quantities of plant nutrients from the soil. Nutrients are also lost by leaching and erosion. Nitrogen is also lost by volatilization and denitrification. When the crop requirements are higher than the soil supplying power, nutrients are applied. Plant nutrients can be supplied from different sources *viz.* organic manures, crop residues, bio-fertilizers and chemical fertilizers (in natural forms). To increase production and productivity, maintain soil health, reduce nutrient losses, improve soil environment and minimize energy consumption, it is necessary to use these sources of nutrients in a combined manner which is called Integrated Nutrient Management (INM). These sources are used combined as per availability and feasibility of application under different conditions.

Bio-intensive nutrient management: The practice of biological management of soil fertility is the old concept. It is the use of biological resources of the ecosystem, particularly those of the soil itself, for the manipulation of soil fertility. Biological and physicochemical management are essentially based on integrated approach to soil fertility management. According to Sanchez (1994) we should rely on biological processes by adapting germplasm to adverse soil conditions, enhancing soil biological activity and optimizing nutrient cycling to minimize external inputs and maximize the efficiency of their use. It is an ecological approach to soil fertility management, which has favoured balanced farming systems. Biological approach to soil fertility management will help to restore soil fertility and will solve many problems related to soil management. It is also established that many of the great gains in production made in the green revolution by use of high yielding varieties with high inputs of inorganic fertilizer cannot be maintained indefinitely. Among the causes attributed to yields decline under long term cultivation are changes in soil fertility associated with loss of organic matter and the accompanying decline in soil physical and chemical properties.

The biological soil fertility management is an ecological approach for sustainable development and is mainly concerned with the maintenance of yield, closely associated with desires to conserve natural resources, including a greater value accorded to maintenance of biodiversity. An increased efficient use of resources, including the need to utilize all available resources within economic limits will be realized in the long term as well as profitable in the short-term too.

Soil populations and processes: Biological populations and processes influence soil fertility in a variety of ways each of which can have an ameliorating effect on the main soil-based constraints to productivity:

1. Symbionts such as rhizobia and mycorrhiza increase the efficiency of nutrient acquisition by plants.

1. A wide range of fungi, bacteria and animals participate in the process of decomposition, mineralization and nutrient immobilization and therefore influence the efficiency of nutrient cycles.

1. Soil organisms mediate both the synthesis and decomposition of soil organic matter (SOM) and therefore influence cation exchange capacity; the soil N, S and P reserve; soil acidity and toxicity; and soil water holding capacity.

1. The burrowing and particle transport activities of soil fauna and soil particle aggregation by fungi and

   bacteria, influence soil structure and soil water regimes.

The above practices are not unique to biological management but common to farming practice the world over. The use of biological inputs such as N-fixing bacteria, mycorrhiza or soil fauna as a mean of enhancing the endemic biological activities is the means of biological soil management. Direct management is also achieved by the use of organic matter inputs - a mean of selectively feeding the heterotrophic biological populations of soil - a practice of very ancient origin but at times eschewed in modern agriculture. Equally direct but usually unintentional effects are also achieved by the use of pesticides, which may kill particular group of soil organisms that are involved in processes of significance to soil fertility. Management techniques such as tillage and fertilization also influence the activity of the biota indirectly by altering the physical and chemical environment of the soil.

Principles of microbial degradation

Action of microorganism. The biodegradation process is carried out by different groups of heterotrophic micro-organims, bacteria, fungi, actinomycete and protozoa. The role of cellulolytic and lignolytic microorganisms in decomposition of crop wastes and residues is of prime importance. Micro-organism involved in the process derive their energy and carbon requirements from the decomposition of carbonaceous materials and for every 10 parts of carbon, 1 part of N is required for building up of their cell protoplasm. Fungi are more efficient in carbon assimilation than bacteria and actinomycetes. Thus carbon dioxide evolution is comparatively less when fungi are more active in biodegradation than bacterial.

When organic materials are broken down in presence of oxygen, the process is called as aerobic decomposition. Under aerobic conditions, living organisms which utilize oxygen, decompose organic matter and assimilate some of the C, N, P, S and other nutrients for synthesis of their cell protoplasm. Heterotrophs derive energy from the decomposition of organic matter, resulting on production of CO_2, humic substances and release of available plant nutrients. Carbon serves both as energy source and is also required for cell protoplasm, greater amount of carbon is assimilated than N. Generally about two-thirds of the carbon is required/evolved as CO_2 and the remaining one-third is combined with N in the living cells.

Aerobic decomposition of organic materials is most common in nature and generally occurs in arable soils and in forest soil surfaces where animal droppings and organic residues are stabilized into humus, with involvement of different groups of microflora. In the aerobic process, there are no nuisance problems such as foul odour associated with it as is produced under anaerobic conditions due to intermediate compounds.

A great deal of exothermic energy is released during the oxidation of carbon to carbon dioxide. Organic materials in compost heaps or piles under proper insulation generate substantial amount of heat which increase the temperature upto 65-70 ^oC. However, if the temperature exceeds 65-70 ^oC, the microbial activity is decreased due to the thermal kill of microorganisms and the stabilization of organic matter is slow down. Thermophilic organisms develop when the temperature exceeds above 45 ^oC, and they thrive best in temperature range of 45-65 ^oC. The major reactions likely to occur under aerobic decomposition system are as follows:

Sugars, celluloses, hemicellulosis, Lignins $(CH_2O)_\times$ + X O_2--------------× H $_2O$ + Energy

Proteins (Organic N)	NH_3	NO_2^-	NO_3^-	
Organic S + x O	SO_4^-			
Organic Phosphate (Phytin, Lacithin)			H_3PO_4	$Ca(HPO_4)_2$

Anaerobic microorganisms break down organic materials by a process of reduction in absence of oxygen. First a special group of acid producing bacteria, facultative heterotrophs degrade organic matter into fatty acids, aldehydes and alcohol, etc. Then a group of bacteria convert the intermediate products to methane, ammonia, carbon dioxide and hydrogen. Oxygen is also required for the anaerobic process but its source is chemical compounds and not free dissolved oxygen. Like aerobic process, the organisms use N, P and other nutrients in developing cell protoplasm. During this process the decomposition is not complete and there is less production of carbon dioxide and intermediates, like organic acid will occur in greater amounts. So is the case of N containing substances such as ammonia. Due to lesser microbial biomass production and carbon assimilation, there is greater production of methane. This type of fermentation takes place in gobar-gas plants, marshy soils, in buried organic materials devoid of oxygen or with low oxidation-reduction potential. Intensive reduction of organic matter is also known as a putrefactive process accompanied by foul odours of hydrogen sulphide and of reduced sulphur containing organic compounds such as mercaptans.

As compared to aerobic process where the release of energy is much greater (484-674 K Cal/glucose molecule) only about 26 K Cal of energy per gram of glucose is released. The energy of carbon is in the methane gas and the resultant energy from gober-gas plants in India is utilized for cooking purpose can also be used in running engines. The biochemical reactions that occur in anaerobic decomposition of wastes are as follows:

(CH_2O) x	CH_3COOH
CH_3COOH	$CH_4 + CO_2$
Organic N	NH_3
$2H_2S + CO_2$ + Light	(CH_2O) x + $S_2 + H_2O$
Organic P	Reduced P

ORGANIC MANURES

Manures are plant and animal wastes that are used as sources of plant nutrients. They release nutrients after their decomposition.

Manures can be grouped into bulky organic manures and concentrated organic manures based on concentration of the nutrients.

Bulky organic manures

Bulky organic manures contain small percentage of nutrients and they are applied in huge quantities. Farmyard manure (FYM), compost and green manure are the most important and widely used bulky organic manures. Use of bulky organic manures have several advantages: (1) they supply plant nutrients including micronutrients, (2) they

improve soil physical properties like structure, water holding capacity etc., (3) they increase the availability of nutrients, (4) carbon dioxide released during decomposition acts as a CO_2 fertilizer, and (5) plant parasitic nematodes and fungi are controlled to some extent by altering the balance of microorganisms in the soil.

Farmyard Manure

Farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with litter and left over material from roughages or fodder fed to the cattle. Cattle manure is slow acting, bulky organic and however is a low analysis fertilizer, obtained from dung and urine of farm animals mixed with litter and other miscellaneous farm wastes.

On an average well decomposed farmyard manure contains 0.5 % N, 0.2 % P_2O_5 and 0.5 percent K_2O. The present method of preparing farmyard manure by the farmers is defective. Urine, which is wasted, contains one % nitrogen and 1.35 percent potassium. Nitrogen present in urine is mostly in the form of urea which is subjected to volatilization losses. Even during storage, nutrients are lost due to leaching and volatilization. However, it is practically impossible to avoid losses altogether, but can be reduced by following improved method of preparation of farmyard manure.

Quality and composition of FYM:

The quality of manure and chemical composition in particular is highly variable depending upon the kind of animal, age and condition of the individual animal, quality and quantity of feed consumed, kind of litter used, collection and storage of manure

1. **Kind of animal**: The quality of manure depends on the class of manure viz., cattle, horse manure. Within the same class, quality varies according to the kind of animal, such as milch cattle, dry cattle, work cattle, breeding bulls etc. By and large the dung and urine from animals, which assimilates less (little) for their maintenance and production, will provide better quality manure.

1. **Age and condition and individual animal:** Growing animals, milch cattle, pregnant or carrying cattle utilize much of the ingredients in the feeds for building up their growing

bodies, milk production and for the development of the embryo [calf]. Old or adult animals kept on light work or no work, utilize little from feeds and as such, most of nitrogen is voided through urine and dung. Eventually, the adult old cattle provide better manure.

1. **Quality and quantity of feed consumed:** Nutritious and protein rich feeds like oil cakes enriches the nitrogen content to the resulting manure than the bulky feeds like straw and green grass. Animals fed on concentrated feeds yield better quality manure.
2. **Kind of litter used:** The quality of manure depends to a considerable extent on the nature of litter used. Remnants of leguminous hays (*Bhusa*) give richer manure than usual straws.
3. **Collection of manure:** The method adopted for collection of dung, urine and litter primarily decide the quality of manure as the loss of nutrients particularly nitrogen occurs from the time urine and dung are voided by cattle .The quality of manure depends upon the methods of collection *viz*., Byre, Lose box and

- **Byre system:** Cattle are stalled in a shed with a non absorbent floor provided with necessary slope towards the urine drains. The urine that flows into the drains is collected into a covered tank. From where it is periodically removed and sprinkled on the manure stored in a covered pit .The urine which is an important component of FYM can be properly stored (conserved) in this system. The perfect cleanliness and hygienic conditions of the stalls as well as cattle can be maintained in this system.

- **Dry earth system:** The floor of the cattle shed is well rammed and compacted. Layers of fine sand, red earth of loamy soil are spread as an absorbent for urine. The wet portions are properly covered with dry layers or any of the above materials and once a week the surface layer is removed and dumped in the manure pit. Available saw dust, paddy husk, groundnut shell, paddy winnowed dust would serve the purpose very well compared to the earth absorbents. This system is popular and extensively adopted in rural parts being cheep, convenient and practicable under the existing rural conditions in India.
- **Storage of Manure:** Method of storage of manure influences the quality of manure to a large extent. During storage the manure undergoes fermentative changes, decomposition which leads to loosing its original structure and shape. There are three methods of storage viz., pit method and heap method and covered pit method.

A. **Pit method (Below ground level):** In this method, the manure is stored in a pit with non –absorbent bottom and sides. The pit is provided with a bund at the rim of the pit to prevent the surface run-off of waters during rainy season. The dimensions of the pit can be variable depending on the quantity of dung, urine and litter produced on the farm per day. The losses also occur in this method due to exposure to sun and rain, but it is relatively a better method than the heap method.

A. **Heap method (Above the ground level):** This is the most common method adopted in Indian villages. Manure is heaped on the ground preferably under the shade of a tree. Ideal procedure is to dump the dung first and to cover it with litter soaked urine. This is further covered with a layer of litter/ash / earth to prevent the loss of moisture and to avoid direct exposure to sun. It is also desirable to put up a small bund around the base of the heap to protect against surface run-off washing out the manurial ingredients. It is beneficial to cover the exposed portion of the heap with Palmyra leaves or any other available material. The maximum losses of nutrients occur in this method of storage, resulting in poor quality manure. Direct exposure to the vagaries of climate such as sunshine and rainfall causes looseness and dryness of manure, which hasten the losses of nutrients and rapid oxidation of organic matter.

A. **Covered pit method:** Of all the methods described, it is the best method. In this method, the bottom and sides of the pit are made non-absorbent by granite stone lining. The pit is also provided with a bund of 1½ feet height to prevent surface flow of water (Rain water) and a suitable cover by way of roofing with locally available materials like Palmyra or phoenix leaves etc., organic matter and nutrient losses can be effectively controlled in this method of storage in order to obtain better quality manure [FYM: 0.68% N - 0.5% P – 1% K].

Improved methods of handling farm yard manure

It is practically impossible to check completely the loss of plant nutrients and organic matter during handling and storing of FYM. However, improved methods can be adopted to reduce such loss. Considerably, they are.

A) Trench method of preparing FYM:

This method has been recommended by **C.N. Acharya**. Trenches of size 6 m to 7.5 m length, 1.5 m to 2.0 m width and 1.0 m deep are dug. All available litter and refuse is mixed with soil and spread in the shed so as to absorb urine. The next morning, urine soaked refuse along with dung is collected and placed in the trench. A section of the trench from one end should be taken up for filling with daily collection. When the section is filled up to a height of 45 cm to 60 cm above the ground level, the top of the heap is made into a dome and plastered with cow dung earth slurry. The process is continued and when the first trench is completely filled, second trench is prepared. The manure becomes ready for use in about four to five months after plastering.

If urine is not collected in the bedding, it can be collected along with washings of the cattle shed in a cemented pit from which it is later added to the farmyard manure pit. Chemical preservatives can also be used to reduce losses and enrich farmyard manure. The commonly used chemicals are gypsum and rock phosphate. Gypsum is spread in the cattle shed which absorbs urine and prevents volatilization loss of urea present in the urine and also adds calcium and sulphur. Rock phosphate also acts similarly in reducing losses and also increases phosphorus content.

Losses of Nutrients From FYM During Collection and Storage There are two types of losses of FYM, which are as follows.

A. Losses during handling

B. Losses during preparation and storage

A. **Losses during handling:**

FYM consists of two original components such as i) dung (solid portion) and ii) urine (liquid portion) which are subjected to different losses in different ways. Both the components contain N, P_2O_5 and K_2O. Approximately, half of nitrogen and potash is in dung and other half in urine. Nearly all the phosphorus (96%) is in the solid portion. To conserve N, P_2O_5 and K_2O, it is most essential that both the parts of cattle manure are properly handled and stored

i. Losses of dung**:** Dung is valuable manure. Still larger portion is dried in dung cakes and burnt as fuel. Besides this large portion of cattle excrements is dropped outside the cattle shed, when the animals are grazing on the uncultivated lands. This can be used for preparation of FYM.

i. Losses of urine: Urine contains nitrogen and potassium in large portions. But there is no good method of preserving the urine in our country. In our country most of the cattle sheds have un-cemented or *kachha* floor and the urine gets soaked in the soils of *kachha* floor of the cattle shed and the large quantities of nitrogen are thus lost through the formation of gaseous ammonia as follows.

$CO\ (NH)_2 + 2H_2O \rightarrow (NH_4)_2\ CO_3$
Urea in urine Ammonium carbonate
$(NH_4)_2\ CO_3 + 2H_2O \rightarrow 2\ NH_4OH + H_2CO_3$
Carbonic acid

$NH4OH \rightarrow \quad NH3 \uparrow + H2O$

Ammonium hydroxide

Ammonia

B. Losses during preparation and storage:

Cow dung and other farm wastes are collected daily and these are accumulated in manure pit in open space for

months together. The manure remains exposed to sun and rain during this period. Due to this effect the nutrients are

lost in following ways.

i) By leaching**:**

Nutrients of manures are water soluble and these are liable to get washed by rain water. The leaching loss of nutrients will vary with the surface exposed, the intensity of rain fall and the slope of the surface on which manure is heaped. The leaching loss may be prevented by erecting a roof over the pit. ii) By volatilization:

During storage, the urine and dung are decomposed and considerable amount of ammonia is produced. The ammonia combines with carbonic acid to form ammonium carbonate and bicarbonate, which are rather unstable and gaseous ammonia may be readily liberated and passes into atmosphere as indicated in the following equations.

I. Urea and other nitrogenous compounds in urine and dung by microbial decomposition liberate NH_3 (Ammonia) II. $2NH_3 + H_2CO_3 \rightarrow (NH_4)_2CO_3$

A. $(NH_4)_2 CO_3 + 2H_2O \rightarrow 2NH_4OH +$
H_2CO_3 IV. $NH_4OH \rightarrow NH_3 \uparrow + H_2O$

Ways to minimize these losses from FYM during handling

1. Adopt trench method as suggested by C.N. Acharya for handling of dung and urine

1. Use of Gobar gas plant: 50% of dung is made dung cakes and burnt as fuel for cooking. The use of cow dung in gas plant produces a combustible gas, methane used as fuel gas which, is an improved method of handling FYM.

1. Adopting covered method of storing FYM: Nutrients losses can be effectively controlled by this method

1. Adoption of BYRE system in collection of FYM

1. Proper field management of FYM: During spreading of FYM in the field in small heaps leads to loss of nutrients from it. It is advisable to spread the FYM before ploughing.

1. Use of chemical preservatives: Chemical preservatives are added to FYM to decrease nitrogen losses. To be most effective, the preservatives are applied in the cattle shed to permit direct contact with the liquid portion of excreta or urine. This has to be done because the loss of nitrogen from urine starts immediately.

Commonly used preservatives are 1) Gypsum 2) rock phosphate. It is recommended that 450 g to 900 g of rock phosphate should be applied per day per animal in the cattle shed. Rock phosphate should be applied in places where animal pass urine. The reaction of gypsum with ammonium carbonate (intermediate product from decomposition of urea present in urine) is

$(NH_4)_2 CO_3 + CaSO_4 \rightarrow CaCO_3 + (NH_4)_2SO_4$
With this reaction ammonium carbonate is converted to $(NH_4)_2SO_4$. As long as manure is in moist, no loss of ammonia will occur but if dried the chemical reaction is reversed and loss of

ammonia may occur. Use of gypsum also prevents the bad smell caused by production of ammonia in the cattle sheds. As such in Indian conditions use of gypsum to decrease N loss does not offer practical solution. Super phosphate has been extensively used as a manure preservative. Since ordinary superphosphate contains up to 50 to 60 % gypsum besides mono calcium phosphate. The reaction with ammonium carbonate is given below

$2CaSO_4 + Ca(H_2PO_4) + 2(NH_4)_2CO_3 \rightarrow Ca_3(PO_4)_2 + 2(NH_4)_2SO_4+$
$2H_2O + 2CO_2$ (TCP)

In this reaction, tricalcium phosphate is formed which does not react with ammonia sulphate when manure becomes dry as such there is no loss of ammonia.

Partially rotten farmyard manure has to be applied three to four weeks before sowing while well rotten manure can be applied immediately before sowing. Generally 10 to 20 t/ha is applied, but more than 20 t/ha is applied to fodder grasses and vegetables. In such cases farmyard manure should be applied at least 15 days in advance to avoid immobilization of nitrogen. The existing practice of leaving manure in small heaps scattered in the field for a very long period leads to loss of nutrients. These losses can be reduced by spreading and incorporating by ploughing immediately after application.

Vegetable crops like potato, tomato, sweet-potato, carrot, radish, onion etc., respond well to the FYM. The other responsive crops are sugarcane, rice, Napier grass and orchard crops like oranges, banana, mango and plantation crop like coconut. The entire amount of nutrients present in FYM is not available immediately. About 30% of N, 60-70% P and 70% K are available to the first crop.

Sheep and Goat Manure

The dropping of sheep and goats contain higher nutrients than farm yard manure and compost. On an average, the manure contains 3% N, 1% P_2O_5 and 2% K_2O. It is applied to the field in two ways. The sweeping of sheep or goat sheds are placed in pits for decomposition and it is applied later to the field. The nutrients present in the urine are wasted in this method. The second method is sheep penning, wherein sheep and goats are allowed to stay overnight in the field and urine and fecal matter is added to the soil which is incorporated to a shallow depth by running blade harrow or cultivator.

Poultry Manure

The excreta of birds ferments very quickly. If left exposed, 50 % of its nitrogen is lost within 30 days. Poultry manure contains higher nitrogen and phosphorus compared to other bulky organic manures. The average nutrient content is 3.03 % N, 2.63 % P_2O_5 and 1.4 % K_2O.

Compost

A mass of rotted organic matter made from waste is called compost. The compost made from farm waste like sugarcane trash, paddy straw, weeds and other plants and other waste is called farm compost. The average nutrient content of farm compost is 0.5 % N, 0.15 % P_2O_5 and 0.5 % K_2O. The nutrient value of farm compost can be increased by application of superphosphate or rock phosphate at 10 to 15 kg/t of raw material at the initial stage of filling the compost pit. The compost made from town refuses like street sweepings and dustbin refuse is called town compost. It contains 1.4 % N, 1.00 % P_2O_5 and 1.4 % K_2O.

Farm compost is made by placing farm wastes in trenches of suitable size, say, 4.5 m to 5.0 m long, 1.5 m to 2.0 m wide and 1.0 m to 2.0 m deep. Farm waste is placed in the trenches layer by layer. Each layer is well moistened by sprinkling cow-dung slurry or water. Trenches are filled up to a height of 0.5 m above the ground. The compost is ready for application within five to six months.

Compost prepared by traditional method is usually low in nutrients and there is need to improve its quality. Enrichment of compost using low cost N fixing and phosphate solublizing microbes is one of the possible ways of improving nutrient status of the product. It could be achieved by introducing microbial inoculants, which are more efficient than the native strains associated with substrate materials. Both the nitrogen fixing and phosphate solubilising microbes are more exacting in their physiological and ecological requirements and it is difficult to meet these requirements under natural conditions. The only alternative is to enhance their inoculums potential in the composting mass. Studies conducted at IARI, New Delhi, showed that inoculation with Azotobacter/Azospirillum and phosphate solubilising culture in the presence of 1% rock phosphate is a beneficial input to obtain good quality compost rich in N (1.8%). The humus content was also higher in materials treated with microbial inoculants.

The following basic rules are important for the production of good quality compost:

1. The purpose of composting is to convert organic matter into growth promoting substances, for sustained soil improvement and crop production.

1. The organic matter is partially decomposed and converted by microbes. These microbes require proper growth conditions, for their activity i.e moisture content: 50% and 50% aeration of total pore space of the composting material. This is achieved through stacking and occasional turning over. Microbes also need sufficient nitrogen for synthesizing their body cells [the optimum C:N ratio of the composting material is 20:1 to 30:1]

1. Soil microorganisms constitute sufficiently to the decomposition of organic matter through their continuous activities. The majority of these soil animals provide optimal conditions in their digestive track for their synthesis of valuable permanent humus and stable soil crumbs. A typical compost earthworm is *Eisenia foetida*.

1. Certain additives accelerate the conversion and improve the final product. The materials such as lime, earth, gypsum, rock phosphate act as effective additives. The addition of nitrogen (0.1 to 1 %) is important in case of large C:N ratio of the composting material. Addition of lime (0.3 to 0.5 %), if sufficient lime is not present. The preparation of compost takes 2-3 months. The composition of compost varies with in wide limits.

Stages of composting

There is a huge difference between a backyard humanure composter and a municipal composter. Municipal composters handle large batches of organic materials all at once, while backyard composters continuously produce a small amount of organic material every day. Municipal composters, therefore, are "batch" composters, while backyard composters tend to be "continuous" composters. When organic material is composted in a batch, four stages of the composting process are apparent. Although the same phases occur during continuous composting, they are not as apparent as they are in a batch, and, in fact, they may be occurring concurrently rather than sequentially.

The four phases include: 1) the mesophilic phase; 2) the thermophilic phase; 3) the cooling phase; and 4) the curing phase.

Compost bacteria combine carbon with oxygen to produce carbon dioxide and energy. Some of the energy is used by the microorganisms for reproduction and growth, the rest is given off as heat. When a pile of organic refuse begins to undergo the composting process, mesophilic bacteria proliferate, raising the temperature of the composting mass up to 44°C (111°F). This is the first stage of the composting process. These mesophilic bacteria can include *E. coli* and other bacteria from the human intestinal tract, but these soon become increasingly inhibited by the temperature, as the thermophilic bacteria take over in the transition range of 44°C-52°C (111°F-125.6° F).

This begins the second stage of the process, when thermophilic microorganisms are very active and produce a lot of heat. This stage can then continue up to about 70°C (158°F), [30] although such high temperatures are neither common nor desirable in backyard compost. This heating stage takes place rather quickly and may last only a few days, weeks, or months. It tends to remain localized in the upper portion of a backyard compost bin where the fresh material is being added, whereas in batch compost, the entire composting mass may be thermophilic all at once.

After the thermophilic heating period, the humanure will appear to have been digested, but the coarser organic material will not. This is when the third stage of composting, the cooling phase, takes place. During this phase, the microorganisms that were chased away by the thermophiles migrate back into the compost and get back to work digesting the more resistant organic materials. Fungi and macroorganisms such as earthworms and sowbugs that break the coarser elements down into humus also move back in.

After the thermophilic stage has been completed, only the readily available nutrients in the organic material have been digested. There's still a lot of food in the pile, and a lot of work to be done by the creatures in the compost. It takes many months to break down some of the more resistant organic material in compost such as "lignin" which comes from wood materials. Like humans, trees have evolved with a skin that is resistant to bacterial attack, and in a compost pile those lignins resist breakdown by thermophiles. However, other organisms, such as fungi, can break down lignin, given enough time; since they don't like the heat of thermophilic compost, they simply wait for things to cool down before beginning their job.

The final stage of the composting process is called the curing, aging, or maturing stage, and it is a long and important one. Commercial composting professionals often want to make their compost as quickly as possible, usually sacrificing the compost's curing time. One municipal compost operator remarked that if he could shorten his compost time to four months, he could make three batches of compost a year instead of only the two he was then making, thereby increasing his output by 50%. Municipal composters see truckloads of compost coming in to their facilities daily, and they want to make sure they don't get inundated with organic material waiting to be composted. Therefore, they feel a need to move their material through the composting process as quickly as possible to make room for the new stuff coming in. Household composters don't have that problem, although there seem to be plenty of backyard composters who are obsessed with making compost as quickly as possible. However, the curing, aging, or maturing of the compost is a critically important stage of the compost-making process. And, as in wine-making, an important element to figure into the equation is *patience*.

A long curing period (e.g., a year after the thermophilic stage) adds a safety net for pathogen destruction. Many human pathogens only have a limited period of viability in the soil, and the longer they are subjected to the microbiological competition of the compost pile, the more likely they will die a swift death.

Immature compost can be harmful to plants. Uncured compost can produce phytotoxins (substances toxic to plants), can rob the soil of oxygen and nitrogen, and can contain high levels of organic acids. So relax, sit back, put your feet up, and let your compost reach full maturity *before* you even think about using it.

Methods of composting

The process of composting was first initiated in England during the period of First World War (1914 -1918). The various systems of composting are

1. ADCO process (Agricultural Development Company)

1. Activated compost process

1. Indore process

1. Bangalore process

1. Coimbatore process

1. Rain -water compost

1. Rural compost

1. Urban compost

1. Mechanical compost and

1. Vermicompost

1. ADCO process:

Agricultural Development Company was initiated, [A private concern operating at Harpenden, England] developed by **Hutchinson, H.B and Richards , E.H.** during 1914-1918, at Rothamsted Experimental Station , England. Materials needed:

1. Straw and other wastes -Basic raw material)

1. Ammonium sulphate/Ammonium phosphate /Super phosphate/Muriate of potash Ground limestone/ urea - Starters

Procedure:

The basic raw material straw is spread in layers and sprinkled over with a solution of ammonium sulphate. Then powdered lime stone is applied as broadcast. Then another straw layer is put on. The piling of the layer is continued till a decent heap of convenient height is built up. After about 3 months of fermentation the resulting material is similar to FYM and hence called “synthetic FYM”

The ADCO process was patented and concentrated starters were put in the market with the trade names of ADCO accelerator and ADCO complete manure with full direction for their use.

2. Activated compost process

This method was developed by Fowler and Ridge in 1992 at Indian Institute of Science, Bangalore Materials needed:

- Basic raw materials (straw and farm wastes

- Starters: a) Cow dung b) Urine c) Night soil d) Sewage

and sludge Procedure:

In this process the basic raw material for composting straw and other farm wastes is treated with mixture of cattle dung and urine as decoction. So that every portion of mass comes in contact with the inoculants (dung + urine) and fermentation takes place evenly. On piling up in a heap of 3 feet or 4 feet height and turning over from time to time, keeping moist with dung and urine decoction, very high temperature attained. When the temperatures begin to drop at the end of one week, the volume of the material gets reduced. Further quantity of the material is added onto the heap. About 25% of the new materials should be added at one time and thoroughly mixed with starters (dung +urine decoction) at intervals as before. If properly carried out, the compost will be ready in 5-6 weeks. Night soil and sewage and sludge are also used as starters in this method.

- **Indore process:**

This process is developed in India by **Howard and Ward** at the Indian Institute of plant Industry, Indore Materials needed: a) Straw or organic farm wastes as basic raw materials
a. Cattle dung as starter (urine, earth and wood ashes)

Procedure:

A compost pit of dimensions of 30 x 14 x 3 feet with sloping sides (narrow at bottom and at wide surface) is prepared and the raw material is spread in layers of 3" thickness. A mixture of urine, earth, and wood ashes is sprinkled and this is followed by 2" layer of dung. The pit is filled up this way until the material occupies a height of 3 feet above the ground level. As air can conveniently penetrate only to a depth of 1.5 to 2.0 feet extra aeration has to be provided, which is done by means of artificial vents (holes) of 4" diameter pipe for every 4 fee t length of the pit. The pit is watered twice a day i.e., morning and evening with rose can. The material is turning over 3 times, i.e.,

First – at the end of the first fort night

Second – at the end of the second fort night

Observations:

I. After 10 days of composting the following things happens

- Synthesis of humus begins i.e., development of fungi and the height of the material is reduced by half
- Check anaerobic decomposition, as indicated by the foul smell and fly breeding
- If there is an anaerobic decomposition ,turn over material for proper aeration
- If insufficient fermentation, hasten by watering the material.

- At the end of two months
  - Fungal activity is over
  - Materials become dark
  - Now the bacterial aeration takes place

- Stock the material on the ground after 2 months .So 25 % of additional free nitrogen will be fixed from atmosphere. Compost is ready by 3-4 months. One cattle pair produced 50-60 cartloads per year.

4. Bangalore process

This process of composting was developed by **Dr. C.N.Acharya in 1949.**

1. Basic raw material used: Any organic material

1. Starters or inoculants: FYM or mixture of dung and urine or litter [Undecomposed]

1. Additives:Bone meal or oil cakes, wood ash

Procedure [Pit size: 20 x 4 x 3 feet

The basic raw material is spread in a pit of 20 x 4 x 3 feet dimensions to a depth of 6 " layer, moistened with 20-30 gallons of water if the material is dry. Over this FYM or preferably a mixture of dung, urine and litter (un-decomposed) from the cattle shed is placed as a layer of 2" thickness. It is again covered on the top with a layer of earth to a thickness of 6”. It is beneficial to mix the earth with bone meal or oil cakes, wood ash etc., to improve manurial value of the compost .The piling of layers is continued till the heap raises above the ground level to a height of 2 feet.Then the heap is kept open for one week to facilitate aerobic decomposition. Later the heap is plastered with a layer of moist clay for anaerobic fermentation to occur. Fissures , or cleavages (cracks) that occur in the clay layer , have to be sealed off periodically .The compost will be ready in 4-5 months period starting from the day of preparation .This process is called as aerobic and anaerobic decomposition of compost.

In this process the basic raw material is not so well decomposed as in the other methods .But organic matter and N contents are well conserved. The number of turnings are reduced .The out turn of the compost is relatively greater and cheapest process.

5. The coimbatore process:

1. The basic raw materials: raw organic matter

1. Starters : Powdered bone meal and cattle dung and water emulsion
prepared by mixing Dung in water at 5-10 kg dung in 5-10 litres water.

Procedure [Pit: 12 x 6 x 3 feet]:

The basic raw material loosely spread [Pit: 12 x 6 x 3 feet] to a depth of 9" and water is sprinkled till the entire material is moist. Then about one kg of powdered bone meal is broadcasted uniformly above the layer and above this an emulsion of 5 5-10 kg of fresh cattle dung in 5-10 liters of water is applied. Repeat this process until a heap 2 feet above ground level is formed. Then the entire exposed surface area of heap is plastered with mud to facilitate semi-aerobic fermentation which would takes place for above 4-6 weeks depending upon the nature of the raw material. After 4-6 weeks, the mud plaster is removed to permit aerobic fermentation. If the heap has sunk unevenly which is a sign of defective fermentation, the material is reheaped after forking and moistened .The decomposition is complete in 3-4 months and is fit for application to the field.

6. Rain watered compost

In dry areas where it is difficult to obtain water for watering, the composting can be done with the aid of rain fall. The compost heap is built up as usual before the rains set in. The turnings are given during the rainy period at the end of rains the material will be ready for application. About 400 mm rain fall received in 3-4 months is considered sufficient.

Vermicompost

Soil fauna including protozoa to mammals though not considered major is the important source of nutrients. Among the soil fauna earthworms have attracted more attention than others because of their importance in agriculture. Earthworm gut is the site of production of genuine humic acids which are distinct from the polysaccharide-gum humic acids. About half of the gums secreted by earthworm are in form of mucoproteins that help stabilizing pore space distribution. The earthworm soil casts are richer in available plant nutrients (nitrate nitrogen, exchangeable Ca, Mg, K and P) and organic matter. The earthworms through their casts and dead tissues supply about 60-90 kg N to the soil. Earthworm eats on fungal mycelia. Earthworms convert farm waste and organic residues into high quality compost. For this, *Eisenia foetida*, *Perionyx exacavatus*, *Eudrillus euginiae* and *Lumbrius rubellus* are important. These species can be cultured on organic wastes and dung. The technique of culturing them is called vermiculture and using these for decomposing residue to make compost is called vermicomposting. About 1000 adult earthworms can convert 5 kg waste into compost per day. The earthworm assimilate 5-10% of the substrate and rest passes through the alimentary canal and is excreted as cast. Earthworm cast contains nutrients, vitamins, hormones and antibiotics.

Vermi-compost is a stable fine granular organic matter, when added to clay soil loosens the soil and provides the passage for the entry of air. The mucus associated with the cast being hygroscopic absorbs water and prevents water logging and improves water holding capacity. In the sandy soils where there is the problem of water retention, the young strong mucus coated aggregates of vermicompost hold water for longer life.

In the vermicompost, some of the secretions of worms and the associated microbes act as growth promoters along with other nutrients. It improves physical, chemical and biological properties of soil in the long run on repeated application. The organic carbon in vermicompost releases the nutrients slowly and steadily into the system and enables the plant to absorb these nutrients. The soil enriched with vermicompost provides additional substances that are not found in chemicals. The multifarious effects of vermicompost influence the growth and yield of crops.

Definition of vermicomposting:

Vermicomposting is a method of making compost, with the use of earthworms, which generally live in soil, eat biomass and excrete it in digested form. This compost is generally called vermicompost or Wormicompost.

Definition of Vermiculture:

Vermiculture means scientific method of breeding and raising earthworms in controlled conditions.

Vermitechnology:

Vermitechnology is the combination of vermiculture and vermicomposting. Thus, earthworms can be used in the following areas.

1. For development of arable soils, turnover of soil, break down of plant organic matter aeration and drainage

1. For production of useful products like vermifertilizer and worm tissue for animal feed.

1. For maintenance of environmental quality and monitor of the environment for soil fertility, organic and heavy metal non-biodegradable toxic material pollution.

Types of earthworms in vermicomposting

Earthworms belong to phyllum Annelida of Animal Kingdom. They are long and cylindrical in shape and size having a large number of grooves. There are about 3000 species of earthworms in the world which are adapted to a range of environment. More than 300 species have been identified in India. Although, hermophrodite, two mature earthworms are required to propagate. At the time of egg laying, the clitellum is transformed into hard, girdle like capsule called cocoon. Shedding of cocoon ranges from 1 to 5, only a few of them survive and hatch. The juveniles and again formation of cocoons takes a period of 50-60 days. Normally, the average life span of earthworms varies with species ranging from 1 to 10 years.

Epigeics (surface feeders) are important in vermicomposting. The epigeics such as *Eisenia foetida* and *Eudrilus eugeniae* are exotic worms and *Perionyx excavatus* is a native one being used for vermicomposting in India. Epianecic are feeders on leaf litter and soil at upper layers of soil. This group such as *Lampito mauritii* is indegenous and is active in in-situ decomposition of organic wastes and residues in soil.

Both epigeics and epianecics groups of earthworms are slender, shorter in length and red to dark brown in colour. They have high reproduction activity and efficient in recycling of organic materials. Increased attention has been paid to *Eisenia foetida* and *Eudrilus eugeniae* which have been found to be potential agent in vermicomposting of wide range of agricultural wastes and can grow at a wide range of temperature varying from 0-40 ◦C. However, the optimum temperature ranges from 20-30 ◦C.

Mechanism of vermicomposting

Materials consumed by worms undergo physical breakdown in the gizzard resulting in particles < 2 μ, gi ving thereby an enhanced surface area for microbial processing. This finally ground material is exposed to various enzymes such as protease, lipase, amylase, cellulase and chitinase secreted into lumen by the gut wall and associated microbes. These enzymes breakdown complex biomolecules into simple compounds. Only 5-10% of the ingested material is abosrbed into the tissues of worms for their growth and rest is excreted as cast. Mucus secretions of gut wall add to the structural stability of vermicompost.

Vermiculture industry or vermicompost preparation:

1. Basic raw material: Any organic material generated in the farm like bhusa, leaf fall etc., Horse dung, due to the risk of Tetanus virus, lethal to human beings is not advisable to be used as feeding material for earthworms. Paddy husk, merigold and pine needles have also nto advised to be used as feeding materials for earthworms.

1. Starter: Cow dung , Biogas slurry, or urine of cattle

1. Soil animal: Earth worms (Species: *Eisenia foetida*)

1. Thatched roof/vermished.

Favourable conditions of earth worms in the composting material:

A. pH: Range between 6.5 and 7.5

A. Moisture: 60-70% of the moisture below and above range mortality of worms taking place

A. Aeration: 50% aeration from the total pore space
B. Temperature: Range between 18 ^{0}C to 35 ^{0}C

Procedure

It is mostly prepared in either pit or heap method. The dimensions either heap or pit are 10 x 4 x 2 feet. The length and width can be increased or decreased depending on the availability of material but not the depth because the earthworms' activity is confined to 2 feet depth only. First of all select a site which is not under any economic use and is shady and there is no water stagnation. The site should also be nearby to water source. 1st layer: bedding material of 1" thick with soft leaves

2nd layer: 9" thick organic residue layer finely chaffed material

3rd layer: Dung + water equal mixture of 2" layer.

Continue the layer up to pile to ground level in the case of pit method and upto 2′ in heap or surface bed method. Protect the worms against natural enemies like ants, lizards, snakes, frogs, toads etc., Maintain proper moisture and temperature by turnings and subsequent staking. At the day of 24th, 4000 worms are introduced in to the pit [$1m^2$ =2000 worms] without disturbing the pit by regular watering the entire raw material will be turned into the vermicompost in the form of worm excreta. The turnover of the compost is 75% [the total material accommodated in the pit is 1000 kg; the out turn will be 750 kg]

Harvesting of the vermicompost from the pit

Stop watering before one week of harvest. Sometimes the worms spread across the pit come in close and penetrate each other in the form of ball in 2 or 3 locations. Heap the compost by removing the balls and place them in a bucket. However, under most instances, top layer has to be disturbed manually. Earthworms move downward and compost is separated. After collection of compost from top layers, feed material is again replenished and composting process is rescheduled. The material is sieved in 2 mm sieve, the material passed through the sieve is called as vermicompost which is stored in a polythene bags [Note: Vermicomposting is done under thatched roof to protect worms against rain and sun].

Recomposting is done in the same pit or bed. Similar to the above described pit/heap method, vermicompost can be prepared in wooden box or brick column in similar way.

In-situ vermicomposting can be done by direct field application of vermicompost at 5 t/ha followed by application of cowdung (2.5 cm thick layer) and then a layer of available farm waster about 15 cm thick. Irrigation should be done at an interval of 15 days.

Precautions

1. Do not cover vermicompost beds/heaps with plastic sheets because it may trap heat and gases.

1. Do not overload the vermicompost heap to avoid high temperature that adversely affect their population.

1. Dry conditions kill the worms and waterlogging drive them away. Watering should be done daily in summer and every third day in rainy and winter season.

1. Addition of higher quantities of acid rich substances such as tomatoes and citrus wastes should be avoided.

1. Make a drainage channel around the heap to avoid stagnation of water particularly in high rainfall areas in rainy season.

1. Organic materials used for composting should be free from non-degradable materials such as stones, glass pieces, plastics, ceramic tubes/bulbs etc.

Natural enemies and their control

The important natual enemies of vermiculture are ants, termites, centipedes, rats, pigs, birds etc. Preventive measures include treating of the site with chlorpyriphos 20 EC at 2 ml/l or 4% neem based insecticide before filling the heap.

Transportation of live worms

Live earthworms can be packed with moist feed substrate in a container (card board/plastic) with provision of aeration. Feed substrate quantity should be roughly 0.5-1.5 g/individual for 24 hours of transportation journey. Culture should contain cocoon, juveniles and adults because sometimes adults do not acclimatize to new environment and may even die. Under such circumstances cocoons are helpful for population build up of earthworms.

Nutrient composition of vermicompost

SN	**Nutrient**	**Content**
1.	Organic carbon	9.15 to 17.98 %
2.	Total nitrogen	1.5 to 2.10 %
3.	Total phosphorus	1.0 to 1.50 %
4.	Total potassium	0.60 %
5.	Ca and Mg	22.00 to 70.00 m.e / 100 g
6.	Available S	128 to 548 ppm
7.	Copper	100 ppm
8.	Iron	1800 ppm
9.	Zinc	50 ppm

Besides the above nutrients the vermicompost also contains Protease, Lipase, Amylase, Cellulase enzymes

Conversion rates:

1000 earth worms may convert 5 kg waste material per day

1000 worms weighs about a kilogram

Advantages of composting over direct application:

1. There will be no immobilization in compost because of narrow C:N ratio

1. Application is easy, because the compost is humified and have a structure of crumb and granular.

1. It is hygienic, pathogens and weeds seeds are destroyed.

Advantages of direct application:

1. No loss of nutrients

1. It improves physical properties better than compost on soil application**.**

Application rate

It can be applied in any crop at any stage, but it would be more beneficial if mixed in soil after broadcasting. The rate of application is as

Field crops 5-6 t/ha; vegetables 10-12 t/ha; flower plants 100-200 g/sq ft; fruit trees 5-10 kg/tree.

Advantage of vermicompost

1. Vermicompost is a rich source of nutrients, vitamins, enzymes, antibiotics and growth hormones. So it gives disease resistance to plansts. Nutrient content of vermicompost is higher than traditional composts. It is a valuable soil amendment.

1. Vermicompost horbours certain microbial populations that help in N fixation and P solubilization. Its application enhances nodulation in legumes and symbiotic mycorrhizal associations with the roots.

1. Superiority of vermicompost over other synthetic growth media is more pronounced in plant nurseries. It can be used as rooting medium and for establishment of saplings in nurseries.

1. It improves taste, lusture and keeping quality of the produce.

1. It has immobilized enzymes like protease, lipase, amylase, cellulase and chitinese which keep on their function of biodegradation of agricultural residues in the soil so that further microbial attack is speeded up.
2. It does not foul odour as is associated with manures and decaying organic wastes.

Green Manure

Green un-decomposed plant material used as manure is called green manure. It is obtained in two ways: by growing green manure crops or by collecting green leaf (along with twigs) from plants grown in wastelands, field bunds and forest. Green manuring is growing in the field plants usually belonging to leguminous family and incorporating into the soil after sufficient growth. The plants that are grown for green manure are known as green manure crops. The most important green manure crops are sunnhemp, dhaincha, *pillipesara*, clusterbeans and *Sesbania rostrata*.

Nutrient content of green manure crops and green leaf manure

Plant	Scientific name	Nutrient content (%) air dry weight basis		
		N	P2O5	K_2O
Green manure crops				
Sunnhemp	*Crotalaria juncea*	2.30	0.50	1.80
Dhaincha	*Sesbania aculeata*	3.50	0.60	1.20
Sesbania	*Sesbania speciosa*	2.7.1	053	2.21
Green leaf manure				
Forest tree leaf		1.20	0.60	0.40
Green weeds		0.80	0.30	0.20
Pongamia leaf	*Pongamia glabra*	3.31	0.44	2.39

Nitrogen fixation by leguminous green manurecrops can be increased by application of phosphatic fertilizers. This phosphorus is available to succeeding crop after mineralization of the incorporated green manure crop.

Application to the field, green leaves and twigs of trees, shrubs and herbs collected from elsewhere is known as green-leaf manuring.

Average nutrient contents of oil-cakes

Oil cakes	Nutrient content (%)		
	N	P_2O_5	K_2O
Non-edible oil-cakes			
Castor cake	4.3	1.8	1.3
Cotton seed cake (un-decorticated)	3.9	1.8	1.6

Forest tree leaves are the main sources for green-leaf manure. Plants	Karanj cake	3.9	0.9	1.2
growing in wastelands, field bunds etc., are another source of green-	Mahua cake	2.5	0.8	1.2
leaf manure. The important plant species useful for green-leaf manure	Safflower cake (un-decorticated)	4.9	1.4	1.2
are neem, mahua, wild indigo, glyricidia, Karanji *(Pongamia glabra)*	**Edible oil-cakes**			
calotropis, avise *(Sesbania grandiflora)*, subabul and other shrubs.	Coconut cake	3.0	1.9	1.8
Several advantages accrue due to the addition of green manures.	Cotton seed cake (Decorticated)	6.4	2.9	2.2
Organic matter and nitrogen are added to the soil. Growing deep	Groundnut cake	7.3	1.5	1.3
rooted green-manure crops and their incorporation facilitates in	Linseed cake	4.9	1.4	1.3
bringing nutrients to the top layer from deeper layers. Nutrient	Niger cake	4.7	1.8	1.3
availability increases due to production of carbon dioxide and organic	Rape seed cake	5.2	1.8	1.2
acids during decomposition. Green manuring improves soil structure,	Safflower cake (Decorticated)	7.9	2.2	1.9,
increases water-holding capacity and decreases soil loss by erosion.	Sesamum cake	6.2	2.0	1.2

Growing of green-manure crops in the off season reduces weed proliferation and weed growth. Green manuring

Crop residues of different crops and their nutrient value helps in reclamation of alkaline soils. Root-knot nematodes can be controlled by green manuring. **Concentrated organic manures**

Concentrated organic manures have higher nutrient content than bulky organic manure. The important concentrated organic manures are oilcakes, bloodmeal, fish manure etc. These are also known as organic nitrogen fertilizer. Before their organic nitrogen is used by the crops, it is converted through bacterial action into readily usable ammoniacal nitrogen and nitrate nitrogen. These organic fertilizers are, therefore, relatively slow acting, but they supply available nitrogen for a longer period.

Oil-cakes	Nutrient content of animal based concentrated organic manures			
After oil is extracted from oilseeds, the remaining solid portion	Organic manure	Nutrient content (%)		
is dried as cake which can be used as manure.		N	P2O5	K_2O

Blood-meal	10-12	1-2	1.0
Meat-meal	10.5	2.5	0.5
Fish-meal	4-10	3-9	0.3-15
Horn and hoof meal	13	...	…
Raw bone-meal	3-4	20-25	…
Steamed bone meal	1-2	25-30	…

The oil-cakes are of two types:

- **Edible** oil-cakes which can be safely fed to livestock *e.g.* Groundnut cake, coconut cake etc., and
- **Non-edible** oil-cakes which are not fit for feeding livestock *e.g.* Castor cake, neem cake, mahua cake etc.,

Both edible and non-edible oil-cakes can be used as manures. However, edible oil cakes are fed to cattle and non-edible oil cakes are used as manures especially for horticultural crops. Nutrients present in oil-cakes, after mineralization, are made available to crops 7 to 10 days after application. Oilcakes need to be well powdered before application for even distribution and quicker decomposition.

Other Concentrated Organic Manures

Blood-meal when dried and powdered can be used as manure. The meat of dead animals is dried and converted into meat-meal which is a good source of nitrogen .

CROP RESIDUES

The contribution from crop residues is generally ignored. However, crop residues add considerable amount of nutrients and the amount depends on the crop. Finger millet crop residues add about 43 kg N/ha, while rice crop residues add 17 kg N/ha. The addition of phosphorus is 3.7 and 2.9 kg P_2O_5/ha by finger millet and rice residues respectively. By estimating the appropriate amount of nutrients added to the soil by crop residues, chemical fertilizer application can be reduced.

Application of organic matter in any form reduces the loss of nitrogen fertilizer and increases fertilizer use efficiency.

Large amounts of agricultural wastes are available and there is need to properly use them for some industrial purpose or recycle them to replenish soil fertility. Agricultural residues like paddy straw, rice husk, *jute/cotton/arhar* sticks, wheat straw, groundnut shells, maize straw, sugarcane trash, etc. are left in the fields which create many ecological problems. Perpetuation of diseases and other insect pests is helped by such wastes/residues. For example, cotton sticks left in the field harbour pests to affect the next season cotton crop seriously. Burning of rice husk near rice shellers, in the vicinity of towns, creates air pollution. Burning of paddy straw by farmers in their fields also gives out lot of smoke adding in pollution leading to enhanced incidence of deaths due to increased respiratory diseases.

Crop	Total yield (Grain + straw) (kg/ha)	Stubble weight (kg/ha)	Nutrient content (%) N	P_2O_5	K_2O
Rice	15,536	4,200	0.42	0.066	0.66
Sorghum	5,150	2,889	0.21	0.086	0.33
Maize	14,950	667	0.21	0.060	0.83
Finger millet	18,800	3,111	1.40	0.120	0.66
Foxtail millet	6,500	1,200	0.98	0.070	0.17
Gingelly	500	338	0.70	0.098	0.17

Agricultural residues offer a potential scope to meet our growing needs through their recycling. Crop residues are important energy source. About 2000 million tonnes (Mt) of straw is produced annually in India. Only rice, wheat, sorghum, maize and pearl millet leave 173 Mt of crop residues (Gaur, 1979). Though bulk of such crop straw is used as cattle feed in India, 51Mt of only paddy straw remains unutilized, particularly in wheat belt. Another 16 Mt of sugarcane trash is not utilized properly. Such surplus farm wastes have an estimated potential of 100 Mt/year for recycling of nutrients in agriculture (Gaur and Singh, 1982), which would be equivalent to 2.6 Mt of NPK after proper decomposition, and maintenance of proper C:N ratio through the use of celluloitic fungal culture inoculation. Water hyacinth, an aquatic weed of 2,92,000 ha is a nuisance and creates serious problem in normal flow of water, fish transport and human health. Water hyacinth can be used as compost, green manuring, soil mulch, etc. It can contribute about 0.17 million tonnes equivalent of NPK (Gaur and Singh, 1982). Water hyacinth on dry weight basis can yield 370 l of biogas with average methane content of 69% (Gaur, 1979).

Industrial wastes like rice husk, rice bran, bagasse, press mud, cotton dust, oil cakes, slaughter house wastes, faecal matter, marine residues, city garbage, night soil, etc. could also provide NPK equivalent to about 4.72 Mt for increasing agricultural production and, thus, become a vast source of energy after developing a sound system of their use and recycling. A large quantity of about 247 Mt of agricultural byproducts like wood, dung and crop residues are burnt annually in India due to fire needs. This vast source of energy, thus, could not be recycled back into the ecosystem, until an alternative source of energy is provided for home consumption. Biogas technology may help to provide valuable energy source for cooking and would also provide digested slurry as a valuable source of organic manure. Systematic, efficient and safe collection and disposal of city garbage like rubbish, dead animals, tanneries wastes, street sweeping, night soil, etc. cou1d be economical, besides, reducing environmental pollution, foul smell and nuisance for health hazard. With proper treatment such garbage could be turned to valuable compost.

Agro-industries generate residues like husk, hull, shell, peel, testa, skin, fibre, bran, linter, stone, seed, cob, prawn, head, frog legs, low grade fish, leather waste, hair, bones, coir dust, saw dust, bamboo dust, etc. which could be recycled or used efficiently through agro-processing centres. In the last three decades, rice and sugarcane residues have increased by 162 and 172 %, respectively. Their disposal problem needs serious rethinking (Vimal, 1981). To some extent these organic residues are used as soil conditioner, animal feed, fuel, thatching and packing materials. These can also be put to new uses for manufacture of various chemicals and specific products (like silica, alcohol, tannins, glue, gelatine, wax, etc), feed, pharmaceuticals (Iycogenin, antibiotics, vitamins, etc.), fertilizers, energy, construction materials, paper pulp, handicraft materials etc. Residues from fruit and vegetable industries, fish and marine industries and slaughter houses leave a stinking smell. Similarly, presence of bitter components in non-edible oil seeds, wax in sulphitation press mud, tannins in cashew testa and potassium oxalate in rice straw decrease their efficiency without pretreatment.

Agro-industrial byproducts can be utilized only through the development of secondary and tertiary industries. The operation of this concept can be illustrated with respect to the utilization of the byproducts of sugar and rice factories (Fig. 1) with minimized pollution hazards and sanitary conditions at the mill premises. Adoption of an integrated system utilizing cattle shed wastes, biogas slurry, crop residues, weeds, fallow leaves, etc. can provide gas for milk processing, feed for animals and manure for soil. Efficient utilization of agricultural residues would conserve non-renewable resources, establish secondary and tertiary industries, create employment opportunities, provide economical products, reduce the overall cost of production, minimize environmental pollution, satisfy local needs as well as promote science and technology in the country.

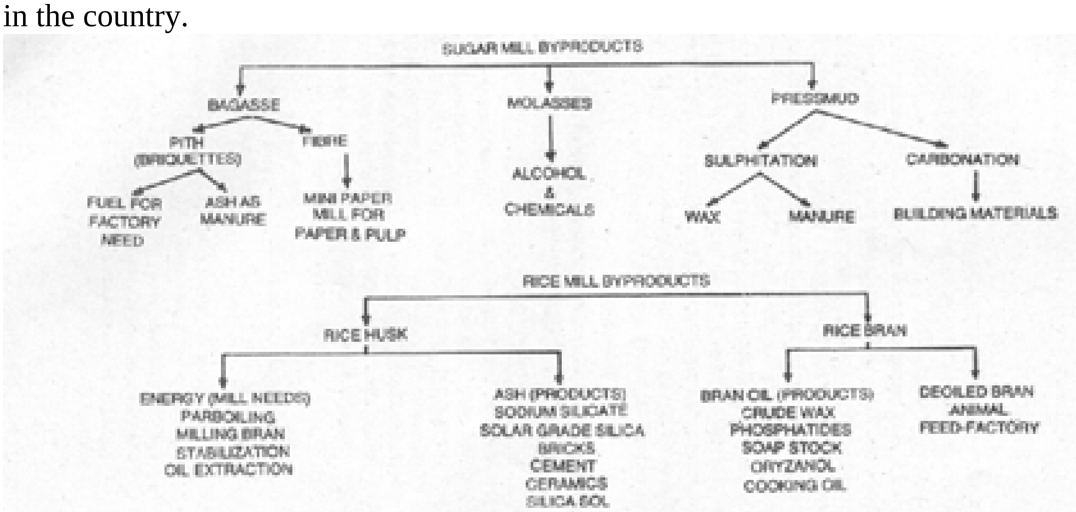


Fig 1. Integrated use of byproducts of sugar/rice mill after conversion into a complex of secondary and tertiary industries (After Vimal, 1981).

BIOFERTILISERS

Atmosphere contains 78 % nitrogen and 0.03 % carbon dioxide. Plants are able to assimilate carbon dioxide through photosynthesis even when carbon dioxide content is less, but most of the plants cannot fix atmospheric nitrogen though it is abundant. Some microorganisms are capable of fixing nitrogen, while some can increase the availability of nitrogen and phosphorus.

Symbiotic Bacteria

Bacteria belonging to the genus *Rhizobium* are capable of fixing atmospheric N_2 in association with leguminous crops. Different species of *Rhizobium* are used for treating the leguminous crops (Table). Rhizobium sp enter the roots of host plants and form nodules on the root surface. The bacteria depend on the host plant for carbohydrates and water while *Rhizobium* supplies N to the host. Nitrogen fixed by the Rhizobium is translocated through xylem vessels of the host plant mainly in the form of aspergine and to some extent as glutamine. Rhizobium species suitable for different crops are multiplied on a peat base in laboratories. This inoculum can be applied in three ways and among them, seed treatment is the best.

Rhizobium species suitable for different crops

Rhizobium sp	*Crops*
R. leguminosarum	Peas *(Pisum)*, lathyrus, vicia, lentil *(Lens)*
R. Tripoli	Berseem *(Trifolium)*
R. phaseoli	Kidney bean *(Phaseolus)*
R. lupine	*Lupinus. Ornithopus*
R. japonicum	Soybean *(Glycine)*
R. meliloti	*Melilotus.* Lucerne *(Medicago),* Fenugreek *(Trigonella)*
Cowpea miscellany	Cowpea, clusterbean, greengram, blackgram, redgram, groundnul, moth bean, dhaincha, sunnhemp, *Glyricidia. Acacia.*
	Prosopis. Dalbergia. Albizzia. Indigofera. Tephrosia. Atylosia. Stylo
Separate group	Bengal gram (gram)

Seed Treatment. Depending on the seed rate, the required quantity of jaggary is boiled in water and cooled. *Rhizobium* inoculum (1.5 kg/ha) is mixed in the jaggary solution and sprinkled over the seeds. Then the seeds are thoroughly mixed to spread the inoculum over the entire surface of the seeds. Seeds are then shade dried.

Soil Treatment. The *Rhizobium* inoculum is mixed with soil and spread over the field.

Soil Application. If *Rhizobium* inoculum is not available, 200 kg of surface soil (2 to 10 cm depth) can be collected from the fields where that 'particular leguminous crop is grown luxuriantly and this soil can be broadcasted over the field where crop is grown for the first time.

FREE LIVING ORGANISMS

The important free living organisms that can fix atmospheric nitrogen are blue green algae (BGA), *Azolla, Azotobacter* and *Rhizospirillum.* Among them, BGA and *Azolla* can survive only in lowland conditions. Small quantity of inoculum of BGA and AzolIa can be obtained from laboratories and they can be multiplied in the farmers' fields for subsequent application.

Blue-green Algae (BGA)

Several species of BGA can fix atmospheric N. The most important species are *Anabaena* and ***Nostoc***. The amount of N fixed by blue-green algae ranges from 15 to 45 kg N/ha. Standing water of 2 to 10 cm in the field is a prerequisite for the growth of BGA. It can grow in a temperature range of 25 to 45°C. Bright sunshine increases the growth rate while rains' and cloudiness slows growth rate. It grows well in a pH range of 7 to 8 and in soils with high organic matter. BGA inoculum is multiplied in iron trays of 2 m x 2 m x 0.25 m size. These trays are lined with polythene sheet. Each tray is filled with 20 kg of soil and 400 g of superphosphate. Blue-green algae inoculum is sprinkled in the tray and water is let in. Standing water of 5 to 10 cm is maintained continuously. Within a week, a thick algal scum is formed. At this stage, water is drained out and soil is allowed to dry. The dried flakes of blue green algae are collected and stored for application in the main field. Blue green algae inoculum is applied after transplantation of rice crop in the main field. The inoculum required is 10 kg/ha. For higher nitrogen fixation, 3 to 4 t/ha of farmyard manure and 200 kg/ha of superphosphate are applied.

Azolla. Azolla is a free floating fresh water fern. *Azolla pinnata* is the most common species occurring in India. It fixes nitrogen due to *Anabaena* species of blue-green algae present in the lobes of Azolla leaves. A thick mat of Azolla supplies 30 to 40 kg N/ha. Unlike blue-green algae, it thrives well at low temperature. Normal growth of Azolla occurs in the temperature range of 20 to 30° C. It grows better during monsoon season with frequent rains and cloudiness. Suitable soil pH is 5.5 to 7.0.

Nursery area should be under the shade of trees. Small plots of 4 m x 2 m with bunds of 30 to 40 cm height all around are prepared. The bunds may be lined with polythene sheets to avoid leakage of water from plots. Water is let into the plots and Azolla is applied at 0.1 to 0.5 kg/m^2. For faster growth of nursery, superphosphate at the rate of 2.5 g/m^2 is applied. Carbofuran granules at 1.2 g/m^2 are applied to control leaf eating caterpillars and other pests.
Azolla is applied to the main field as a green manure crop and as a dual crop. As green manure crop, AzolIa is allowed to grow on the flooded fields for 2 to 3 weeks before transplanting. Later water is drained and Azolla is incorporated by ploughing in. As a dual crop, 1,000 to 5,000 kg/ha of Azolla is applied to the soil one week after transplanting. When a thick mat forms, it is incorporated by trampling. The left over Azolla develops again which is trampled in as a second crop. For better growth of Azolla, 25 to 50 kg/ha of superphosphate is applied and standing water of 5 to 10 cm is maintained continuously in the rice fields.

Azotobacter and Azospirillum

Azotobacter chroccum is capable of fixing 20 to 30 kg N/ha. It can be applied by seed inoculation, seedling dip or by soil application. The inoculum required is 3 to 5 kg/ha. Application of 5 t/ha of farm yard manure helps in better growth of *Azotobacter*. *Azotobacter* can be used for rice, cotton and sugarcane. *Azospirillum* inoculum is used for sorghum.

Mycorrhiza and Phospho-micro Organisms

Phosphorus availability and fertilizer phosphorous use efficiency can be increased with mycorrhiza, phosphate solubilizing bacteria and fungi. Mycorrhiza inhabits roots of several crops and solubilises soil phosphates. Inoculation of mycorrhiza increases the pod yield of groundnut. Some microorganisms like *Psuedomonas striate*. *Aspergillus awaneorii* and *Bacillus polymyxa* are capable of solubilising phosphates. The inoculum of these microorganisms is applied to increase the availability of phosphorus.

Saprophytes

Microorganisms that are capable of decomposing organic matter at a faster rate can be used as a fertilizer for quick release of nutrients. *Aspergillus*, *Penicillium*, *Trichoderma* are cellulolytic fungi which break down cellulose of plant material. The natural process of decomposition is accelerated and composting time is reduced by 4 to 6 weeks by the use of inoculants of these organisms.

SOIL IMPROVEMENT AND AMENDMENTS

Soil is foundation to every field/garden. Every healthy, productive field, yard and garden starts with healthy, productive soil. Preparing the soil properly makes more difference than any other thing you can do. You cannot put on enough nutrients and water to make up for poor soil. Since soils are so different in different areas, it is necessary to know what soil is, what your soil is like and what to add to improve it.

SOIL COMPONENTS

Soil is made up of four main components: mineral, water, air and organic.

MINERAL
The mineral component is non-living material. It is divided by the size of the particles, into:
Sand: Rounded particles 1/12 to 1/500 inch (2.0 to 0.06 mm) in diameter.
Silt: Rounded particles 1/500to 1/12,500 inch(0.06 to 0.002 mm) in diameter.
Clay: Flattened particles less than 1/12,500 inch (0.002 mm) in diameter.

Loam: Mixture of the above in roughly equal proportions.

Sand has large spaces between the particles, which allow air and water to move easily, so sand has good aeration and drainage. Clay packs down with only tiny spaces between particles so there is poor aeration and drainage. However, clay has about 100 times the surface area as the same volume of sand. More surface area means that clay will hold more water and more nutrients. Silt has some of the qualities of both sand and clay. Loam combines the best features of all three: aeration, drainage and storage capacity for water and nutrients. Often, soil particles are clumped together into crumbs, which create

3.2.7 Soil and Water Conservation

General Principles
Soil and water resources should be handled in a sustainable manner.
Recommendations

Relevant measures should be taken to prevent erosion, salination of soil, excessive and improper use of water and the pollution of ground and surface water.
Standards

3.2.7.1. Clearing of land through the means of burning organic matter, e.g. slash-and burn, straw burning shall be restricted to the minimum.
3.2.7.2 The clearing of primary forest is prohibited.
3.2.7.3. Relevant measures shall be taken to prevent erosion.

3.2.7.4. Excessive exploitation and depletion of water resources shall not be allowed.

3.2.7.5. The certification programme shall require appropriate stocking rates which do not lead to land degradation and pollution of ground and surface water.
3.2.7.6. Relevant measures shall be taken to prevent salination of soil and water.

large spaces between the crumbs for aeration and drainage. Pebbles and rocks also increase drainage; sometimes so much that plants wilt from lack of water. Rocks also may interfere with root growth.

WATER

The amount of water in the soil is described in these ways:

Saturated: All of the spaces in the soil are filled with water.

Field capacity: Excess water has drained away leaving a film of water on each particle and air in the spaces.

Wilting Point: The film of water on each particle is so thin that roots can no longer pull enough water from the soil, so the leaves droop.

Plants grow best when the soil is at field capacity. Frequent watering in controlled amounts on well-drained soil to maintain field capacity has doubled vegetable yields. However, it takes careful monitoring and controlled watering to maintain field capacity so usually soil is watered to near saturation and the excess is allowed to drain away.

AIR

Air in the soil is made of the same gases as the air in the atmosphere. Air doesn't move as freely in the soil so there may be too much or too little of certain gases in parts of the soil. Plant roots need oxygen to absorb water and nutrients. The lack of oxygen limits how deep roots can grow. Roots may grow thirty feet deep in well-drained sandy soil, but most roots are in the top foot of clay soil. Oxygen is replenished in the soil when water forces the air out of the soil, then fresh air is pulled back into the soil as the water drains away. Large spaces between soil particles and crumbs allow soil to breathe better. Deep watering helps the soil breathe much better than frequent, shallow watering.

ORGANIC

The organic component of the soil is made up of living and dead plants and animals.

Living: Bacteria, Fungi, Insects, Worms, and Roots.

Dead: All of the above as they decay.

Humus: Dead organic matter that has decomposed until it is very fine, black and sticky.

Bacteria and fungi extract nutrients from the soil minerals and make them available to plants. Mycorhizae are fungi that are partly in the soil and partly inside plant roots. They can transport a very large amount of nutrients into plant roots. Insects and worms create air passages deep into the soil. The carbon dioxide produced by roots becomes carbonic acid, which breaks down minerals to make nutrients available. Dead organic material provides rich nutrients for the living. It also holds the nutrients from applied fertilizers until the plants can use them. Humus sticks the soil particles into larger crumbs so there are bigger spaces for air and water.

Dead organic matter is decaying continually, so it needs to be replenished every year. Excessive nitrogen fertilizer will cause the dead organic matter to decay even faster; so more organic matter will have to be applied. Also, careless use of pesticides may harm or kill the living organisms and damage the soil.

SOIL TESTING

Soil testing is done to determine how much of each soil component is present in the soil. Soil testing laboratories can give a detailed and accurate measurement of the soils components. However, these simple tests can reveal much about the soil.

SOIL PROFILE TEST

Dig a hole 18" deep and wide enough that the soil can be seen. Sand can be seen or felt. Black color indicates high organic matter; gray indicates medium organic matter. Red, tan or blue color indicates little organic matter and high clay. Blue color indicates that there is no oxygen in the clay. Therefore, no roots will grow in blue clay. Normally, the organic matter is mainly in the topsoil. Forest soils have a one to four inch thick layer of organic matter on top of mineral soil. Grassland soils have a much thicker layer of organic matter mixed with mineral soil. Wetland soil may have a layer of organic matter several feet thick because the lack of air in wet soil slows down the decay of organic matter.

SEPARATING SOIL IN WATER TEST

Fill a glass jar about half full with soil. Fill to the top with water. Shake the jar, but do not swirl. Let stand. Sand will settle in about ten seconds. Silt will settle in two minutes. Clay will take hours to settle. Larger pieces of organic matter will float for awhile. The thickness of the layers indicates the proportions of sand, silt, clay and organic matter.

SOIL pH OR ACIDITY TEST

Soil pH is a measure of hydrogen ion concentration. It is tested either with a chemical pH test, or by a pH meter. 7.0 is neutral. 4.0 is very acid. 10.0 is very alkaline. High rainfall and high organic matter produces acid soil. Low rainfall and high lime or sodium produces alkaline soils. Soils naturally have a pH between 4.5 and 5.5 are fine for acid loving plants such as rhododendrons, azaleas, camellias and conifers. Lawns, roses, lilacs, fruit trees, vegetables and many flowers prefer a soil pH near neutral, 6.5 to 7.0. The majority of plant nutrients are most available at slightly acid to neutral, though iron is more available as soil is more acid. Soil can be made less acid by adding lime (calcium carbonate), or more acid by adding sulfur or aluminum sulfate. Aluminum sulfate is especially helpful to produce good blue flowers on hydrangeas. Adding lime produces pink hydrangea flowers. Lime will raise the soil pH in a few weeks or several months depending on how finely ground the lime particles are. Sulfur takes about a year to lower soil pH since bacteria are required to complete the process.

SOIL NUTRIENTS

There are thirteen essential nutrients which plants get from soil. The six that the plants need the most of are called Macronutrients. They are Nitrogen, Phosphorus and Potassium, which are abbreviated N-P-K, Calcium, Magnesium and Sulfur. The other nutrients, which are needed only in trace amounts, are called Micronutrients. They are Iron, Manganese, Boron, Zinc, Copper, Molybdenum and Chlorine.

Nitrogen encourages leaf growth. Phosphorus encourages roots and flowers. Potassium encourages general vigor. If one of these nutrients isn’t available, then plant growth will be slower or stunted, and leaves will be discolored. For example, lack of nitrogen causes the old leaves to turn yellow. Lack of iron causes the new leaves to be yellow. Nutrient deficiencies will form patterns on the leaves that follow the vein patterns: sometimes along the veins, sometimes between the veins. Disease symptoms don't follow the veins.

Soil laboratories will test soils for nutrients as well as pH and organic matter. However, a general recommendation is: All soils are short on nitrogen; shallow rooted plants such as lawns and flowers need extra phosphorus and potassium; iron and sulfur are often deficient, especially around acid loving plants. Usually, the soil contains enough of the other nutrients, although some may be deficient in certain parts of the country. Boron is sometimes deficient in the Northwest.

The nutrients are identical whether they come from organic or synthetic sources, but the source will affect how fast the nutrients are available to plants. Organic fertilizers and specially treated synthetic fertilizers are slow release so they won't burn and the nitrogen won't wash away in the rain before plants can use it.

IMPROVING SOIL

The ideal soil would have sand, silt, clay and organic matter in about equal amounts. It would also be uniformly mixed to at least twelve inches deep. The subsoil would allow the excess water to drain away. No soil is ideal but soil can be improved with soil amendments and drainage.

SOIL AMENDMENTS

Soil amendments are organic or inorganic matter added to the soil to improve texture, water retention, drainage or aeration. Sandy or rocky soil requires amendments to improve the texture and add water retention properties. Clay soils require the addition of material to improve texture, aeration and drainage. Soil amendments come in a variety of sources.

Amendments that are commonly added to soil are:

Sand or Profile Soil Conditioner: to improve aeration and drainage.

Compost: to add organic matter, nutrients and to improve aeration and drainage.
Lime or Sulfur: to raise or lower pH.

Manures: to add nutrients

Organic soil amendments

Organic soil amendments can increase soil health and productivity.
Soil health is the foundation for plant health. Soil rich in organic material is an ideal environment for planting; however, soil can become--or naturally be--nutritionally deficient, which reduces the quality and health of plants growing in the soil. To correct soil deficiency, many organic and natural soil treatments, known as "soil amendments," can increase the health of your soil and therefore the health of your garden or lawn.

Aged Manure Animal waste is an excellent organic amendment for its high concentration of nitrates and restoring nutrients. Only aged manure should be used, as the high amount of ammonia in fresh manure can actually burn plant roots. Manure as an amendment is safest when used to enrich soil in flower gardens as opposed to vegetable gardens because of the pathogens--disease causing infectious germs.

Compost

Compost can be made up of decomposing food material--such as leftover food, apple cores, watermelon rinds--or it can be made up of grass clippings or other decomposing organic material.

Humus

Humus is the term for organic matter of any kind that has reached a level of balance. This means it will not break down any further. Humus offers stability to imbalanced soil and rectifies deficiencies while maintaining its own balance.

Mulch

Mulch comes in many different forms, but it is essentially decomposing wood products or byproducts. You can purchase bark mulch or make your own or wood chips or sawdust. Mulch helps soil retain its moisture.

Peat Moss

Peat moss is a kind of moss of the Sphagnum genus that grows in very wet areas. It is ideal for stabilizing both clay soils and sandy soils and is prized as a soil amendment. However, finding peat moss to purchase that is harvested from its natural environment in a responsible way can be a challenge. Some gardeners choose to avoid peat moss simply because the healing properties it has in their gardens may be a result of irresponsible harvesting practices.

Composted organic matter improves the texture of the soil, increases aeration, promotes both water retention and drainage as well as adds valuable nutrients necessary for plant growth. Home compost bins provide the main source of compost for home gardeners. Vegetation added to the compost bin breaks down into rich friable soil that provides valuable nutrients to the existing soil in the garden. Compost bins provide a convenient area to deposit leaves and plant material from harvests, grass clippings and organic yard debris. Peat moss sold in large compressed bales provides organic matter to soil. It increases the ability of the soil to retain water and is ideal for sandy or rocky soil. Peat moss is acidic and will lower the PH of soil. Wood products like wood chips and shavings improve soil, but may create a nitrogen deficiency. Microorganisms in the soil use nitrogen to decompose the wood and may tie up useable nitrogen for weeks or months. Add a source of nitrogen at the time of application if you intend to cultivate crops on the soil. Composted manure improves the quality of the soil and provides nutrients necessary for plant growth. The addition of manure decreases the need for other fertilizer additives. Vermiculite, a natural balsamic mineral and perlite made from heated amorphous volcanic glass sold for horticultural use, provides an inorganic soil amendment that increases aeration, improves texture and assists in water retention. Suitable for any type of soil, vermiculite and perlite do not alter the nutrient content.

For flower bulbs and root crops, the soil should be double dug to fifteen to eighteen inches deep. Double digging involves digging up the top eight inches of soil and piling it to the side of the hole. Soil amendments are spread in the hole and worked into the lower eight inches. Then amendments are added to the piles of soil as they are shoveled back into the hole.

Soil should be worked when it is moist but not wet. Wet soil will be packed into hard clods, which are about like rocks. To check the soil for dampness, squeeze a handful of soil into a ball, then push your thumb into the ball. It should crumble, not dent like modeling clay. Dry soil is harder to work and the soil disintegrates into dust. Dust will turn into mud when watered, then dry like brick. Dry soil should be watered well then allowed to soak in for a day before tilling.

Soil should not be worked into dust. Leaving marble-sized to golf ball-sized clumps will give better aeration and drainage. Besides destroying the structure of soil, over working soil also kills off the mycorhizae which are beneficial fungi for moving nutrients from soil into roots. Roto-tilling may be required to incorporate amendments into the soil but more mycorhizae will survive if the soil is loosened with a spading fork. Simply stomp the tines into the soil and tilt back the handle to lift and fracture the soil.

Sharp sand or Mason's sand creates spaces much better than river sand, which has rounded edges and packs down tighter. Profile Soil Conditioner is even better, since it is porous so it holds both water and nutrients. Compost is made of partially decomposed yard debris, bark dust, sawdust, manure or other organic matter. Fresh organic matter can also be used, but extra nitrogen fertilizer will be needed to help it decompose. Fresh manure may contain too much uric acid, which can burn roots. It is best if manure is aged for at least six months.

The best and easiest time to improve soil is to do an entire area at once, such as when planting a new lawn or landscape. The amendments should be spread evenly over the area and worked into the soil at least ten inches deep. A spade or spading fork works best for small areas. A roto-tiller handles large areas. For existing beds, the soil can be improved every time something is planted.

TILLAGE

Soil conditions must be made favourable for crop growth and development from seeding to harvesting – m ay be annual, biennial or perennial. It begins from sowing of seeds and continues to harvest. Management, a continuous process – may be for less than a month as in the ca se of short duration vegetables, for a few months as in case of annuals – green gram, black gram, rice, wheat, for 2 seasons as in case of sugarcane or for many years – more than one hundred years – as in case of coconut.

- Preparation of soil by cultivation is called tillage. By the term 'cultivation of crop' it means growi ng the crop from sowing to harvest. For this, tilling the soil is essential (some crops can be grown without tillage, or can be grown in a chemical solution without soil called hydroponic):

- Tillage is required to make the soil porous, to increase aeration, to incorporate the organic matter, to increase their rate of evaporation and to make it weed free and make it a home for the crop to grow.

- Tillage requirement is different for different crops and even for the same crop grown under different tillage requirements.

- Small seeded crops like ragi, onion, Lucerne and berseem require fine seed bed.

- But crops like jowar, rice, cotton, gram germinate well if the bed is coarse and moderately compact.

- It is easier to get desire tilth in sandy and loamy sand soils of oxisol origin but difficult in clay, clay, clay loam and fine soils of vertisol origin.

- The soil of oxisol origin can be worked upon any time because its opportune time to work with is quite longer whereas in fine soils it is very short.

- Unless it is tilled at appropriate moisture it creates more problems than solves for getting a good tilth. If left too cloddy, the clods will harden on drying and after a shower of rain the clods will slake and cake. If powdered very finely, after a shower of rain the finer particles will seal the pores and permeability will decrease accelerating runoff. The problem is more if the soil is highly swelling and shrinking type as in most of the black soil areas of the country.

- At what moisture content the soil needs to be tilled to get required tilth depends more on experience than theory.

Tilth and tillage

- Tilth is the physical condition of the soil caused by the practices of tilling called tillage. The practices are ploughing, discing, harrowing etc.

- Tillage is the cause and tilth is the effect.

- The objective of tillage is to provide a soil condition favourable for growth and development of the crop. If this condition is not satisfactory, it is said the tilth is poor/bad and the soil is not prepared well.

- Good tilth should provide adequate aeration, warmth and moisture to the crop and ensure good infiltration, besides being favourable for supply of nutrients and growth of microbes and making the soil weed free.

- Soil consistency and structure provide basis for good tilth. Consistency depends on type and amount of clay and moisture content. Good tilth cannot be got if soils are tilled at their extreme moisture content (very dry or wet).

- Accordingly at what stage the soil is to be tilled for good tilth depends on contents of clay (texture), moisture and structure. As the clay content increases soil plasticity increases. Plasticity is a physical property of clay that develops due to hydration and brings adhesion, cohesion consistency and swelling as its companions. Plasticity renders ability to the soil to form a ball when wet that does not come back to its original state on drying.

- Sandy soil has no plastic property. Ploughing a clayey soil at moisture content forms lumps and clods. These clods do not break easily, remain sharp and angular and do not produce a good tilth. As drying increases these lumps and clods becomes very hard and more power is required to break them into finer sizes. Sandy soils are less plastic. They can be made into a ball only when wet; on drying the ball collapse into single grains. This is why a sandy soil can be tilled even after a few hour of rain whereas a clayey soil needs more time to come to condition for tillage. Ploughing at very low moisture content is not possible and at very high moisture contents produces puddles.

- Puddling is a state of soil tilth; at puddling soil moisture content is very high (even there remains standing water on the top). At puddling the particles separate from one another due to presence of water around all particles; there is no structure and cohesion is zero. At puddling bulk density is low; it increases as the soil particles settle. In sandy, sandy-loam, loam and loamy sandy soils settling occur quicker than in fine textured soils. For this reason, the coarse soils need to be planted immediately after puddling. Otherwise, the bed becomes hard and seedlings cannot be planted at desired depth.

- At what stage the soil is fit to be tilled for what purpose and with what implement depends more on experience.

- the main principles being that the soil should be ploughed at right moisture content using the right type of implement to achieve the desired tilth.

Good tilth is the first feature of good soil management.

The maintenance of soil organic matter which encourages granulation is an important consideration of good tilth.

Tillage operations and timings should be adjusted as to cause the minimum destruction of soil aggregates. The choice and sequence of adaptable crops or crop rotation are other very important considerations. These

are related to climate, particularly rainfall and its pattern of distribution and the characteristics of the soil profile, including drainage and extent and duration of available soil moisture.

It is more realistic to evolve cropping patterns and land management practices according to land capability. Cropping patterns chosen and management practices adopted should aim at soil and moisture conservation

for efficient nutrient and moisture utilization.

In irrigated areas, special management practices become necessary to avoid salinity, alkalinity, water logging, leaching of nutrients.

In rainfed areas special management practices include improving soil conditions to receive, retain and release more soil moisture.

Land shaping and leveling, mulching and the use of wind brakes and vegetative cover are the other major aspects.

The productive capacity of the soil should never be allowed to diminish, but rather should be improved and maintained by providing adequate organic manures and plant nutrients through fertilizers and by including legumes in the rotation and the use of biofertilizers.

Conservation Tillage - Any tillage and planting system in which at least 30 percent of the soil surface is covered by plant residue after planting to reduce soil erosion by water; or where soil erosion by wind is the primary concern of at least 1,000 pounds per acre of flat small grain residue equivalent are on the surface during the critical erosion period. [NRI-92]

Conventional Tillage - Tillage types that leave less than 15 percent residue cover after planting, or less than 500 pounds per acre of small grain residue equivalent throughout the critical wind erosion period. Generally involves plowing or intensive tillage. [CTIC-97]

Reduced Tillage - Tillage types that leave 15-30 percent residue cover after planting or 500 to 1,000 pounds per acre of small grain residue equivalent throughout the critical wind erosion period. [CTIC-97]

Tillage practices affect wildlife in 4 different ways

1. Amount of cover provided by crop residues
2. Availability of wildlife in food crop residues
3. Timing and frequency of disturbance
4. Toxicity of nutrient inputs and pesticides

In general, the higher the amount of crop residues, the greater the value for wildlife cover.

Use of tillage

- Weed control
- Alternation of Physical soil conditions
- Management of crop residues Tillage equipments

– **Primary Equipment**

•Moldboard Plows (Mouldboard Ploughs)

–Gunnel, Share, Shin, Moldboard, Landside, Heel

–Down Suction from the plow

•Disk Plows

–Gang Angle, Disk Angle(42-45 deg), Tilt Angle (15- 25 deg)

–Hard soils, non-scouring soils

–180-540 kg/disk

•Chisel Plow / Subsoiler

–Shanks, straight shanks, curved shanks

–V-Frame

•Rotary Tillers

–PTO driven, High Power Requirements, Low Traction requirements –Single Pass operation

– **Secondary Tillage**

•Disk Harrows –Single-
acting, Tandem, Offset
•Cultivators

–Field, Row crop

•Spike, Tine and Spring Tooth
Harrows •Rotary Hoes and
Cultivators •Culti-packers, Rollers

Happy seeder

- Combine harvesters have recently been introduced, with exponential growth in mechanical harvesting of wheat in the better endowed rice-wheat growing area of NW India especially, Punjab, Haryana and western Uttar Pradesh. In these combine harvested areas, managing heavy loads of rice residues is the major issue. Farmers generally burn rice residue prior to wheat sowing as the cheap and easy option for residue management, but burning leads to losses of soil organic matter and nutrients (especially N, P, K, S and C), and creates environmental pollution (particulates and greenhouse gases) (Singh et al. 2007).

- The Happy Seeder technology provides an alternative to burning for managing rice residues and allows direct drilling of wheat in standing as well as loose residues (Gathala et al. 2009).

SOIL DRAINAGE AND AERATION

Drainage and aeration is improved by soil amendments, but there must be some place for the water to go. Fields/Yards should be graded so surface water drains off. Drainage sensitive plants such as Japanese maples, daphne and heather should be planted on a mound at least a foot tall or on a slope. Vegetables are best grown in raised beds, which provide better drainage and warmer soil in the spring for an earlier start.

In mostly flat fields/yards, subsurface drainage may have to be provided. Perforated plastic drainpipe can be buried about a foot deep. It is important that drainpipes slope evenly so dirt doesn't clog up the low spots. Drain pipes can drain into down spouts if allowed by local building codes.

Aeration can be improved on existing lawns and beds without tearing up the soil. Sod core aerators cut out plugs of soil and leave holes about six inches apart and four inches deep. Root feeders can be used around trees and shrubs to create holes eighteen inches deep. These holes allow air and water to quickly penetrate deep into the soil. The holes will stay open much longer if sand or Profile Soil Conditioner is raked into the holes to fill them.

INTEGRATED DISEASES AND PEST MANAGEMENT

Definitions of 'pest'

1. An annoying person or thing; a nuisance.
2. An injurious plant or animal, especially one harmful to humans.
3. A deadly epidemic disease; a pestilence.

Integrated Plant Protection

Plant protection (against pests, diseases and weeds) determines the effectiveness of other inputs in crop production. Exclusive reliance on pesticides, fungicides and herbicides resulted in pesticide and herbicide resistance, pest resurgence, residues and environmental pollution. This led to the development of integrated plant protection strategies, which are components of sustainable agriculture with a sound ecological foundation. **Integrated plant protection** should be understood as an ideal combination of agronomical, biological, chemical, physical and other methods of plant protection against entire complex of pests, diseases and weeds in a specified farming ecosystem, with the object of bringing down their infestation to economically insignificant levels with minimum interference on the activity of natural beneficial organisms. The essence of integrated plant protection concept lies in the harmonious integration of compatible multiple methods use singly or in combination against insect pests, pathogens and weeds.

a. Integrated disease management

For mitigating the loses due to diseases, several methods such as fungicides, organ mercurial, chemotherapy, thermotherapy, cultural methods and host resistance are employed. However, no single method is effective in controlling a disease. Therefore, integrated disease management (IDM) became imperative for effective disease control. Integrated disease management in organic farming combines the use of various measures. The usefulness of certain measures depends on the specific crop-pathogen combination. In many crops, preventative measures can control diseases without the need of plant protection products. However, for certain disease problems, preventative measures are not sufficient. For example, organic apple production strongly depends on the multiple uses of plant protection products.

All the cultural methods discussed under IPM hold well for IDM also. Broad based tentative IDM components are being adopted for disease control. However, all these components are not feasible for any specific ecosystem or any specific disease. For many other diseases the role of host resistance, cultural methods and chemical methods are integrated. Solar heat therapy (drying the seed in hot sun after harvest and again before sowing) is a common practice in our agriculture. Among mechanical methods for prevention and against spread of diseases uproot and burn is the age old and the best method so far. It is better to prevent and control vectors against spread of diseases. Disease affected plants are to be uprooted and burnt and alternate and collateral host-crops, grasses, stubbles etc. destroyed. Disease can affect any part of a plant. Disease may be fungal, bacterial and viral. Viral diseases are more serious than fungal and bacterial.

Disease management in organic cropping systems combines various components which can be divided into strategic preventative measures, tactical preventative measures and control measures. For each crop-pathogen relationship and cropping system such components will contribute to different extent to disease management (Termorshuizen, 2002). The development of integrated disease management systems depends on thorough knowledge of the cropping systems as well as of the pathogen and can only be achieved by interdisciplinary research.

PATHOGEN CHARACTERISTICS AND DISEASE MANAGEMENT Host-specificity and mobility are the two main characteristics of pathogens determining the choice of disease management measures (Wijnands et al., 2000). Strictly host-specific pathogens which are not mobile can be controlled by using cropping systems with low frequencies of the susceptible crop. Examples are cyst nematodes of potato or sugar beet. Pathogens which are not host-specific and not mobile can be controlled by the choice and sequence of crops grown in the rotation supported by preventative measures increasing soil suppressiveness and plant health. Examples are the soil borne pathogens *Sclerotinia sclerotiorum* and *Rhizoctonia solani*. Host-specific pathogens with high mobility such as *Phytophthora infestans* in potato cannot be controlled by crop rotation.

Preventative measures are sanitation in a cropping area and the choice of crop structure and planting date in combination with resistant varieties. In many situations also control measures such as applications of plant protection products may be needed to achieve sufficient yield. Also pathogens which are not host-specific but highly mobile cannot be controlled by crop rotation. Disease prevention depends on strengthening the crop, escaping the disease by choosing proper seeding dates and creating an open crop structure. Disease control by using crop protection products may be needed in many cases. Example for a mobile pathogen with a broad host range is *Botrytis cinerea* causing grey mould in various crops such as beans, peas, strawberries, grapes and many other crops. How differently various measures contribute to disease management in different crop-pathogen relationships will be illustrated by the comparison of two systems. In wheat, various *Fusarium* spp. can cause *Fusarium* Head Blight (FHB) leading to a decrease of yield and, more important, the production of mycotoxins in the grain. *Fusarium* sp have a broad host range and also can survive saprophytically. Mobility of spores of most *Fusarium* sp is low. In apple, *Venturia inaequalis* can cause apple scab on leaves and fruit resulting in reduced yields and quality of fruit. The pathogen is strictly host-specific and can survive only on apple tissues. The mobility of spores is low.

STRATEGIC PREVENTATIVE MEASURES

Many measures for preventative disease control have a long-term strategic character. Various aspects of the farm management and the long-term cropping system as well as of the location including the farm neighbourhood have impact on diseases of crops and thus should generally be considered in integrated disease management.

Avoidance of pathogen sources in neighbourhood of field and crop rotation in neighbouring field: Since most *Fusarium* spores travel only a few centimetres, sources in the crop neighbourhood will not cause epidemics. Ascospores of *V. inaequalis* produced in neighbouring orchards may reach the crop. Abandoned orchards and orchards with high apple scab pressure should not be found in the neighbourhood of an apple orchard.

Soil structure, soil suppressiveness, biological soil disinfection, and catch crops: These measures are important for managing soil borne diseases but will have no direct effect on the above-ground development of *Fusarium* spp. and *V. inaequalis*.

Crop rotation: Main inoculum source of FHB are crop residues of preceding diseased crops. The best documented example is the high risk of FHB when wheat is grown after maize. Maize stubble are often colonized by the same *Fusarium* sp affecting wheat and such *Fusarium* sp can survive and multiply on maize stubble for several years. Avoiding growth of maize in rotation with wheat will substantially reduce risks of FHB epidemics. Rotation schemes with cereals grown after cereals should generally be avoided. In the perennial apple production crop rotation is no issue.

Tillage: Primary inoculum of FHB are crop residues left on the soil after tillage. Using reduced tillage systems will increase FHB risks since much more residues will be present on the soil surface. In apple orchards, tillage is not an option.

TACTICAL PREVENTATIVE MEASURES

Tactical preventative measures deal with the planning and realization of a certain crop. Typical measures are the choice of variety, seed quality, seeding time and crop structure.

Resistant varieties: In wheat, resistance breeding made considerable progress and partly resistant cultivars are used in practice. In apple, partly resistant varieties are available. However, the pathogen has the potential to adapt. Furthermore, changing varieties in a perennial crop needs high investments.

Removal of crop residues from field: *Fusarium* sp threatening wheat crops are surviving primarily in stubble of cereals including maize. Removing this potential inoculum sources is not feasible, although physical removal especially of maize stubble may have a significant impact on disease development. In apple, removal of fallen leaves as the principle inoculum source of apple scab in spring is an interesting option. Removal of leaves by using specially designed vacuum cleaners has been demonstrated. However, mechanization is difficult, cost intensive and application depends much on orchard circumstances.

Biological crop residue treatments: Microbial decomposition of crop residues is a natural process which can be supported by adding stimulating nutrients or selected micro-organisms. Also earthworms can be protected and stimulated to consume plant residues on the soil surface. In arable crops, stimulation of resident microbial populations on residues may be achieved by creating a suitable microclimate, e.g. by using mulches.

Healthy seeds and planting material: Seeds of wheat can be infected by *Fusarium* spp. Producing healthy seeds is important to guarantee the establishment of a vigorous crop. For the development of FHB epidemics after flowering, the major inoculum sources are infested crop residues and thus field-borne. Reducing the seed-borne fraction of the disease inoculum may only have very limited effect against FHB. Using clean planting material of apple will not result in any disease prevention since *V. inaequalis* overwinters on the orchard floor and easily can enter disease– free young trees.

Sowing time: For infections of wheat ears by *Fusarium* sp, the crucial factor are the climatic conditions during the short window of flowering. Choosing early or late sowing times is not an option for disease prevention since weather during flowering cannot be predicted. Also for apple, no effect of planting time on apple scab can be expected.

Crop structure: Crop structure affects microclimatic conditions within the canopy and determines the distance pathogen spores have to spread to reach susceptible host tissue. A dense wheat crop will favour pathogen sporulation on the soil, but may block spore flights of *Fusarium* sp. Depending mainly on splash dispersal during rainfalls, vertical leaf positions may also block spore flights. Ears on taller plants may have a better change to escape infections which may have a moderate effect on FHB. The canopy structure of apple trees is managed to obtain sufficient yield and possibilities to create more open canopies are limited. Spores of *V. inaequalis* are very much adapted to infect trees and spread from orchards floors and within canopies. Possibilities to manage the apple scab by crop structure are low.

DISEASE CONTROL MEASURES

Disease control measures are used to control a certain disease of a crop. Physical, chemical or biological control measures may be used.

Physical treatments. *Fusarium* spp. on seeds can be controlled by warm water treatments. However, the effect on FHB will be limited.

Natural compounds and biocontrol agents as plant protection products. The control of FHB does not depend on plant protection products since preventative measures such as rotation, and tillage can be used. In apple, preventative measures such as removal of fallen leaves can delay the outbreak of epidemics. However, epidemics need to be controlled by multiple applications of plant protection products such as copper. Environmentally friendly new products are strongly needed.

Biological based technologies are most effective when integrated with physical and chemical approaches in the process towards sustainable ecological based plant diseases management. The important measures are:

- Use of antagonists is equivalent to natural enemies used in control of insects. Seeds treated with antagonists can be used as feed and food.

- Use of non-pathogenic materials like *F. oxysporum* (Fusariclean) and F. fluorescens (biocoat) for fusarium wilt in vegetables and flower crops.
- 2,4-diacetyl fluoroglucinol for all diseases of wheat.
- Biosave 10 and biosave 11 (based on strains of *Pseudomonas syringal* against storage rot of vegetables and fruits.
- Use of root-knot nematode.
- Use of molecular tools to assure pathogen free planting materials.

b. Integrated pest management

Integrated pest management (IPM), which by definition is a pest management system that, in the context of associated environment and population dynamics, utilizes all the appropriate techniques to minimize the pest population at levels below those causing economic injury. Though several parasitoids, predators and pathogens of pests, antagonistic microorganisms were known to be effective for several decades, they were not commercially exploited because of quick knock down effect and easy availability of chemical pesticides instead of **biopesticides and IPM.** Steadily, there has been growing appreciation about the role of cultural and biological methods in pest control. Cultural and biological methods are the two major components in integrated plant protection.

Cultural methods

Agronomic adjustments, necessary for higher yield, are at the same time are directed at prevention, mass multiplication and spread of pests by modifying the crop microclimate.

Sanitation: It includes removal or destruction of breeding refuges and over wintering of pests. Seed material, farm yard manure etc carrying insect eggs or its stages of development should be carefully screened before their use. Destruction of alternate hosts minimizes pest population build up.

Tillage and inter-cultivation: Ploughing and inter-cultivation brings about unfavourable conditions for multiplication of pests as well as diseases and weeds. Quiescent stages (pupae) of harmful organisms will be exposed to dehydration or to predation by birds and other stages may be mechanically damaged or buried deep in the soil.

Cultivar selection: cultivars with high yield potential and quality without resistance to pests and diseases are the main causes of frequent epidemics and mass multiplication of pests and diseases. A large number of cultivars resistance/tolerance to pest and diseases has been developed to suit different agro-ecosystems. Selection of such cultivars can bring down the losses considerably.

Time of sowing: As weather influences developmental rhythm of plansts as well as growth and survival of pests and diseases, serious setback occurs when the weather conditions are such as to bring about coincidence of susceptible growth stages with highest incidence of pests and diseases. Therefore, adjustment in sowing dates is often resorted to as an agronomic strategy to minimize the crop losses. Maize sown late suffers little borer damage, as by then the egg parasite *Trichogramma* is able to keep down the population of the pest. Rice may suffer less from borer attack if planted early (early June). Early maturing cotton cultivars have become popular in Punjab and Haryana as they escape pink bollworm.

Plant population: Plant population per unit area influence crop microclimate. Dense plant canopy leads to high humidity build up congenial for pest and disease multiplication. Keeping the total plant population constant, inter and intra row plant population can be adjusted to minimize the humidity build up within the plant canopy.

Manures and fertilizers: Excessive nitrogen increases susceptibility of crop to sucking and leaf eating pests. Higher rates of nitrogen application than the recommended rate to hybrids without corresponding increase in phosphorus and potassium is the main factor for heavy pest and disease incidence. Balanced application of NPK helps the crop to tolerate pests and diseases considerably.

Water management: Irrigation can reduce the soil inhabiting pests by suffocation or exposing them to soil surface to be preyed upon by birds. Irrigating potato crop at tuber formation can minimize potato scab. Anthracnose of beans, early blight and charcoal rot of potato can be checked by furrow irrigation than sprinkler irrigation.

Habitat diversification: Many pests prefer feeding on a particular plant or others. This preference may be exploited to reduce the pest load on crop. Crop rotation, intercropping, traps cropping and strip cropping can bring down the pest load considerably.

Behavioural methods

Pheromones: Pheromones are ectohormons secreted by an organism, which elicit behavioural responses from other members/sex of its own species. These are extremely selective, nontoxic, highly biodegradable and effective at low application rates. Synthetic sex pheromones are commercially available and are used for surveillance, monitoring and control of many Lepidopterous pests such as spotted bollworm, tobacco caterpillar, potato tuber moth, diamond back moth and leaf folder etc.

Fairomones: These are volatile compounds that evoke behavioural response adaptively favourable to the receiver. Fairomones are released either by the host plant or by the host insects. While former issued by the pest and natural enemies to locate their habitats, the later is used for prey finding and parasitisation/preying. Fairomones from host plant can be effectively used to mass trap pest species as well as for monitoring. Use of fairomonal compounds to increase the efficiency of the predator *C. carnea* and the egg parasitoid *T chilonis* had been successfully demonstrated.

Biological methods

Biological control basically means, "The utilizatio n of any living organism for the control of insect-pest, diseases and weeds". This means use of any biotic agents for minimizing the pest population either directly or indirectly. Biological control of insect-pests is gaining recognition as an essential component of successful IPM. Classical biological control involves deliberate and natural establishment of natural enemies in areas where they did not previously occur. In addition to deliberate introduction of bio-control agents, proper attention needs to be given for conservation and augmentation of natural enemies that already exist in an area. This should be treated as important as many insect predators are much more susceptible to insecticides than the pests they attack. Biological control agents for insect pests are available in nature abundantly and work against crop pests naturally called as Natural Control. The pest management programme where natural enemies of the crop pests form the core component is designated as Bio Intensive Pest Management (BIPM).

The most commonly used bio-agents in BIPM are broadly classified into 3 categories i) Parasitoid ii) Predators iii) Microbes causes diseases in insects.

Parasitoid: These are the insects, either equal or lesser than the size of the host insect (pest) and always require passing at least one stage of their life cycle inside the host system. Due to their high multiplication rates they are of vital importance in the biological control of insect-pests.

Insect parasitoids (parasites thriving on insects): insect parasitoids include

Trichogramma	Egg parasite against eggs of gram pod borer, rice stem borer, castor semilooper, cabbage diamond back moth etc.
Bracon hebetor	Against insect-pest of coconut and sugarcane
Brachymeria	Against the pupae of several pests of plantation crops.
Elasmus	
Eribor	
Trichospilus	
Gonlozus	
Tetrastichus	
Chelonus	

Predators: These are those insects, which are generally bigger than the host and feed on several of the pests by predating upon them externally. They will be consuming several of the insect-pests during their life cycle and hold a key role in minimizing pest population in field conditions.

Commonly used predators are: Chilizonus, Cryptolaemus, Scymnus, Meoichlus and Pharoscymnus.

These predators feed on mealy bugs, coccids, scales and mites on citrus, grapevine and guava. Mirid predator *Crytorhinus* attack brown plant hopper of rice. Insect predator Chrysopa is effective on aphids, mealy bugs and young caterpillars. *Chrysoperla* sp prey upon several of the soft bodied insects such as aphids, leaf hoppers etc; ladybird beetle against aphids and mealy bugs; spiders against a varied number and types of insects especially in rice ecosystem.

Microbial organisms: These are those micro-organims which are capable of causing diseases in insects as a result they lose their appetite, subjected to several physiological disturbances, leading to the ultimate death of the insect. The microorganisms exploited in biological control of insect-pests are broadly classified into a) Insect viruses b) bacteria c) Entomo Pathogenic Fungi d) Entomo Pathogenic Nematodes and other organisms like protozoans and Rickettesia etc. while several antagonistic fungi and bacteria are being successfully used in minimizing the plant disease incidence. Nematode pest management by using biotic agents is also one of the most promising areas and gaining much desired importance in the current scenario of organic farming.

Pathogens causing diseases in insects and destroying them: these include Viruses Bacteria Fungi Nematodes Protozoa

Nuclear polyhedroses viruses (NPV): They cause typical “tree top disease” in insects. The infected insect loose appetite becomes restless and reaches the apical portion of the plant due to O2 depletion inside the insect system. Later the infected
insect will be dying by hanging itself in an inverted ‘V’ shape on the apical portion of the plant. Ef fective against lepidopteran insects in different crops. *Ha* NPV is used for the management of *Helicoverpa armigera* while *Sl* NPV is meant for *Spodoptera litura*. Similarly, castor semilooper is managed by *Ach* NPV and red hairy caterpillar by *Am* NPV. Grunulosis viruses (GV) and Cytoplasmic viruses (CPV): Extensively used against insect-pests of sugarcane.

Entomo Pathogenic viruses are highly specific to host insects which make them exceptionally safe to non target organisms and nature.
Bacillus thuringensis: This bacterium is highly effective against several insect-pests belonging to order Lepidoptera. They cause disease due to which insect turns black and die.
Metarhizium anisopliae, *Beauveria bassiana* and *Verticillium lecanii* are used against important pests like gram pod borer, tobacco caterpillar and sucking pests like thrips, aphids and mealy bugs. The fungi develop hyphae inside insect system resulting in the death of the insect due to mechanical congestion. The mode of action makes these organisms to perfectly suit to the needs of organic farming. In certain cases they produce toxins to kill the insect. Heterorhabditi sp and Steimernema sp: These nematodes harbor certain bacteria which act as toxins to insect systems.

Variomorpha sp: These were found effective against insect pests and can effectively incorporated as tools in organic farming.

Bio-pesticides: Natural occurrence of diseases caused by micro-organisms is common in both insects and weeds and is a major natural mortality factor in most situations. Use of micro-organisms for pest control involves their culture in artificial media and later introduction of larger amounts of inoculums in to the field at appropriate time. Many fungi and bacteria can be handled in this way but insect viruses have the limitation that they have to be raised in living insects. As the biocontrol agents (microbial pathogens) are applied on the targeted pests in much the same way as chemical pesticides, they are often termed as bio-pesticides or natural pesticides.

Bacillus thuringensis, a bacterial pathogen infesting a wide range of insect pests, is the most common microbial insecticide in use today. It is used against caterpillars that attack a wide range of crop. Unlike most other chemical insecticides, it can be used on edible products up to the time of harvest. It is selective in action and does not harm parasites, predators or pests. The bacteria come in several commericla formulations such as Dipel, Delfin, Halt, Spicturin, Biolep, BioAsp etc. Another bacterium *B popilaleis* also commonly available against white grub *Popillae japonica* and *Hototricha* sp. Amongst insect pathogenic fungi, commercial preparations of *Verticillium lecanii* are available for the control of aphids, thrips and white fly under glass house conditions.

Botanicals: Some weeds like Lantana, notchi, tulsi, adathoda etc act as natural repellant to many pests. Trees like pungam, wood apple, anona and their byproducts have excellent insecticidal value in controlling diamond back moth, heliothis, white flies, leafhoppers and aphid infestation.

Most commonly used botanicals are neem (*Azadirachta indica*), pungamia (*Pungamia glabra*) and mahua (*Madhuca indica*). Neem seed kernel extract (2 to 5%) has been found effective against several pests including rice cutworm, diamond back moth, rice BPH, rice GLH, tobacco caterpillar, aphids and mites. The pesticidal ingredients of neem formulations belonging to general class of natural products called triterpenes, more specifically, limonides. They act as repellents and also disrupt growth and reproduction in insects. Commonly known limonoids are azadirachtin, meliantriol, salannin, nimbin and nimbidin. The efficiency of vegetable oils in preventing infestation of stored product pests such as bruchids, rice and maize weevils has been well documented. Root extracts of asparagus work as a nematicide for plant parasitic nematodes. Similarly leaf extracts of many plants can inhibit a number of fungal pathogens.

Trap cropping

Trap cropping is the planting of a trap crop to protect the main cash crop from a certain pest or several pests (See Appendix I). The trap crop can be from the same or different family group, than that of the main crop, as long as it is more attractive to the pest. There are two types of planting the trap crops; perimeter trap cropping and row intercropping. Perimeter trap cropping (border trap cropping) is the planting of trap crop completely surrounding the main cash crop. It prevents a pest attack that comes from all sides of the field. It works best on pests that are found near the borderline of the farm. Row intercropping is the planting of the trap crop in alternating rows within the main crop.

Advantages of trap cropping

Lessens the use of pesticide

Lowers the pesticide cost

Preserves the indigenous natural enemies

Improves the crop's quality

Helps conserve the soil and the environment

Tips for successful trap cropping

- Make a farm plan. This will guide you on where the trap crops are to be sown or planted.
- Learn to know and identify the pests.
- Select a trap crop that is more attractive to the pest than the main crop. Ask for assistance from your local agriculturist.
- Monitor your plants regularly.
- Immediately control the pests that are found in the trap crop. Prune or remove the trap crops once the pest population is high, otherwise they will serve as the breeding ground and the pests will attack the rest of your farm.
- Be ready to sacrifice your trap crop as an early crop and destroy them once pest infestation is high.
- Always keep farm records.

Bird perches

- Bird perches are resting places for predatory birds to rest and to look for preys; such as insect pests of cotton, peanuts, and cowpeas. Predatory birds prefer to look for prey in field crops where they have places to rest.
- To make bird perches, use bamboo or wooden poles or tree branches. Erect either of these at regular intervals in the field.
- To have live bird perches within the field, plant Setaria species (foxtail cultivars). These plants are found to be attractive to predatory birds. The birds feed on their seeds. In cotton field, plant Setaria in every 9th or 10th row of cotton. Once the birds are on the field, they prey on cotton bollworms and other insects.

INTEGRATED WEED MANAGEMENT

Throughout the world, economic crop production is impossible without a well planned weed management programme. Weed problem persists because of the inability to cope with their great reproduction capacity and massive recycling potential. As there are many kinds of weeds with varying germination periods and highly differing lifecycles, weed management requires an integrated approach based on through knowledge of biology and ecology of the species. Integrated weed management (IWM) involves the concept of multiple tactics of weed management, maintenance of weed population below economic injury level and conservation of environmental quality. A successful IWM strategy has the principle of enhancing farmers' profitability, environmental protection and responsiveness to consumer preference.

Weeds vary so much in their growth habit and life cycle under different ecosystems and growing seasons that no single method of weed management can provide effective weed control. Continuous use of one method of weed control creates problems of buildup of weeds that are tolerant to that particular method of weed control. Similarly, shift in weed flora from annual grasses to sedges and appearance of resistant biotypes due to continuous use of some herbicides has been reported. Long term strategy to minimize weed problem is through IWM than with weed control. Major components of IWM include:

- Monitoring weeds, shifts in weed flora, appearance of resistant weeds and introduction of new weeds,
- Emphasis on ecological, biological and biotechnological methods of environmental safety, and
- Low cost agronomic strategy for weed management in IWM systems.

    State seedbed,

    Balanced fertilizer use,

    Higher plant population,

    Intercropping / relay cropping, and

    Use of competitive cultivars,

    Supplement herbicide use at minimum possible rate.

Monitoring of weeds: Systematic monitoring of weeds would help to device effective ways to tackle current emerging problems of shift of grassy weed flora like *Echinochaloa* sp annual sedges like *Cyperus iria*, *Fimbristilis miliacea* and broad leaf weeds *Sphenenoclea zeylanica*. Similarly appearance of propanil herbicide resistant biotypes of *Echinochloa* sp in rice has become a problem.

Ecological management: Ecological management (cultural management) aims by attacking ecological weak points of weeds during field operations such as ploughing, water management, crop season, crop rotation, intercropping etc.

Ploughing is usually done at optimum soil moisture content by which time the weeds seeds start emerging. Hence emerging weed seedlings are buried or exposed to hot Sun for drying in perennial weeds, ploughing is effective to control emergence whose propagules are formed at relatively shallow position within soil. Intensive puddling is very effective for weed control in lowland rice.

Water management practices are very effective for weed control especially in lowland rice. Continuous land submergence beyond 5cm depth for rice is very effective against several weeds and can substitute for weed control.

Lowland rice crop rotation with an upland crop is effective against moisture loving weeds. The population of scirpus maritimus and echinochloa increases with continuous cropping of lowland rice but decline when rice is rotated with and upland crop. Similarly population of celosia Argentina increases due to continuous growing of short saturated crops such as groundnut but decreases considerably when rotated with tall crops such as sorghum, maize, pearl millet etc.

Biological management: biological weed control using insects, pathogens, fish and snails (bio agents) appears to be ideal for reducing the inputs of herbicides. Some promising examples include:

Weed	**Bio control agent**
Alternanthera philozeroid	*Cassida* sp.
Salvania molesta	*Paulinia acuiminata* (insect) and *Myrothecium rovidium* (fungus)
Eichhornia crossipes	*Alternaria eichhornia* (pathogen) and *Neochetina bruchi* (insect)
Cyperus rotundus	*Bactra minima* (insect) and *Athespacuta cyperi* (weevil)
Parthenium histerophrous	*Zygograma bicolorata* and *Smicronyx lutulentus*

Bio herbicides: Although herbicides are effective for weed control, there has been increasing concern about their safety for food products, their adverse effect on environment and widespread weed resistance to herbicides. These factors along with rising prohibitive costs have provided the impetus to develop alternative weed management strategies. In this contest, biological control has an alternative or supplement weed management appears to play a major role in crop production. Biological approach includes bio control agents such as insects, nematodes, fungi and bacteria as well as plant based chemicals that exhibit herbicidal properties. A bio-herbicide is a plant pathogen use for weed control through application of its inoculums. A list of bio-pesticides is given in Table below.

Bioherbicide	**Bioagent**	**Target weed**	**Crop**
DeVine	*Phytophthora palmovora*	*Morrenia odorata*	Citrus groves
Collego	*Colletotrichum gloeosporioides*	*Aschyynomene virginica*	Rice
Biomal	*Colletitrichum gloeosporioides*	*Malva pusilla*	Row crops
Biopolaris	*Bipolaris sorghicola*	*Sorghum halepense*	Rice and wheat
BioChon	C*hondrostereum* purpureum	*Prunus serotina*	Forests
Emmalocera sp	Stem boring moth	*Echinochloa* sp	Rice and wheat
Tripose	Shrimp	*Echinochloa* sp	Rice and wheat
Uromyces rumicis	Plant pathogen	*Rumex* sp	Rice and wheat
Gastrophysa	Beetle	*Rumex* sp	Rice and wheat
Bactra verutana	Shoot boring moth	*Cyperus rotundus*	Rice and wheat

The present system of plant protection, which relies heavily on agrochemicals, is no more viable from ecological and economical viewpoint. It is time to look at traditional plant protection practices as they hold greater promise in the context of sustainable agriculture. Necessity of their integration with chemical control methods is strongly felt, as the traditional methods are simple and economical with least fear of environmental pollution.

Bio-technology in weed control

The microbial toxins and allelochemicals could be manipulated to produce commercial herbicides. Bioherbicides Collego and Biopolaris are used for controlling grass and broad-leaved weeds in rice. In India, bioherbicides for weed control have not yet developed to the extent of practical application.

Agronomic practices

Agronomic measures necessary for higher yields are at the same time are directed at preventing mass multiplication of weeds.

Stale seed bed

It involves the removal of successive flushes of weeds before sowing a crop. Weeds that germinate after land preparation are destroyed mechanically, manually or chemically. In mechanical or manual method, soil disturbance should be as shallow as possible.

Crop stand

Closure the spacing or higher the seed rate, better the crop can compete with weeds due to its smothering effect on weeds.

Nutrient management

Nutrient application should be timed to prevent weed proliferation and yet to obtain maximum benefit from the applied nutrient.

Intercropping and Relay cropping

Intercropping upland rice with groundnut, soybean, or green gram minimizes weed density leading to yield advantage. A pulse crop is usually broadcast as relay crop into standing rice crop 10-15 days before harvest. As soon as rice crop is harvested the pulse crop cover the field in dry season and suppress the weed growth.

Cultivars

High yielding cultivars are less competitive against weeds than traditional cultivars. For rainfed areas, heavy tillering varieties of medium stature may be better suited than semi-dwarf varieties.

Herbicides

Non chemical methods of weed control when integrated with one manual weeding are as effective as standard rice herbicides at different ecosystems throughout the country.

QUALITY CONSIDERATIONS, CERTIFICATION, LABELING AND ACCREDITATION

PROCESSSORS, MARKETING, EXPORTS

Quality considerations

There is one issue that concerns every human being-Food. Food safety and quality issues have received a great attention in recent years. The primary concern of food industry is to provide wholesome, tasty and safe food to the customers. Never has the safety of our food supply come under such scrutiny. Regulations are increasingly active to safeguard the food we eat. Coupled with the international and domestic revolution in quality assurance, consumers are demanding products and services with a high degree of safety, consistency of quality and value for money.

The rapid globalization of market concerns over food safety, the dismantling of traditional investment and trade barriers and the emergence of private labels is resulting in many changes and developments in today's International Food Trade Environment. These events are having an impact on rules and regulations concerning Product quality, Product safety, Environmental, ecological, ethical and social issues and regulatory requirements.

Two of the WTO Agreements have set new dimensions for International food trade, namely

- Agreement of Technical Barrier to Trade (TBT)
- Agreement on Phytosanitary Regulations (SPS)

Among many trade and tariff related issues, the Agreements state that "Members shall ensure that their Central Governments standardizing bodies accept and comply with the Code of Good Practice for the Preparation, Adoption and Application of Standards. The obligations shall apply rules to protect human, animal and plant life are also embodied in the above Agreements.

This means we have to adopt quality and food safety systems to demonstrate compliance. The agreement also imposes a binding obligation to harmonize its domestic mandatory standard with international standards such as ISO, Codex Alimentarius to avoid trade barriers. Codex standards are identified as the international standards for reference as mentioned in the WTO proposal. As per the recommendations of Codex and FAO, the best way to integrate and harmonize the safety system is by an integrated company wide Quality System including HACCP (Hazard Analysis and Critical Control Points, developed in 1960 for US Space Program).

Several International Agencies have come up with their own standards to tackle the food safety issue in their Exports and Imports. Some of the notable ones are;

- AQIS – Australian Quarantine and Inspection Service , with its own set of Standards for various food product.
- National Food Safety Initiative of the USA 1997

- White paper on Food Safety of the European Commission – January 2000

In this fast changing International Food Trade environment and India being a member of WTO, it has now become imperative that Indian Food Industry take a fresh look at the challenges ahead if they have to be the players in the future; the old practice. Mental blocks and boundaries have to be dismantled and a new approach to food business has to emerge, namely the, Food Safety and Quality.

HACCP (Hazard Analysis Critical Control Points) is the state of the art food safety system developed to control the risk of food contamination in the manufacturing/processing of food. It is designated to minimize the risk of food safety hazards. It is not a no risk system. It is based in seven principles:

- Identification of potential hazards and preventive measures
- Identification of critical control points
- Set critical limits
- Monitoring of critical limits
- Corrective actions
- Develop record keeping system
- Develop verification procedures
- Customer (Customer preferences)
- Regulatory bodies (Governments)
- World Health Organization (CODEX)
- Market Access (EC/USFDA)
- Shareholders, Insurers (Litigation/Claims)
- Retailers and Private Labels (Brand Protection)

Food safety needs to be managed along the entire supply chain from paddock to plate. This is the **Food Quality Safety Challenge**.

Private Labels, Marks and Brands

We are entering a new era of consumer awareness and concerns. More and more producers, processor, manufacturers, retailers and caterers are responding to this and are turning their attention to meeting consumer perceptions and requirements. This requires the design of products and services to meet consumer requirements. It is a major shift from the old commodity mentality of production at all costs and then worrying about finding a market later. The new approach is about transforming commodities into products known as the value added concept. These market forces will lead to the increased emergence of private labels, international marks, and brands that consumers can trust – products that signify a higher degree o f safety, consistency, predictability and value for money. Research into the Food/Agri industry indicates the importance of

- **Brand image**
- **Brand loyalty**
- **Good public perception**

Quality assurance is the best way of achieving all three.

Without an effective quality management system companies are at risk of producing defective and contaminated goods which can lead to food poisoning, damaging public recalls, huge legal costs, loss of public image and market share.

Some characteristics of successful marks, brands and private labels include:

- Conformity to a recognized standard by objective assessment.
- Independent certification by an accredited body
- International recognition of the certifying body.
- Recognition by regulatory and statutory bodies.
- A network to enforce and protect the mark against fraud and abuse.
- Promotion of the mark.
- Tangible benefits to the consumer.

Examples of product branding attributes could include:

- Confirms to Codex HACCP Guidelines for safety, e.g. SQF 2000CM
- Origin, place of manufacture, assembly or packing imprinted.

- Contains less than a specified amount of nominated substances.
- Complies with product specifications e.g. taste, texture, size, shape or other quality attributes.
- Organic – grown under conditions specified in organ ic definition.
- Chemical residue status – tolerance levels for pest icides, herbicides etc.
- Ecological – grown under certain environmental cond itions.
- Healthy lifestyle perception e.g. free from salt, low fat.

Delivering quality and safety in food to customers in world market is a tall order. It requires special skills, systems and attention to detail.

Quality standards

The major issue confronting the global trade in food is the need for stakeholders to agree on standard approaches to food safety and quality (HACCP). The number of standards and guidelines for food in the market today is growing exponentially and imposing huge costs and confusion on the supply chain. Different buyers are imposing in house HACCP/QA schemes on suppliers as they or the governments in the countries from which they operate do not understand, relate to or accept local standards initiatives.

As a results of this, internationally recognized standards such as ISO 9000, ISO 14000, SQF 2000CM and others will continue to be developed to formalize systems which will

- Provide uniformity and standardization
- Prevent duplication of standards
- Provide a level playing field

These standards will encompass product and service quality as well as safety, environmental and social issues and will eventually become common terms of trade.

In the food /Agri industry such standards already exist and include;

ISO 9000	Internationally recognized qorld-clas quality management system.
HACCP (Codex)	Hazard Analysis Critical Control Points. A process for managing food safety. A system of prevention.
SQF 2000^{CM}	Safety Quality Food. A standard designed specifically for the industry to manage food safety and quality based on Codex
	HACCP and compatible with ISO 9000.

EMS-ISO 14000	An International environmental standard which sets guidelines for clean and more sustainable processes and production techniques.

Managing Risk

Risk will change as consumer perceptions change.

What is tolerated and acceptable today will not necessarily be acceptable in the future. As consumers become better educated, more aware through improved communications and more effluent, their perceptions and buying patterns will change. This is what changes markets.

The question this raises is. “How do we manage thes e types of risk?”

The answer is- By building quality and safety into the product using HACCP technique to determine the critical points and then incorporating this into an auditable quality management system to ensure that the preventive controls and corrective actions are implemented.
If your customers ask you to prove that you have an appropriate system in place to ensure

- Product specifications are met.
- Consistency and predictability is maintained.
- Regulatory compliance is fulfilled.

How will you prove this?

With QF 2000CM (Safe Quality Food) – a standard tha t provides a useful option to manage food safety risk and to build in product quality.

SGS (Societe Generale de Surveillance) is the world’s largest testing, inspection and quality systems certification organization operating in 140 countries and employing over 39000 employee. SGS offers a full range of service to support the implementation of:

- GMP, SSOP Certifications
- HCAAP, SQF 2000^{CM} Certification
- ISO 9001:2000 Certification
- ISO 14000 Certification
- Organic Certification
- EUREPGAP Certification
- BRC Certification

- CIEH (Chartered Institute of Environmental Health) Training Programs

Is Organic Food Better in Quality?

The USDA and FDA clearly mention that organic food is not superior to conventional food in any respect. It also mentions that conventional food is as healthy as organic food. There are no additional nutrients in organic food and they also taste, look and smell exactly same as conventional food products.

What do Proponents of the Organic Movement Say? Recently, the food we consume has increased amounts of chemical residues due to increased use of harmful chemical fertilizers, pesticides and insecticides in farming. Consume a few millilitres of these chemicals by mistake and you are sure to be hospitalized immediately. However, usage of these chemicals is not limited to farming. Post harvest processing of agricultural produce also involves usage of chemicals - in the form of preservative.

All these chemical fertilizers, insecticides, pesticides and preservatives enter our body daily through the food we eat and get accumulated over a period of time making our body an abode for a number of diseases such as skin disorders, heart disease and even cancer. The World Health Organization provides more information on chemical risks in food. In addition to this, the genetically modified food has created a fear of hormonal and transgenic contamination. All this has called for a serious thought over our dependence on chemical farming.

Organic Food is Better in Quality - Is It Proved? Though the claimed benefits of organic food have not been proved, people still believe them to be true. Organic food is considered to be far superior in quality than non-organic food items and hence has an ever increasing demand.

Research is being carried out throughout the world to prove/disprove these claims. Recently two different research teams from University of Aberdeen and Institute of Grassland and Environmental Research found that organic milk contains 71% more Omega 3 than conventional milk. Research conducted at the Danish Institute of Agricultural Sciences and the University of Newcastle has shown that organic milk contains 75% more beta carotene and 50% more Vitamin E than non-organic milk. These path-breaking research findings have firmed the belief of organic food consumers in their choice.

So, if you prefer to have fewer chemicals in your food, or want something that is better for you and your family, or want something that is better for the environment, or prefer the taste and looks of organic, then ask or check if your purchase is *certified* organic.

After all, you deserve to be assured that you are getting the best because that is what you pay for.

Health Benefits of Organic Food

The health benefits of organic food are more perceived than real. However, the public opinion that organic food is healthier than conventional food is quite strong and is the sole reason for about 30% growth in the organic food industry since the past 5-6 years.

There is little scientific evidence to prove that organic food is better in quality than conventional food. Scientific research conducted so far on various organic food items have not been able to give strong signals about the superiority of organic food over non organic food. As a result, even the FDA and the USDA clearly mention that non organic food is as healthy as organic food. However, there are some scientific studies that have proved organic milk and organic tomatoes to be better than the non-organic ones.

Organic Milk: Recent research conducted on organic milk has shown that it has more anti-oxidants, omega 3, CLA, and vitamins than non organic milk. According to the researchers at the Danish Institute of Agricultural Research, University of Aberdeen, and the Institute of Grassland and Environmental Research, organic milk is healthier than non organic milk as organic cows are pasture grazed which results in better quality milk.

Organic Tomatoes: According to a 10 year study conducted by the University of California, Davis, organic tomatoes are produced in an environment that has lower nutrient supply as nitrogen-rich chemical fertilizers are not added. This leads to excessive formation of antioxidants such as quercetin (79% higher) and kaempferol (97% higher) in organic tomatoes. As we all know, antioxidants are good for health and help in reducing heart diseases.

These studies have increased the hopes of numerous people who strongly believe that mankind should stop using chemical fertilizers and pesticides and shift to the more sustainable organic farming practices. There are many studies that prove that there is some pesticide and fertilizer contamination in non organic food, and there are others which claim that organic food is not healthy (they contain harmful bacteria and viruses) because of non usage of strong chemicals. However, none of these studies (showing chemical contamination or presence of bacteria/viruses) do not show any impact on health of individuals.

In general, organic food consumers, manufactuers and farmers strongly believe in organic food having following benefits over non organic food:

- **Better health:** Since **organic food** is not prepared using chemical fertilizers and pesticides, it does not contain any traces of these strong chemicals and might not affect the human body.

- **Better taste:** People strongly believe that **organic food** tastes better than non **organic food**. The prominent reason for this belief is that it is produced using organic means of production. Further organic food is often sold locally resulting in availability of fresh produce in the market.

- **Environment safety:** As harmful chemicals are not used in **organic** farming, there is minimal soil, air and **water** pollution; thus ensuring a safe world for future generations to live in.

- **Animal welfare:** Animal welfare is an important aspect of producing **organic milk**, **organic meat**, **organic** poultry, and organic fish. People feel happy that the animals are not confined to a miserable caged life while eating organic animal products.

Certification

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

- avoidance of most synthetic chemical inputs (e.g. fertilizer, pesticides, antibiotics, food additives, etc), genetically modified organisms, irradiation, and the use of sewage sludge;
- use of farmland that has been free from synthetic chemicals for a number of years (often, three or more);
- keeping detailed written production and sales records (audit trail);
- maintaining strict physical separation of organic products from non-certified products;
- undergoing periodic on-site inspections.

In some countries, certification is overseen by the government, and commercial use of the term *organic* is legally restricted. Certified organic producers are also subject to the same agricultural food safety and other government regulations that apply to non-certified producers.

Purpose of certification

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

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

Third party certification process

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

- **Study** the organic standards, which cover in specific detail what is and is not allowed for every aspect of farming, including storage, transport and sale.

- **Compliance —** farm facilities and production methods must comp ly with the standards, which may involve modifying facilities, sourcing and changing suppliers, etc.
- **Documentation —** extensive paperwork is required, detailing farm history and current set-up, and usually including results of soil and water tests.

- **Planning —** a written annual production plan must be submitt ed, detailing everything from seed to sale: seed sources, field and crop locations, fertilization and pest control activities, harvest methods, storage locations, etc.

·	**Inspection —** annual on-farm inspections are required, with a physical tour, examination of records, and an	
	oral interview.	
·	**Fee —** an annual inspection/certification fee (currentl y starting at $400–$2,000/year, in the US and Canad a,	
	depending on the agency and the size of the operation).	

- **Record-keeping —** written, day-to-day farming and marketing record s, covering all activities, must be available for inspection at any time.

In addition, short-notice or surprise inspections can be made, and specific tests (e.g. soil, water, plant tissue) may be requested.

For first-time farm certification, the soil must meet basic requirements of being free from use of prohibited substances (synthetic chemicals, etc) for a number of years. A conventional farm must adhere to organic standards for this period, often, two to three years. This is known as being in *transition*. Transitional crops are not considered fully organic.

Certification for operations other than farms is similar. The focus is on ingredients and other inputs, and processing and handling conditions. A transport company would be required to detail the use and maintenance of its vehicles, storage facilities, containers, and so forth. A restaurant would have its premises inspected and its suppliers verified as certified organic.

Participatory certification

“ *Participatory Guarantee Systems are locally focused quality assurance systems. They certify producers based on active participation of stakeholders and are built on a foundation of trust, social networks and knowledge exchange*” (IFOAM definition, 2008).

Participatory Guarantee Systems (PGS) represent an alternative to third party certification, especially adapted to local markets and short supply chains. They can also complement third party certification with a private label that brings additional guarantees and transparency. PGS enable the direct participation of producers, consumers and other stakeholders in:

- the choice and definition of the standards
- the development and implementation of certification procedures
- the certification decisions

Participatory Guarantee Systems are also referred to as "participatory certification".

History of Participatory Guarantee Systems

The organic movement has been a pioneer in the implementation and definition of Participatory Guarantee Systems (PGS). Organic certification started in various parts of the world in the 70s and 80s based on associative systems that were very close to what is now called PGS. Some of these associations are still doing participatory certification today, such as for example Nature & Progrès in France. Even though third party certification (following ISO 65 requirements) has become the dominant form of certification in the food sector, as well as many other sectors, alternative certification systems have never ceased to exist.

In 2004, IFOAM, the International Federation of Organic Agriculture Movements, and MAELA, the Latin American Agroecology Movement, jointly organized the first International Workshop on

Alternative Certification that took place in Torres, Brazil. It is at that workshop that the concept of	**Organic**
"Participatory Guarantee Systems" was adopted. At t his event, an international working group on	**Certification**
PGS was established, which later became an official Task Force under the umbrella of IFOAM.	

The Task Force worked on further defining PGS, and established the key elements and key features	
of PGS in a document entitled “Shared Visions – Sha red Ideals”.	Australia
Since then, IFOAM has continuously supported the development of PGS in the organic sector. In	
parallel, other sectors have been looking into the concept to certify various products or processes.	
Still, IFOAM and the organic movement remain a leader in the concept of PGS at the international	
level, and are now advocating for their recognition by governments as valid local certification	Germany
systems in cases where the organic sector is legally regulated.	
Certification & product labeling	
In some countries, organic standards are formulated and overseen by the government. The United	
States, the European Union, Canada and Japan have comprehensive organic legislation, and the	
term "organic" may be used only by certified producers. Being able to put the word "organic" on a	
food product is a valuable marketing advantage in today's consumer market, but does not guarantee	Canada
the product is legitimately organic. Certification is intended to protect consumers from misuse of	

the term, and make buying organics easy. However, the organic labeling made possible by certification itself usually requires explanation. In countries without organic laws, government guidelines may or may not exist, while certification is handled by non-profit organizations and private companies.

Internationally, equivalency negotiations are underway, and some agreements are already in place, to harmonize certification between countries, facilitating international trade. There are also international certification bodies, including members of the International Federation of Organic Agriculture Movements (IFOAM) working on harmonization efforts. Where formal agreements do not exist between countries, organic product for export is often certified by agencies from the importing countries, who may establish permanent foreign offices for this purpose.

In the US, the National Organic Program (NOP), was enacted as federal legislation in Oct. 2002. It restricts the use of the term "organic" to certified organic producers (excepting growers selling under $5,000 a year, who must still comply and submit to a records audit if requested, but do not have to formally apply). Certification is handled by state, non-profit and private agencies that have been approved by the US Department of Agriculture (USDA).

In Japan, the Japanese Agricultural Standard (JAS) was fully implemented as law in April, 2001. This was revised in November 2005 and all JAS certifiers were required to be re-accredited by the Ministry of Agriculture.

In India, APEDA regulates the certification of organic products as per National Standards for Organic Production. "The NPOP standards for production and accreditation system have been recognized by European Commission and Switzerland as equivalent to their country standards. Similarly, USDA has recognized NPOP conformity assessment procedures of accreditation as equivalent to that of US.

With these recognitions, Indian organic products duly certified by the accredited certification bodies of India are accepted by the importing countries." 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 Regulations 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. The regulations make provision for export, import and local trade of organic products. However, currently only the exports of organic products come under government regulations.

Thus an agricultural product can only be exported as an organic product if it is certified by a certification body duly accredited by APEDA. Organic crop production, organic animal production, organic processing operations, forestry and wild products are the categories of products covered under accreditation.

In China, the China Green Food Development Center awards two Standards: A and AA; while the former standard does permit some use of synthetic agricultural chemicals, the latter is more stringent.

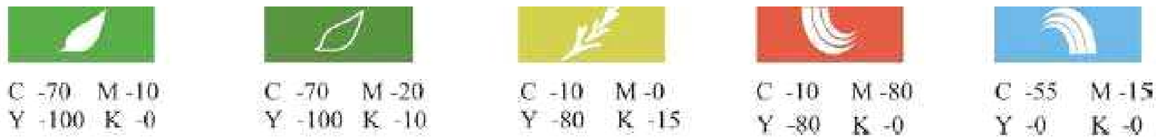
ORGANIC CERTIFICATION MARK

ORGANIC LOGO

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

SPECIFICATIONS

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



CONCEPT OF ORGANIC LOGO

Symbolizing the rhythm of cosmic and earth forces represented by the blue and brown waves of force and energy, 'India Organic' logo celebrates the essence of natu re. These forces work in harmony upon the earth's environment and this rhythm is reinforced and supported by the green plant growth. The colours used have a special significance in the logo concept. The cosmic force in blue symbolizes universal purity. Richness of soil, nourished with natural ingredients in organic farming, is symbolized by the earth forces in golden brown. The plant in green uses the colour of nature and natural products untouched by chemicals. The blue background is symbolic of earth's environment that is congenial for life to thrive in and is also free of pollution and harmful chemicals. India Organic etched over the surface authenticates the carrier as "Organic" and also establishes the Indian connection for all the carriers of the mark. Beautifully synthesizing all the elements of our environment, the logo also communicates total adherence to the National Organic Standards.

Certification issues

Organic certification is not without its critics. Some of the staunchest opponents of chemical-based farming and factory farming practices also oppose formal certification. They see it as a way to drive independent organic farmers out of business, and to undermine the quality of organic food. Other organizations such as the Organic Trade Association work within the organic community to foster awareness of legislative and other related issues, and enable the influence and participation of organic proponents.

Obstacle to small independents

Originally, in the 1960s through the 1980s, the organic food industry was composed of mainly small, independent farmers, selling locally. Organic "certification" was a matter of trust, based on a direct relationship between farmer and consumer. Critics view regulatory certification as a potential barrier to entry for small producers, by burdening them with increased costs, paperwork, and bureaucracy.

Manipulation of regulations

Critics of formal certification also fear an erosion of organic standards. Provided with a legal framework within which to operate, lobbyists can push for amendments and exceptions favorable to large-scale production, resulting in "legally organic" products produced in ways similar to current conventional food. Combined with the fact that organic products are now sold predominantly through high volume distribution channels such as supermarkets, the concern is that the market is evolving to favor the biggest producers, and this could result in the small organic farmer being squeezed out.

Manipulation of certification regulations as a way to mislead or outright dupe the public is a very real concern. Some examples are creating exceptions (allowing non-organic inputs to be used without loss of certification status) and creative interpretation of standards to meet the letter, but not the intention, of particular rules. For example, a complaint filed with the USDA in February 2004 against Bayliss Ranch, a food ingredient producer and its certifying agent, charged that tap water had been certified organic, and advertised for use in a variety of water-based body care and food products, in order to label them "organic" under US law. Steam-distilled plant extracts, consisting mainly of tap water introduced during the distilling process, were certified organic, and promoted as an organic base that could then be used in a claim of organic content. The case was dismissed by the USDA, as the products had been actually used only in personal care products, over which the department at the time extended no labeling control. The company subsequently adjusted its marketing by removing reference to use of the extracts in food products. Several months later, the USDA extended its organic labeling to personal care products; this complaint has not been refiled.

In December 2005, the 2006 agricultural appropriations bill was passed with a rider allowing 38 synthetic ingredients to be used in organic foods. Among the ingredients are food colorings, starches, sausage and hot-dog casings, hops, fish oil, chipotle chili pepper, and gelatin. This allowed Anheuser-Busch in 2007 to have its Wild Hop Lager 'certified organic' even though hops were gro wn with chemical fertilizers and sprayed with pesticides."

Misrepresentation of the term *organic*

The word *organic* is central to the certification (and organic food marketing) process, and this is also questioned by some. Where organic laws exist, producers cannot use the term legally without certification. To bypass this legal requirement for certification, various alternative certification approaches, using currently undefined terms like "authentic" and "natural" instead of "organic", are emerging. In the US, motivated by the cost and legal requirements of certification (as of Oct. 2002), the private farmer-to-farmer association, Certified Naturally Grown, offers a "non-

profit alternative eco-labelling program for small farms that grow using USDA Organic methods but are not a part of the USDA Certified Organic program."

In the UK, the interests of smaller-scale growers who use 'natural' growing methods are represented by the Wholesome Food Association, which issues a symbol based largely on trust and peer-to-peer inspection.

A related concern holds that certification is replacing consumer education, and this goes against the essential, holistic nature of organic farming. By reducing complex issues and regulations to a simple, convenient *certified organic* label, consumers may more easily ignore the principles and practices behind organics, leaving the definition of organic farming and organic food open to manipulation.

Accreditation

The act of accrediting or the state of being accredited, especially the granting of approval to an institution of learning by an official review board after the school has met specific requirements. Or

A process of formal recognition of a school or institution attesting to the required ability and performance in an area of education, training, or practice.

Or

The act of granting credit or recognition (especially with respect to educational institution that maintains suitable standards)

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

Organizations that issue credentials or certify third parties against official standards are themselves formally accredited by accreditation bodies (such as UKAS); hence they are sometimes known as "accredited certification bodies". The accreditation process ensures that their certification practices are acceptable, typically meaning that they are competent to test and certify third parties, behave ethically and employ suitable quality assurance.

One example of accreditation is the accreditation of testing laboratories and certification specialists that are permitted to issue official certificates of compliance with established standards, such as physical, chemical, forensic, quality, and security standards.

Position of Accreditation in India

As per the National Programme for Organic Production (NPOP) an accreditation refers registration by the accreditation agency for certifying agency for certifying organic farms, products and processes as per the guidelines of the National Accreditation Policy and Programme for Organic Product.

NPOP programme in context of Indian accreditation scenario, defined the function of accreditation agencies like

- Prescribe the package of practices for organic products in their respective schedule;

- Undertake accreditation of inspection and certifying agencies who will conduct inspection and certify products as having been produced in accordance with NPOP;
- Monitor inspection made by the accredited inspection agencies;
- Lay down inspection procedures;
- Advise the National Steering Committee on Organic Production;
- Accept Accredited certification programmes if such programme confirm to National Standard;
- Accreditation Agencies Shall evolve accreditation criteria for inspection and/or certifying agencies and programme drawn up by such agencies for their respective area of operation and products;
- Accreditation agencies shall prepare an operating manual to assist accredited agencies to abide by such a manual must contain appropriate directions, documentation formats and basic agency and farm records for monitoring and authentication of adherence to the organic production programme;
- Eligible inspection and certification agencies implementing certification programmes will be identified by the Accreditation Agency.

In the year 2000, Ministry of Commerce, Government of India has launched the NPOP. The following accreditation agencies are designated vide TRADE NOTICE (NO ORG/004/2001) date June13, 2001:

Agricultural and Processed Food Product Export Development Authority (APEDA)

Coffee Board

Spice Board

Tea Board

Marketing and Organic Food Exports from India

Organic food exports from India are increasing with more farmers shifting to organic farming. With the domestic consumption being low, the prime market for Indian organic food industry lies in the US and Europe. India has now become a leading supplier of organic herbs, organic spices, organic basmati rice, etc.

RCNOS recently published a report tilted ‘Food Processing Market in India (2005)’. According to its research, exports amount to 53% of the organic food produced in India. This is considerably high when compared to percentage of agricultural products exported. In 2003, only 6-7% of the total agricultural produce in India was exported.

Exports is driving organic food production in India: The increasing demand for organic food products in the developed countries and the extensive support by the Indian government coupled with its focus on agri-exports are the drivers for the Indian organic food industry.

Organic food products in India are priced about 20-30% higher than non-organic food products. This is a very high premium for most of the Indian population where the per capita income is merely USD 800. Though the salaries in India are increasing rapidly, the domestic market is not sufficient to consume the entire organic food produced in the country. As a result, export of organic food is the prime aim of organic farmers as well as the government.

The Indian government is committed towards encouraging organic food production. It allocated Rs. 100 crore or USD 22.2 million during the Tenth Five Year Plan for promoting sustainable agriculture in India.

APEDA (Agricultural and Processed Food Export Development Authority) coordinates the export of organic food (and other food products) in India. The National Programme for Organic Production in India was initiated by the Ministry of Commerce. The programme provides standard for the organic food industry in the country. Since these standards have been developed taking into consideration international organic production standards such as CODEX and IFOAM, Indian organic food products are being accepted in the US and European markets. APEDA also provides a list of organic food exporters in India.

Organic food costs in India are expected to decrease, driving further exports in future. 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 a 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.

Organic food products exported from India include the following:

- Organic Cereals: Wheat, rice, maize or corn
- Organic Pulses: Red gram, black gram
- Organic Fruits: Banana, mango, orange, pineapple, passion fruit, cashew nut, walnut
- Organic Oil Seeds and Oils: Soybean, sunflower, mustard, cotton seed, groundnut, castor
- Organic Vegetables: Brijal, garlic, potato, tomato, onion

- Organic Herbs and Spices: Chili, peppermint, cardamom, turmeric, black pepper, white pepper, amla, tamarind, ginger, vanilla, clove, cinnamon, nutmeg, mace,

- Others: Jaggery, sugar, tea, coffee, cotton, textiles

Organic Food Consumption in India

Organic Food Consumption in India is on the rise. Some people believe that organic food is only a “con cept” popular in the developed countries. They think that when it comes to organic food, India only exports organic food and very little is consumed. However, this is not true.

Though 50% of the organic food production in India is targeted towards exports, there are many who look towards organic food for domestic consumption.

ACNielsen, a leading market research firm, recently surveyed about 21,000 regular Internet users in 38 countries to find their preference for functional foods – foods that have additional health benefits. The survey revealed that India was among the top ten countries where healthy food, including organic food, was demanded by the consumers.

The most important reason for buying organic food was the concern for the health of children, with over 66 percent parents preferring organic food to non organic food. Though organic food is priced over 25 percent more than conventional food in India, many parents are willing to pay this higher premium due to the perceived health benefits of organic food.

The increase in organic food consumption in India is evident from the fact that many organic food stores are spurring up in India. Today (2006) every supermarket has an organic food store and every large city in India has numerous organic food stores and restaurants. This is a huge change considering that the first organic food store in Mumbai was started in 1997.

What do Indian organic food consumers prefer? The pattern of organic food consumption in India is much different than in the developed countries. In India, consumers prefer organic marmalade, organic strawberry, organic tea, organic honey, organic cashew butter and various organic flours.

However, the Indian organic food consumer needs education. There are many consumers who are unaware of the difference between natural and organic food. Many people purchase products labelled as Natural thinking that they are Organic. Further, consumers are not aware of the certification system. Since certification is not compulsory for domestic retail in India, many fake organic products are available in the market.

GLOSSARY

ACCREDITATION: Accreditation means Registration by the National Accreditation Body for certifying organic farms, products and processes as per the National Standards for Organic Products and as per the guidelines of the National Accreditation Policy and Programme for organic products.

ACCREDITED PROGRAMME: Means programme of accrediting Inspection and Certification Agencies which have been accredited by the Accreditation Agency and which have agreed to comply with the Accreditation contract. **ANNUAL REPORT:** Means the report on operators, products and processors submitted annually to the Accreditation Agency by the accredited Inspection and Certification Agencies.

APPEAL: Shall be the process by which an Inspection and Certification Agency can request reconsideration of a decision taken by the Accreditation Agency or an operator can request reconsideration of a decision by the Certification Agency.

APPLICANT: Shall be the Inspection and Certification Agency that has applied for Accreditation to the Accreditation Agency.

AYURVEDA: Ayurveda is a traditional naturopath system of medicines and health care of India.

BUFFER ZONE: A clearly defined and identifiable boundary area bordering an organic production site that is established to limit application of, or contact with, prohibited substances from an adjacent area.

CERTIFICATE: Would mean a document issued by an accredited agency declaring that the operator is carrying out the activities or the stated products have been produced in accordance with the specified requirements in accordance with the National Standards for Organic Products.

CERTIFICATE OF REGISTRATION: Shall mean the document issued by the Inspection and Certification Agency, declaring that the operator is licensed to use the certificate on specified products.

CERTIFICATION: Shall be the procedure by which a written assurance is given by the Certification Agency that a clearly identified production or processing system has been methodically assessed and conforms to the specified requirements.

CERTIFICATION MARK: Shall mean certification programme’s sign, symbol or logo which identifies the products as being certified according to the National Standards for Organic Products.

CERTIFICATION PROGRAMME: Shall mean the system operated by an Inspection and Certification Agency in accordance with the criteria for carrying out certification of conformity as laid down herein.

CERTIFICATION TRANSFERENCE: The formal recognition by an Inspection and Certification Agency of another Certification programme or Agency or projects or products certified by that programme or Agency, for the purpose of permitting its own certified operators to trade or process under the programme’s own certification mark, the products which are certified by the other programme.

CHAIN OF CUSTODY: All relevant steps in the production chain including growing, harvesting, processing, handling and related activities detailed in Section 4 of the accreditation criteria that have been inspected and certified, as appropriate.
COMPETENT AUTHORITY: Shall mean the official government agency for accreditation.

CONTAMINATION: Pollution of organic product or land; or contact with any material that would render the product unsuitable for organic certification.
CONSULTANCY: Shall mean the advisory service for organic operations, independent from inspection and certification procedures.

CONVENTIONAL: Farming systems dependent on input of artificial fertilizers and/or chemicals and pesticides or which are not in conformity with the basic standards of organic production.
CONVERSION: The process of changing an agricultural farm from conventional to organic farm. This is also called transition.
CONVERSION PERIOD: The time between the start of organic management, and the certification of crops as organic.

DECLARATION OF INTEREST: Declaration of no personal / commercial conflict of interest by all concerned involved in the process of inspection and certification.

DISINFECTANT: A product that minimizes by physical or accepted chemical means, the number of microorganisms in the environment, to a level that does not compromise food safety and suitability. **EVALUATION:** Shall be the process of systematic examination of the performance of an Inspection and Certification Agency to meet the specific requirements under the National Accreditation Programme.

FARM UNIT: An agricultural farm, area or production unit managed organically, by a farmer or a group of farmers.

FOOD ADDITIVE: Food additive is an external permissible ingredient added to improve the keeping quality, consistency, colour and other physico chemical, sensory properties, wholesomeness and safety of food

GENETIC DIVERSITY: Genetic diversity means the variability among living organisms from agricultural, forest and aquatic ecosystem. This includes diversity within species and between species.

GREEN MANURE: Manure consisting of fresh green plant matter, which is ploughed in or turned into the soil for the purpose of soil improvement.

GROUP CERTIFICATION: Certification of an organized group of producers, processors and exporters with similar farming and production systems and which are in geographical proximity.

GUIDELINES FOR ORGANIC PRODUCTION AND PROCESSING: Standards for organic production and processing established by the Accreditation Agencies for specific crops in accordance with the National Standards for Organic Products.

HABITAT: The area in which a plant or animal species naturally exists.

HAZARD ANALYSIS CRITICAL CONTROL POINT (HACCP): A systematic process that identifies food safety hazards, critical control points, critical limits, corrective actions and documentation and integrates monitoring procedures to ensure food safety.

OR

The Hazard Analysis Critical Control Point (HACCP) system is a science based on systematic approach to producing safe food. Food safety management systems based on HACCP are internationally recognized as the most effective way to ensure food safety and minimize the risks of food poisoning.

HOMEOPATHY: Homeopathy is a system of medicine based on the principle of "*Similia, Similibus,Curentur* (let likes be treated by likes)" .

HOMEOPATHIC TREATMENT: Treatment of disease based on administration of remedies prepared through successive dilution of a substance that in larger amounts produces symptoms in healthy subjects similar to those of the disease itself.

INGREDIENT: Shall mean any substance, including a food additive, used in the manufacture or preparation of a food and present in the final product although possibly in a modified form.
INPUTS BANNED: Those items, the use of which is prohibited in organic farming.

INPUT MANUFACTURING: Shall mean the manufacturing of organic production or processing inputs.

INPUTS PERMITTED: Those items that can be used in organic farming.

INPUTS RESTRICTED: Those items that are allowed in organic farming, in a restricted manner, after a careful assessment of contamination risk, natural imbalance and other factors arising out of their use. Farmers should consult the certifying agency.

INSPECTION: Shall include the site visit to verify that the performance of an operation is in accordance with the production or processing standards.

INSPECTION AND CERTIFICATION AGENCY: Shall be the organization responsible for Inspection and Certification.

INSPECTION AGENCY: Shall mean the agency that performs inspection services as per the National Accreditation Policy and Programme.

INSPECTOR: Shall be the person appointed by the Inspection and Certification Agency to undertake the inspection of an operator.

INTERNAL CONTROL SYSTEM: A documented quality assurance system that allows the external certification body to delegate the inspection of individual group members to a body identified from within the operators of the group.

INTERNAL REVIEW: Shall mean an assessment of the objectives and performance of a programme by the Certification or the Accreditation Agency itself.

IRRADIATION: High energy emissions from substances for the purpose of controlling microbial, pathogens, parasites and pests in food, preserving the food or inhibiting physiological processes such as sprouting or ripening. **LABELLING:** Means any written, printed or graphic matter that is present on the label, accompanies the food, or is displayed near the food, including that for the purpose of promoting its sale or disposal.

LICENCE: Shall be the Accreditation contract that grants a certifier the rights associated with its accredited status in line with the National Program for Organic Production.

LIVESTOCK: Shall mean any domestic or domesticated animal including bovine (including buffalo and bison), bovine, porcine, caprine, equine, poultry and bees raised for food or in the production of food. The products obtained by hunting or fishing of wild animals shall not be considered as part of this definition.
MARKETING: Means holding for sale or displaying for sale, offering for sale, selling, delivering or placing on the market in any other form.

MULTIPLICATION: The growing of seed / stock / plant material to supply for future production

NATIONAL ACCREDITATION BODY (NAB): Shall be the agency set up by the Steering Committee for National Programme for Organic Production for accrediting Inspection and Certification Agencies.
NATURAL FIBRE: A filament of plant or animal origin.

OPERATOR: Shall mean an individual or a business enterprise practicing organic farming or organic processing. **ORGANIC:** Refers to a particular farming system as described in these standards and not to the term used in chemistry.
ORGANIC AGRICULTURE: It is a system of farm design and management to create an eco system, which can achieve sustainable productivity without the use of artificial external inputs such as chemical fertilizers and pesticides.

ORGANIC PRODUCTION UNIT: Shall mean a unit / holding or stock farm complying with the rules of NPOP regulations.
ORGANICALLY-PRODUCED FEEDING STUFFS / FEED MATERIALS: Shall mean feeding stuffs / feed material produced in accordance with the rules of production laid down in NPOP regulations.

ORGANIC SEEDS AND PLANTING MATERIAL: Seed and planting material produced under certified organic system.
PACKAGE OF PRACTICES: Guidelines for organic production and processing established by the Accreditation Agencies for specific crops, specific to the region.

PARALLEL PRODUCTION: Shall mean any production where the same unit is growing, breeding, handling or processing the same products both in a certified organic and a non-certified organic system. Similarly a situation with "organic" and "in conversion" production of th e same product is also parallel production.

PART CONVERSION: Shall be when part of a conventional farm or unit has already been converted to organic production or processing and a part is in the process of conversion.

PLANT PROTECTION PRODUCT: Shall mean any substance intended for preventing, destroying, attracting, repelling, or controlling any pest or disease including unwanted species of plants or animals during the production, storage, transport, distribution and processing of food, agricultural commodities, or animal feeds.
PREPARATION: Shall mean the operations of slaughtering, processing, preserving and packaging of agricultural and animal products and also alterations made to the labeling concerning the presentation of the organic production method.

PROCESSING AIDS: A substance or material not consumed as a food ingredient by itself but used in the processing of raw materials, food or its ingredients to fulfil a certain technological purpose during treatment or processing and which may result in unintentional but unavoidable presence of residues or derivatives in the final product.

QUALITY SYSTEM: Documented procedures, which are established, implemented, and periodically audited to ensure that production, processing, handling, management, certification, accreditation and other systems meet the specified requirements and outcomes by following standardized protocols. **RAW MATERIALS:** All ingredients other than food additives.

SANITIZE: To adequately treat the produce or food-contact surfaces by a process that is effective in destroying or substantially reducing the numbers of vegetative cells of micro organisms of public health concern, and other undesirable micro organisms, but without adversely affecting the safety and quality of the product.
SPLIT PRODUCTION: Where only part of the farm or processing unit is certified as organic. The remainder of the property can be (a) non-organic, (b) in conversion or (c) organic but not certified. Also see parallel production.

STANDARDS: Shall mean the standards for National Organic Products established by the Steering Committee for National Programme for Organic Production.

SURVEILLANCE: The measures undertaken to provide monitoring of an operator's / certification body's compliance with the standards / criteria for meeting the certification / accreditation requirements.

TRANSACTION / IMPORT CERTIFICATE: Document issued by a certification body declaring that the specified lot or consignment of goods is derived from production and / or processing system that has been certified. **USE OF GMO AND GMOs DERIVATIVES:** A plant, animal, microbe or their derivatives that are transformed through genetic engineering.

VETERINARY DRUG: Means any substance applied or administered to any food-producing animal, such as meat or milk-producing animals, poultry, fish or bees, whether used for therapeutic, prophylactic or diagnostic purposes or for modification of physiological functions or behaviour.