PROCEEDINGS
OF
NATIONAL SYMPOSIUM
ON
RECENT TRENDS IN ORGANIC FARMING

11-12th September, 2007

Organized by

MAHATMA PHULE KRISHI VIDYAPEETH,

RAHURI 413 722, DIST. AHMEDNAGAR

Sponsored

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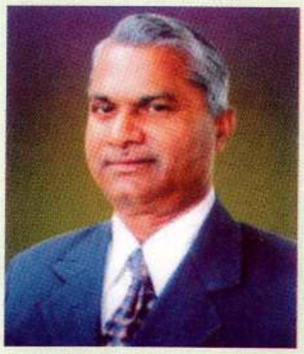
FOREWORD

There is a global shift in the agricultural production system towards the organic agriculture in recent years. During last few years, the organic farming has emerged as an alternative form of agriculture, which not only promises the chemical residue free food but also addresses the environmental and sustainability concerns with the optimum productivity. The movement of organic farming has taken up the shape of a strategy and is spreading very fast. India is now on the verge of an organic revolution with policies being framed and massive progrmames being launched both at government and non-government levels. However, the major problems for the growth of organic farming in the country are the lack of awareness, output marketing problems, shortage of biomass, inadequate supporting infrastructure, high input cost and lack of quality standards etc. The appropriate information on scope and status of organic farming, myths and realities associated with it, accurate package of practices for different crops is the real need of the hour.

To address the burning issues of the organic farming and to evolve necessary consensus, a two days' National Symposium on "Recent Trends in Organic Farming" was organized at the College of Agriculture, Pune on 11-12th September, 2007, on the eve of centenary celebration of this historical college. The papers were invited from Hon. Vice Chancellors and the eminent scientists from agricultural universities on various themes of organic farming, such as natural resource management, recycling of crop residues, crop production, processing, quality, microbial technology, socio-economic aspects and government policies. The proceedings and recommendations from this symposium will help to promote the organic farming in real sense.

R.B. Deshmukh
Vice Chancellor
MPKV, Rahuri.

PREFACE



Indiscriminate use of chemical fertilizers and pesticides for maximization of yield has created several problems, which are associated with the soil health, crop management and the environment. The necessity of having an alternative agriculture method, which can function in an eco-friendly method in sustaining and increasing the crop productivity is realized now. The organic farming is recognized as the best known alternative to the conventional agriculture. It is a system, which encompasses the natural resources utilization for maintaining the soil health including quality and fertility, the control of weeds, pests and diseases as well as residue-free food production. In India, an increased emphasis is being given on the organic agricultural production. However, there is need to develop the package of practices on scientific basis to formulate rules, regulations and policies for the organic products certification. To resolve this National symposium on "Recent Trends in Organic Farming" was organized at the College of Agriculture, Pune on 11-12th September, 2007 to commemorate the centenary celebration of this historical college.

The papers were invited from the Hon. Vice-Chancellors and the eminent scientists of agricultural universities on various themes of the organic farming. The proceedings and recommendations emerged from these deliberations will certainly be helpful in planning the national policy on organic farming.

A.S. Jadhav
Dean, Faculty of Agriculture and
Director of Instructions,
MPKV, Rahuri.

ACKNOWLEDGEMENT

It is my privilege to express my deep sense of gratitude to honourable Vice-Chancellor Dr. R.B. Deshmukh, M.P.K.V., Rahuri for inspiring to organize a national symposium on "Recent Trends in Organic Farming" on the auspicious occasion of Centenary Celebration of College of Agriculture, Pune, during 11-12 September, 2007 and giving me an opportunity to serve as a Organizing Secretary for the said symposium.

I express my extreme appreciation to the Chairman Dr.M.P. Yadav ,Vice-Chancellor, SBBPUA&T, Modipuram, Meerut and Executive Srectary Dr. R.P. Singh, Indian Agricultural Univesities Association, New Delhi for providing financial support to organize this symposium. I must whole heartly express my sincere thanks and special appreciation to Dr. A.S. Jadhav, Dean, Faculty of Agriculture and Director of Instructions, Dr. S.S. Mehetre, Director of Research and Dr. K.D. Kokate, Director of Extension Education, M.P.K.V., Rahuri for their constant inspirations and valuable suggestions for smooth conduct of symposium.

I take this golden opportunity to expresss indebtedness to all the Vice Chancellors / Directors of different state agricultural universities / institutes for sparing their valuable time to participate in the symposium and grace the function.

Thanks are also due to Director, Agricultural and Processed Foor Export Development Authority, (APEDA), New Delhi and Commissioner, Department of Agriculture (M.S.), Pune for providing substantial financial support to the symposium I acknowledge with thanks to the donors who have generously contributed a lot for this symposium. I express my thanks to the Chairman, Co-chairman and rapporteurs of different technical sessions for their painful efforts to make these sessions successful.

I am thankful to Chairman, Co-chairman, Secretaries and members of various committees for their day and night efforts to make this symposium a grand success.

I also find worth to mention here my heartfelt thanks to Dr. R.N. Sabale, Associate Dean and the staff from College of Agriculture, Pune for their untiring efforts to make this symposium successful.

It is not possible for me to acknowledge all the individual persons involved in making this symposium success even though, I know that many known and unknown hands pushed me forth and learned hearts put me on right path lightened by their knowledge and experience I remain thankful to all of them.

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Organizing Secretary (RTOF)
and
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Session-I
Organic farming and natural resource management

Organic farming in the past, its relevance in the present and the future agriculture

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There is a growing concern about the health and the environmental hazards of chemical-based intensive agriculture. The excessive and inappropriate use of the pesticides and the fertilizers has led to a contamination of food, water and fibre in several countries and thus, resulting in overall deterioration in soil health and environmental quality. This has led to a sudden switch over to an organic farming virtually at all the levels either in the private or in the public sectors during the last 15-20 years. Organic farming is considered to be a self-sustaining system of agriculture and attractive alternative to high input chemical-based production system. This system is believed to promise maintenance of soil productivity and control of pests and diseases by enhancing natural process and cycles in harmony with the natural environment. The production system entails no use of synthetic fertilizers, pesticides, ammendments, growth regulators and livestock feed additives, while relying more on organic manures, composts, biofertilizers, crop rotations with inclusion of legumes, mechanical cultivation, minerals bearing nutrients and biological pest control measures.

It is a harsh reality that India is expected to produce more than 450 million tonnes of foodgrains annually to feed its 1.5 billion people that are expected around 2050 A.D. The food security is one aspect in the Indian context, which can not be neglected to a second position in the foreceable future and this implies that the intensive agricultural production has to continue at a faster rate to feed the soaring Indian population. The organic nutrient application has decreased from 99.9 per cent in 1949 to 30.3 per cent in 2000 and it is again reduced to 25 per cent by 2005. The total acreage at the global level under the organic farming is around 24 million ha spread in almost 100 countries accounting for only five per cent of the total cultivated area. The area under the organic farming in Australia alone is 10 million ha which is 11.30 per cent of the cultivated area of the country. In India, it has been estimated that the area under the organic farming is only 0.03 per cent of the total cultivated area. There has been a phenomenal growth in the organic agriculture with the rising demand for the organic produce, especially in the developed countries.

Concept

India has become self-reliant in food production after independence, thanks to the green revolution technology. Of late, there is a increasing realization among scientists, farmers and administrators that the system is unsustainable and there is every likelihood of decline in soil health and environment if we don't take urgent steps to remedy the situation. The excessive use of fertilizers and insufficient use of organics has led to a decrease in soil fertility and health. Air and water pollution has become serious. Agricultural chemicals including pesticides, hormones and antibiotics leave residues in soil that eventually get into the food chain causing the health and environmental problem. The continued use of high analysis NPK fertilizers has led to a occurrence of zinc and sulphur deficiencies. Conservation and efficient use of natural resources are the means to achieve sustainable high yields in food and nutritional security and environmental safely.

Organic farming in the past

India is one of the few geographical locations of the world where agriculture was initiated by aboriginals. The people developed all aspects of the agriculture including the discovering and improving upon the indigenous seeds, inventing tools and employing animal draft power to help this process. The agriculture here had been close to nature and organic since the time immemorial. Farmers had developed understanding of the natural laws, climate and available resources which they used in their future pursuit of the knowledge and the action.

Looking back of the status of Indian agriculture before 1947, it seems important to remember Sir Albert Howard, Director, Institute of Plant-Industry, Indore who observed that the most ideal agriculture was what was found in the forests, the mixed farming, plants growing with animals, absence of any monoculture, soil protected from direct sun, rain and wind. In traditional Indian agriculture the food and the forage crops are predominant, while mixed crops are the rule. The mixed cropping is perhaps most universal when the cereal crop is the main constituent. The mixing of cereals and pulses appears to help both the crops. Whatever be the reason why crops thrive best when associated in a suitable combinations, the fact remains that the mixtures generally give better results than monoculture.

The traditional knowledge of agriculture, which was essentially organic, was nurtured and groomed by millions of farmers, over the several hundred years and it continued to grow systematically without any adverse impact on the soil and the environment. The wisdom kept on growing and developing from generation to generation in the families. Such traditional farm families are still surviving in many parts of the country and they are the living authorities of traditional agriculture and the repositories of our traditional wisdom.

Rishi Krishi

Acharya Vinoba Bhave initially experimented with this approach at his Paunar Ashram (Wardha), advocating the tilling of the land with the bare-hands, as the Rishis (who wrote *Vedas*) possibly did for meeting their food and fibre requirements. Later, he relented and allowed the use of bullocks to till the land. It was believed that the cosmic energy is the only source of the plant growth, and no organic manures or fertilizers are required to raise the plants (Deshpande, 2004).

Cow horn technology relating to the universe

Some nine preparations are made by using the cow-dung from lactating cows, silica or the blossoms, leaves, bark etc. of some plant species filled in hollow of cowhorn, intestine, mesentery or skull and composting the contents for six months by burrying them in soil during some auspicious moments (Tandon, 1997). These BD preparations, applied in very small quantities in homoeopathic doses, are claimed to have magical properties of meeting the crop nutrient demands, preventing and the curing disease and the pest infestations and increasing the soil fertility particularly NO_3-N content from 0.06 to 1.7 per cent (Menon and Karamarkar, 1994) leading ultimately the net dramatic increase in crop growth and yields.

Farming calendar

A calendar developed by the missionaries of organic farming attempts at the linking of planetary rhythms and constellation with nutrient use-efficiency, with the recommendation to apply manures with the ascending of full moon to derive maximum advantage (Menon and Karmarkar, 1994 b). One thumb rule of this calendar is that the ascending moon period causing breathing-out of earth favours the development of the above ground plant parts and the periods of descending the moon are related with the breathing-in of the earth causing the development of below-ground plant parts i.e. root (Chonkar and Dwivedi, 2004).

Homa farming

This form of organic farming involves *Agnihotra* (burning of whole rice grain mixed with cow-ghee in a copper pyramid of specified size, along with the chanting of mantras at sunrise and sunset). This practice is said to gather the tremendous amount of energy around the copper-pyramid, which goes to the atmosphere along with the holy smoke and exerts the dramatic benefits to the crop growth and the productivity by way of injecting the nutrients to the environment and mitigating the ill effects of pollution. The ash left after performing the *Agnihotra* is touted as complete plant food (Murthi, 2004).

Homoeopathic farming

In this farming some homoeopathic preparations are used for improving the soil-health and the crop yields without any plant protection measures (Murthi, 2004).

Status of Organic Farming

At present, farmers are widely adopting the traditionally prepared organic inputs for raising the different high value crops.

Following this, the organic preparations are used as a input for raising the different crops.

1. *Bijamrit* : For seed treatment

About 10 to 15 kg soil for underneath Baniyan tree + 10 kg cow dung +250 g cow ghee + 500 g honey + water and mix it well and make the slurry. Treat the seed with slurry. Dry the seed under the shade and then use it for sowing.

2. *Jivamrit* : For foliar application / through irrigation

Ten kg cow dung + 10 litre urine + 2 kg Jaggery + 2 kg Pulse flour + 25-30 g Biofertilizer or soil + 200 litre water. Mix it well, ferment the same for 5-6 days and then use it for 0.40 ha area.

3. *Amritpani* : For foliar spray / through irrigation

Rishi Krishi method : Ten kg cow dung + 250 g cow ghee + 500 g honey or jaggery + 200 litre water. Mix thoroughly and use it for 0.40 ha area.

4. Vermiwash – For foliar spray

Plastic drum (50-60 lit. capacity), with the small hole at bottom. Cover the hole with pieces of bricks and coarse sand, cover it with mesh. Fill it with half decomposed cowdung, add 1 kg verms and add 1 lit water daily – Collect the drainout fluid. Use this fluid for foliar spray @ 1 litre in 50 litre water. It will supply the nutrients and also useful for the plant protection purpose.

5. Dashparni ark

For preparation of dashparni ark, use one kg leaves each of Neem, Custard apple, Besharam, Nirgudi, Karanj, Ghaneri, White dhatura, Jatropha, Korphad, Adulsa /Castor and add 20 litres cow urine in the plastic drum for the fermentation for eight days. During fermentation, stir the volume everyday. Filter the extract and use @ 1 litre extract in 10 litre water for the plant protection.

The organic farming movement in India is led by the Members and Associates of the International Federation of Organic Agriculture Movements (IFOAM) with its headquarter at Bonn, in Germany. It has over 600 organizational members from 120 countries. All India Federation of Organic Farming (AIFOF) is the member of IFOAM from India. AIFOF has a large number of NGOs, farmers, organizations, promotional bodies, corporate entities and the institutions as its constituent members. The AIFOF works on lines similar to other associations like the Soil Association, UK and California Certified Organic Farmers, USA (CCOF). It has the necessary infrastructure for the purpose of approval and granting the license to the farmers or the producers allowing them the use of AIFOF "CERTIFIED ORGANIC" as a symbol on their productions.

In India, the Agriculture and the Processed Food Products Export Development Authority (APEDA), Ministry of Commerce, Government of India, is the key accreditation agency, the others being Coffee Board, Spices Board, Tea Board, Coconut Development Board and Directorate of Cocoa and Cashewnut Board. The National Programme for the Organic Production (NPOP) was initiated by the Ministry of Commerce, Government of India in May, 2000 for specifically looking at all the issues associated with the organic farming and an India Organic Logo was also released in July, 2002.

The Government of India is also taking keen interest in promoting the organic farming and has set up a National Institute of Organic Farming at Ghaziabad, Uttar Pradesh. Other states of the country have already taken initiative steps as this institute will take care of the rules and regulations and the certification of the organic products in conformity with the international standards. One of the key factors in favour of the organic farming is the spiralling demands for the organic products in the international market.

Sikkim has declared itself as an organic farming state from the year 2002.Uttaranchal is the first state in the country to establish organic commodities board and created the organic export zones by establishing the organic bio villages.Madhya Pradesh state has declared many villages as organic.

Prospects of Organic Farming :

There is going to be a greater spurt in the practice of organic farming in the years to come with the global trade in organic farming picking up from the present US$ 13 billion to US$ 100 billion by 2006. At present, India's exports of organic produce are worth 1 to 2 crores only and that in mainly of tea, cotton and spices etc. There is tremendous potential to increase India's share in international trade on the organic food by including the commodities such as durum wheat, basmati rice, fruits, aromatic/medicinal herbs, vegetables, coffee, pulses, sugar, etc. India has competitive advantages in the world markets due to the low production costs, a premium in organic farming and the availability of diverse climates to grow a large number of crops throughout the years.

Availability of Organic Resources

The success of organic agriculture depends upon the development and the integration of various activities at farm in a way that availability of the organic resources for recycling nutrients is not a constraint. The animal dung, crop residues, green manures, bio-fertilizers, agro-industrial waste, food processing waste and urban solid waste are the potential organic sources of the nutrients, while animal dung is used extensively in the form of farmyard manure in the country, the other resources are utilized in a limited scale. Greater research and development and promotional efforts are required to transform the non-conventional resources into the valuable manures. The greater access to good quality manure and the availability of crop residues/green manures for nutrient recycling will promote the adoption of organic agriculture in the large areas.

Crop Residues

The availability of crop residues has been estimated to be 355.7 million tonnes. Three-fourth of the total residues are produced by rice, wheat and oilseed crops. The remaining one-fourth are from sugarcane and sorghum. A sizeable portion of the crop residues i.e. about two – third is fed to animals in India and only remaining one-third is available for the incorporation into the soil. A greater proportion of nutrients in the residues on which the animals are fed is, nevertheless, recycled to soils through dung.

According to the another projection, the availability of the crop residues in India would be 300, 343 and 496 million tonnes in 2000, 2010 and 2025, respectively. The tappable nutrients ($N+P_2O_5+K_2O$) would be of the order of 2.05, 2.34 and 3.39 million tonnes in the respective periods.

Green Manuring

Green manuring with leguminous crops is a well-accepted practice for augmenting nutrient supply, particularly with the nitrogen and organic matter. Under the organic farming system, this practice is widely utilized for not only improving the nutrient and organic matter supply, but also to manage weeds and pests. Improvements in soil properties and productivity due to the incorporation of green manure crops are observed in soils under the different agro-ecological zones. The most commonly grown green manure crops are *Sesbania aculeate* (Dhainhca) and *Crotalaria juncea* (Sannhemp), having the potential to provide 4-5 t ha^{-1} of dry biomass and 80-100 kg of N ha^{-1} within 50-60 days of plant growth (Singh and Singh, 1997).

Agro-Industrial Wastes

Agro-based industries and food processing industries are developing fast due to the greater incentive offered by the government for the value addition to products of farm sector. The Government of India in its recently declared Agriculture Policy has also emphasized for making the agriculture a more profitable venture by diversifying into the activities adding the value to the farm produce. Wastes generated during the processing of agricultural products can be recycled advantageously to the soil for improving the nutrient availability.

Sugar Industry Waste

Processing of cane in the sugar mills and fermentation of molasses in distilleries result into the production of solid and liquid wastes known as the pressmud and spent wash, respectively. These wastes have potentials to supply nutrients and organic matter provided technology of co-composting is utilized for their conversion into valuable manures. In fact, at present almost all the distilleries have started co-composting of pressmud with spent wash. About 5 to 5.5 million tonnes of pressmud is being produced in India annually, having potential to generate about 3 to 4 million tonnes (60 per cent of total press mud) of manure with very high nutrient content.

Plantation Crops Waste

The plantation and the spice crops are important commercial crops grown in Assam, Kerala, Karnataka, Tamil Nadu and other parts of India. The large quantities of bio-degradable wastes *viz.*, coir dust, husk, dried leaves, pruning, coffee husk, tea wastes, oil palm wastes etc. are available for recycling the organic matter and nutrients. Recycling of these wastes after composting has the high potential to supplement the nutrient requirements of the crops.

Fruits and Vegetables Produce Waste

India produces around 33 million tonnes of fruits and 50 million tonnes of vegetables annually. It is roughly estimated that 10 to 15 per cent of total produce is available either as residues or bio-degradable wastes for recycling in the agriculture.

In addition, the processing of fruits and vegetables result in the production of 5 million tonnes of solid wastes approximately.

Fermentation Industry Waste

India has made rapid progress in the production of drugs and other chemicals through the fermentation processes of different substrates. After production of useful products, the left out materials contain large amount of organic matter and minerals in solid and also in liquid form. It is estimated that with one kg of antibiotic produced through fermentation, there is a generation of around 7000 to 8000 litres of waste water with solid content ranging between 40 to 50 g L^{-1} and BOD load of about 30000 to 60000 mg L^{-1}. This waste water also contains around 2-6 % N. Presently, these wastes are discharged in the sewage water after the treatment.

Urban Solid Waste

At present the total waste generated in India is over 39 million tonnes . The disposal of this huge waste is a big challenge, especially in 300 class I cities having a population of more than 100,000. The mixed Indian waste has a large proportion of compostable material of 30-57 containing 0.56-0.71 per cent nitrogen, 52-0.82 phosphorus and 0.52-0.83 potassium. Obviously, the waste after composting could be an invaluable source of organic manure and plant nutrient. Its application to the agricultural lands is desired to serve the twin objectives of cleaning the environment and replenishing the soils in their depleting fertility.

Bio-fertilizers

The bio-fertilizers being cheap and eco-friendly source of nutrients for the variety of crops, are going to play a critical role in the practice of the organic farming. Presently, the number of agricultural universities, State agricultural departments and the commercial houses are producing the bio-fertilizers in India. The production is about 10,000 tonnes against the production capacity of 18,000 tonnes with *Rhizobium* accounting for 40 per cent.

Bio-control agents and Bio-pesticides

The bio-control agents (natural predators) and bio-pesticides of plant origin have a greater role to play in protecting the crops against pests and diseases under the organic farming regime. The predators feed on crop pests keeping their populations to the minimum levels. The predators, on the other hand, also keep thriving with no use of chemical pesticides. India is rich in bio-control agents bio-diversity, ranking second after Australia amongst the twelve mega-diversity countries in respect of Hymenoptera and a large number of naturally occurring predators are available for controlling the pests in different crops.

Future Thrust

Developing the strains of bacteria which can withstand high temperature and alkali are acid resistant and high pH tolerant, which produce antibiotic in the soil or any in other chemicals which impart the strain competitive edge over the other strain is the real need of the hour. Some of the genes responsible for the production of the plant hormones have been properly characterized and cloned. These genes could be introduced into the *Rhizobium* strains. Strains that can fix nitrogen in the presence of the added nitrogen and those that can increase the nitrogen-fixing efficiency should be selected.

The efforts to mass multiplication of mycorrhizae in a large quantity using the lighter carrier material has to be intensified. The PCR techniques should be standardized to identify the mycorrhizal colonization within plant roots using different species as specific primers.

Remote sensing techniques will provide the information on the detection and the quantifications of damage to plants, assessment of distribution of the principal host plant (s) or habitat of insect pests and surveillance of environmental factors favourable of the development and spread of insect and diseases. The computerized insect acoustic detection technique based on the closed organ pipe principle will be used to detect the presence of larvae of tissue borers, fruit and stored grain pests, etc. in oranges, mangoes, papaya and grains.

Exploitation of natural enemies until now underused (such as entomophilic nematodes and anthocorids), the development of novel bio-rational pesticides and the transgenic plants, the resistance management to extend the life of essential pesticides and the transgenic plants and the utilization of semi chemicals are essential to give us more options or tactics to enrich existing ecological management strategies.

The explosion of information technology is likely to make a certain impact and systems analysis approach will be applied effectively. The reliable predictive models of insect populations based on the real time weather data can be achieved as the programmes and the weather informations are accessible through the internet. The use of the Geographical Information System (GIS) can also be attempted.

The ease and speed of dissemination of information through the internet will also help the researchers and the extension agencies. The successful ecological management has been a result of better fundamental understanding of the ecology of crop/pest interactions and it is rarely due to revolutionarily new pest introductions. The recent introductions such as serpentine leaf miner (*Liriomyza trifoli*), spiraling whitefly (*Aelurodicus disperses*), coffee berry borer (*Hypothenemus hampei*) and the coconut eriophyid mite (*Aceria guerreronis*) have already caused the great damage.

Plant and animal quarantine has assumed the considerable importance in this scenario. Hence, the government agencies have to be very vigilant. Efforts are necessary to formulate the policy guidelines at national level regarding export and import of beneficial organisms including microbial agents.

The efforts should be made to document the indigenous technical knowledge of the farmers and to establish the scientific basis and efficacy of their practices. If it is found effective, then these can be popularized. The Indian farmers have traditionally used extracts of neem, turmeric, garlic etc. over the centuries.These practices are widely followed by the farmers such as application of cow's urine, ash, chilli powder, extracts of various plants etc. needs to be studied and standardized if found effective.

The organic farming at present is in its infancy and therefore faces a number of problems and constraints. To over come these constraints the following practical strategies are suggested.

There is a need to develop manurial schedules for high value organically produced crops, indicating the nature and the composition of organic manures and degree of their maturity keeping in mind the ease of recognition of these attributes by ordinary farmers.

Identify areas which can be encouraged to take up the organic farming. The recommended amount of the manure should aim at producing optimal crop.

The location specific permutation and combination of different organic sources to meet the nutrient requirements of particular crop in order to achieve the optimum productivity.

Soil scientists should evolve the farmers' friendly technologies for using different types of wastes in agriculture, eliminating the heavy metal pollutants and digesting the pathogenic substances. They should make concrete suggestions for enriching the composts using low-grade indigenous rock phosphates.

In order to develop package and practices of various organic farming modules, ICAR has initiated a multi-location National Project on Organic Farming (NPOF) having its lead center at PDCSR, where the soil scientists, the horticulturists , agronomists, plant protection specialists and the social scientists etc. are working in a multi-disciplinary mode.

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Table 1. Organic products involved in the organic trade from Asia

India	Tea, Cotton, Spices
Indonesia	Coffee, Herbs, Spices
Pakistan	Grains, Herbs, Spices, Fruits, Nuts
Papua New Guinea	Coffee, Tea
Thailand	Vegetables, Fruits, Tea, Spices, Cashew Nuts
Sri Lanka	Pineapple, Sesame, Oils, Dried Coconut

Table 2. India organic : An overview (2004-05)

1	Area under certified products	2.5 million ha
2.	Total certified production	115238 metric tonnes
3.	Total project certified	322
4.	Number of processing units	158
5.	Accredited inspection and certifying agencies	11
6.	Number of products exported	35
7.	States involved in organic export	
	i) Kerala	1232 metric tonnes
	ii) West Bengel	937 metric tonnes
	iii) Karnataka	476 metric tonnes
	iv) Tamil Nadu	471 metric tonnes
	v) Punjab	541 metric tonnes
	vi) Himachal Pradesh	521 metric tonnes
	vii) Maharashtra	375 metric tonnes
8.	All India total organic export	6472 metric tonnes
9.	Premium collected against organic export	Rs. 80-90 crores

Table 3. Projection on the availability of organic resources for agriculture in India during 2000-2025

Resources (million tonnes)	Year		
	2000	2010	2025
Theoretical potential			
Human excreta (dry)	16.5	18.5	21.5
Livestock dung sun dry	375	396	426
Crop residues	300	343	496
Resources (considered tappable)			
Human excreta	13	15	17
Livestock dung sun dry	113	119	128
Crop residues	99	112	162
Nutrient (theoretical potential), $N+P_2O_5+K_2O$			
Human excreta dry	2.00	2.24	2.60
Livestock dung sun dry	6.64	7.00	7.54
Crop residues	6.21	7.10	20.27
Nutrient (considered tappable), $N+P_2O_5+K_2O$			
Human excreta dry	1.60	1.80	2.10
Livestock dung sun dry	2.00	2.10	2.26
Crop residues	2.05	2.34	3.39
All resources	5.65	6.24	7.75

Source : Tandon (1997)

Table 4 : Projection of the amount of tappable nutrients from different organic sources for agriculture in India.

Resources	Year		
	2000	2010	2025
Generators			
Human population (million)	1000	1120	1300
Livestock population (million)	498	537	596
Resources (considered tappable)			
Human excreta (dry) (million tones)	13	15	17
Livestock dung (dry) (million tones)	113	119	128
Crop residues (million tones)	99	112	162
Nutrient (potential) (million tones $N+P_2O_5+K_2O$)			
Human excreta	2.00	2.24	2.6
Livestock dung	6.64	7.00	7.54
Crop residues	6.21	7.1	20.27
Nutrient (considered tappable) (million tones $N+P_2O_5+K_2O$)			
Human excreta	1.60	1.8	2.1
Livestock dung	2.00	2.1	2.26
Crop residues	2.05	2.34	3.39
Total	5.65	6.24	7.25

Tappable = 30 per cent of dung, 80 per cent of excreta, 33 per cent of crop residues
Source : Tandon, H.L.S. (1997) Plant nutrient needs, supply, efficiency and policy issues. NAAS, New Delhi, pp 15-28.

Table 5. Quantity of residues of different crops (q/ha⁻¹)

Sr. No.	Crop	Leaf litter	Above ground parts	Roots	Total dry matter
1.	Groundnut	8.75	29.75	0.42	38.92
2.	Greengram	5.46	9.53	1.95	16.94
3.	Blackgram	4.81	10.19	1.76	16.76
4.	Cowpea	16.14	22.78	3.37	42.29
5.	Soybean	13.20	7.40	3.80	24.40
6.	Sunflower	2.10	37.75	1.00	40.85
7.	Sorghum	1.97	88.40	10.13	100.50
8.	Maize	1.97	77.18	3.25	82.40
9.	Paddy	2.70	15.00	9.30	27.00
10.	Cotton	3.05	10.01	1.94	15.00

Table 6. Available and realizable crop residues and major nutrient contents of principal crops in India

Crops	Residue yield (000 tonnes)	Nutrient content (%)			Nutrient potential (000 tonnes)
		N	P	K	
Rice	80744	0.61	0.09	1.15	1493.8
Wheat	44987	0.48	0.07	0.98	688.3
Sorghum	11563	0.52	0.10	0.21	216.2
Maize	6219	0.58	0.09	1.25	119.4
Pearlmillet	8282	0.45	0.07	0.95	121.6
Barley	3180	0.52	0.08	1.25	88.8
Sugarcane	15645	0.45	0.08	1.20	270.7
Potato	5062	0.52	0.09	0.85	73.9
Groundnut	9580	0.165	0.12	1.23	277.3
Total	**185263**				**3320.0**

Table 7. Nutrient potential of biological wastes

Waste	Total quantity available (Mt)	Total nutrients 000 t/year			Total
		N	P_2O_5	K_2O	
Cattle dung manure	2.80	2813	2000	2069	6882
Crop residue	273	1285	1966	3904	7153
Forest litter	18	100	37	100	237
Rural compost	285	1431	861	1423	3715
City refuse	14	98	84	112	294
Sewage sludge	0.5	5	3	3	11
Pressmud	3	33	79	56	168

Source : ICAR – LTFE 1998

Table 8. Estimates of potential nutrient sources

Sources	**Estimated yield (mt)**	**Total N + P_2O_5 + K_2O Potential (mt)**
Water hyacinth	73	0.1700
Forest litter compost	15	0.1530
Rural compost	600	9.5000
Urban compost	15	0.5700
Rice husk	20	0.2100
Pressmud	3.5	0.1140
Cotton dust	0.050	0.0020
Tea waste	0.015	0.0004
Tobacco wastes	0.062	0.0155
Tobacco seed cake	0.012	0.0240
Non edible cake	0.360	0.0288
Sugarcane	30.0	0.5400
Potato plants	10.00	0.1450

Table 9. Manurial potential of livestock and human excreta

Animal	**Population million**	**Nutrient potential (Mt.)**		
		N	**P_2O_5**	**K_2O**
Cattle	197	2.285	0.872	1.465
Buffalo	75	0.820	0.304	0.536
Goat and sheep	165	0.428	0.126	0.040
Pigs	11	0.066	0.040	0.0044
Other livestock	4	0.087	0.020	0.076
Human beings	850	6.133	1.474	1.359
Total		9.900	2.896	3.550

Table 10. Addition of plant nutrients through green manuring

Crops	**Average yield of green manure (Mt $acre^{-1}$)**	**N %**	**N added (kg ha^{-1})**
Sannhemp	9.96	0.48	75.0
Dhaincha	9.40	0.42	68.9
Green gram	3.76	0.53	34.6
Cowpea	7.05	0.49	50.4
Guar	9.40	0.34	55.0
Berseem	7.29	0.43	54.0

Table 11. Bio-mass available in plantations for recycling

Plantation crop	Biomass ($t\ ha^{-1}\ yr^{-1}$)
Coconut	8-12
Arecanut	8
Cocoa	5
Cardamom	5.5
Cashew	1.5
Tea/Coffee	10-20
Shade trees	8-10

Source : Nair *et al.* (1997)

Table 12. Benefits derived from the use of biofertilizer in India

Biofertilizers and crops	Grain Yield (kg/ha)			Increase in yield (%)	Monetary benefits / ha for an input costing Rs. 10-20/ha
	Control	Inoculated	Increase over control		
Rhizobium Chickpea	1956	2228	272	13.9	1101.60
Rhizobium Pigeonpea	1985	2182	197	9.9	1280.50
Blue-green Algae Rice	4175	4650	475	11.4	1311.00
Azolla Rice	2800	3480	680	24.3	1876.80
Azospirillium Sorghum	3130	3700	570	18.2	598.00
Azospirillium Pearl millet	1430	1789	359	25.1	589.80
Azotobecter Cotton	1254	1339	85	6.8	433.50

Source : Dahama 2003

Table 13. Biological control agents of crops

Crop	Pest	Number of natural enemies
Sugarcane	Sugarcane top borer	61
Sugarcane	Sugarcane stalk borer	50
Corn	Corn borer	32
Rice	Rice yellow stem borer	72
Cotton	Cotton bollworm	53
Tobacco	Tobacco caterpillar	42
Groundnut	Groundnut leaf miner	30
Castor	Castor semilooper	45
Mango	Mango leaf hopper	33
Mango	Mango mealybug	23
Citrus	Green scale	23
Coffee	Green scale	23
Crucifers	Diamondback moth	29

Table 14. Fruits and their values added products

Fruit	Value added products
Bel	Aromatic pulp, squash, sherbet, marmalade
Custard apple	Pulp, ice cream, pudding
Chiranji	Tanning, sweet meat
Kair	Pickle, pachkuta
Karonda	Pickle, jam, chutney
Lasora	Pickle
Quince	Jelly, baked fruit
White sapota	Beverage
Aonla	Pickle, preservative, jelly, jam, hair oil, Triphala, Chavanprash
Rose apple	Jam, jelly, pickle
Wood apple	Pulp, chutney, jelly
Fig	Dried fig, preservative, candy, jam
Phalsa	Juice, squash
Jangal jalebi	Pulp
West Indian Cherry	Juice, sauce, jelly
White mulberry	Jelly, beverages
Black mulberry	Jam, jelly, sherbet
Prickly pear	Juice, dried dates, soft dates
Date palm	Jam, jelly dried dates, soft dates
Khejri	Dried pods, pach kuta
Screw pine	Attar, bouquets, lotions, cosmetics, soap, agarbati
Guava	Preservative, jam, jelly
Pomegranate	Anar rub, anardana, R.T.S. jelly
Jamun	Jam, jelly, beverage
Tamarind	Jam, jelly, beverage, juice, pulp, tartaric acid
Ber	Candy, preservative

Water management in relation to organic farming

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About 25 % of the world's fresh water supply is diverted from rivers, lakes and groundwater by humans. Of that, about two-thirds (2700 km^3 per year; about 5 times the flow of the Mississippi river) is used for irrigation (Postel, 1993). All agriculture, through tillage, monoculture and addition of synthetic chemicals, affects the environment. The impacts of irrigated agriculture may be somewhat different than rainfed agriculture. In the process of collecting, storing, diverting,transporting, spreading, consuming and draining water; and enabling the intensive agricultural activities on otherwise marginal or non-productive lands; water, land, plant, animal, and human resources are changed. Some of these changes are positive; others are negative. It is important that we are aware of the changes and their impacts, so that we can minimize the negative impacts and evaluate the benefits and the costs of irrigated agriculture.

The effects of irrigation can be grouped into impacts on the quantity and quality of water resources, impacts on soil quality and sustainability, and impacts on human health and nutrition (Trout, 2000). In order to conserve the water resources and use it sustainably, it is very much essential to reduce some of these impacts through the proper maintenance of soil – plant - water – atmosphere balance and employing are appropriate technologies for irrigation water development and the management including the drainage.

Organic water management

A new term organic water management synonymous to sustainable water management is introduced here and defined as " Irrigation practices to produce agricultural products at reasonable cost ensuring favourable microbial health of the soil and those practices which do not degrade the quality of land, water or other natural resources." In organic farming, the soil microbial health in terms of mass and activity of soil microbes is very much important, thus, the water management practices in organic farming should be helpful in enhancing these activities in addition to other conservation and sustainable benefits expected from the irrigation practices. These practices need to be followed due to the fact that the water management practices being followed world wide now a day are basically unsustainable in the nature.

Un-sustainability of irrigation

The irrigation represents an alteration of the natural conditions of the landscape by extracting water from an available source, adding water to fields where there was none or little before, and introducing man-made structures and features to extract, transfer and dispose of water. The irrigation projects and irrigated agriculture practices impact the environment in a variety of ways. Generally, the irrigation changes the environment through following sources; a) construction of irrigation projects, b) water supply and operation of irrigation projects, and c) irrigated agriculture management practices.

The development of irrigation projects results in an alteration of the current condition of the landscape. Depending on the nature of the projects, many environment related problems are arising which need to be attended immediately. The important issues created by big irrigation projects involved relocation of inhabitants of a given area, impact on wildlife, particularly endangered species and on archaeological patrimony, environmental impact due to hazardous and toxic materials use during construction, seepage from canals and ditches etc. The environmental impact of supply and operation of irrigation systems depends mainly on water source and how water is delivered to the irrigated land. Withdrawing ground-water may cause the land to subside, aquifers to become saline or depleted to maximum extent, or may accelerate other types of ground-water pollution. Withdrawing the surface water implies changes to the natural hydrology of rivers and water streams, changes to water temperature, and other alterations to the natural conditions, sometimes deeply affecting the aquatic ecosystems associated with these water bodies.

However, due to un-sustainable farm water management practices, in addition to the problems of water logging, salinization, and erosion that affect the irrigated areas, the problem of downstream degradation of water quality by salts, agrochemicals and toxic leachates is a serious environmental problem. Salinization of water resources is possibly a greater concern to the sustainability of irrigation than is that of salinization of soils. The most widespread pollution problem from irrigated agriculture is nitrogen leaching into groundwater. Nitrogen leaching is a problem because nitrogen is used extensively as a nutrient and nitrate moves readily with water through the soil. Nitrate nitrogen above 10 mg/L in drinking water is hazard for some humans (Dahab and Sirigina, 1994), and groundwater under some irrigated areas exceeds this limit (Hallberg, 1986; Hamilton and Helsel, 1995).

Principles of organic water management

- While using groundwater extract only the amount of water that can be replenished through the recharge.
- Apply water efficiently by minimizing losses during delivery to site and application to crops and applying precisely the amount of water as per the crop needs.
- Minimize downstream environmental damage through protecting water quality to protect irrigation water by all possible means and isolating, reusing, or disposing saline drainage water through appropriate technology.
- Grow primarily crops that use less water such as pulses, oilseeds, cereals instead of water consuming crops like sugarcane, banana, rice etc.
- Manage soils to capture and hold precipitation through the appropriate tillage operations before onset of monsoon, crop cover, surface residues, mulches etc.
- Reduce irrigation water applied through applying water as needed to obtain the best economic returns from minimum available water. Deficit irrigation practices can also be followed to delay irrigation until plants reach critical need of water. These practices provide the best economic returns rather than highest yields and are especially important where irrigation water is not sufficient to meet the crop water demands.
- Reuse irrigation water prior to discharge and the use municipal waste water for irrigation after necessary treatment.

Means to achieve it

Micro-irrigation management

The micro-irrigation technologies are the most advanced water application techniques and provide the best economical returns using minimal quantity of water and no environmental hazards. These technologies provide many advantages as listed below;

- Water is supplied through a network of pipe using dripper/emitters, thus no losses during delivery.
- Water is supplied precisely as needed by the crop at a regular interval and at a required time. As the water is supplied to the crop but not to the land, the losses during application are minimum.
- Since evaporation and conveyance losses are negligible, water use efficiency is over 90%.
- Productivity gains vary from 10 % to 50 % depending upon the crop and the irrigation system.
- Water and energy saving to the extent of 50% is obtained.
- Can be used to all types of crops including grain crops, vegetables, fruit crops etc.
- The significant saving in farm inputs and services are obtained.

In organic farming, these technologies will be helpful in increasing the microbial activity significantly as the small water doses are applied frequently; thereby the moisture content is always maintained to field condition; which is favourable for the microbe growth.Similarly, when used in compost preparation, low-volume irrigation technology - whether micro-sprinklers or drip-lines is very effective in preventing the leaching of nutrients and consequently environmental pollution.

Soil water conservation practices

- These practices are useful in all the cropped areas, but it has special relevance in non-irrigated areas. It includes following practices,
- Minimise the steep soil slopes to increase water absorption,
- Conservation practices protect top soil and thus, enhance soil's water holding capacity. An appropriate conservation practices are to be followed for slow water flow downslope.
- Rotations with perennial grasses, adding organic matter to soil, cover cropping minimum or managed grazing need to be practiced.

Crop residue and soil covers

Surface residues are very important in organic water management practices as it conserves soil organic matter, feed soil organisms and cool soil and slow organic matter decomposition. The soil cover facilitates water infiltration by working as cushions against the rain drop impact and crust formation and protecting soil against runoff and erosion. Soil cover also decreases water evaporation.

Other important means to obtain all the benefits of organic water management are mulches and appropriate tillage management.

Some important topics in water management in relation to organic farming

Microbial activity under varied moisture conditions

Soil microbial activity is the basic mechanism which supports the mineralization of the organic matter into the nutrient forms that can be absorbed by plants. The microbial activity depends on many parameters but, the soil moisture content is considered as the controlling factor. Microbial activity depends mainly on soil water content and is maximum at water content where the limiting effects of substrate diffusion and O_2 supply are equal. The results indicated that within the moisture ranges detected in the surface soils, increased moisture stimulated microbial activity, whereas further down the soil profile, where moisture ranges reached saturation, increased moisture inhibited aerobic activities and stimulated anaerobic processes. In drying soils especially water availability was the major factor controlling the microbial respiration and activity (West *et al*, 1992). Both respiration and activity declined continuously as gravimetric water content (W) decreased. Microbial mass also declined, but only after W fell below 0.1-0.3. It was also observed that the microbial mass of the lowest-rainfall soil resisted desiccation better than the higher-rainfall soils. Microbial respiration and activity increased sharply within 30 minutes of rewetting gradually dried soils. These increases appeared to be largely due to the carbon released from micro-organisms, killed by drying, being metabolized by the surviving micro-organisms when water was present.

The salinity of the water was also found to influence the microbial activity to large extent. The research was conducted to find out the effect of salinity levels on the microbial activity in terms of CO_2 emission. The water having five salinity levels viz., 0.65, 2, 3.5, 5 and 6.5 dSm^{-1} were used for this experimentation (Ckar et al, 2002). The results indicated that, the microbial respiration decreased by 21% at 2 dSm^{-1} salt concentration and was decreased to 70 % at 6.5 dSm^{-1} salt level (Table 1).

Organic fertigation

The key to bio-organic agriculture is to establish optimal plant nutrition and production while restoring the soil and its micro-organisms to its natural state. The use of inorganic fertilizers, pesticides and herbicides are forbidden, therefore compost and other organic nutrient sources play a key role. However, the use of natural nitrogen sources for fertilisation through the irrigation system needs special attention. For example, proper filtration, maintenance and periodical flushing of the drip system in order to avoid possible clogging are necessary. One of the major problems that affects the efficiency of irrigation in organic agriculture is the creation of bacterial slime and lime scale, which can decrease the flow rate and even clog the dripper. This problem has been overcome by providing suitable disinfestations that enables the free flow of nutrient-enriched water through the pipes. Few research studies have already been conducted to study the effectiveness of organic fertigation and its impact on the system performance.

The study on organic fertigation was carried out on Aloe Vera at IIT Kharagpur (Shah *et al.*, 2005). In the experimentation, the fertigation of vermiwash was compared with inorganic fertilization and application of only FYM through soil. The results indicated that the vermiwash fertigation resulted into almost similar biometric characters as compared to inorganic fertilization treatments. The yields (gel and biological yields) were slightly less than the inorganic fertilization (Table 2). However, the organic fertigation resulted into significantly superior micronutrient contents in the aloe vera leaves (Table 3).

Effect of fertigation using organic fertilizers products *viz.*, spray dried fish protein and spray dried poultry protein on clogging of different irrigation systems was carried out by Schwankl and Mcgourty (1992). The maximum reduction in the discharge to the extent of 8.3% was observed in Bowsmith gripper dripper followed by Netafin Typhon tubing (7.1%). However, no reduction in the discharge was observed while application of spray dried poultry protein through drip (Table 4).

Mulching in organic farming

Mulching especially organic residue mulches are found very beneficial in organic farming due to the following benefits.

1. Favourable microclimatic condition for healthy microbial activity.

2. Reduced soil compaction: Soil under mulch remains loose, friable and well-aerated. Roots have access to adequate oxygen and microbial activity is excellent.
3. Reduced fertilizer leaching.
4. Enhanced microbial activity due to the addition of the food to microbes.
5. Reduced evaporation: Soil water escapes at reduced rate from under organic mulch. Thus, it results into water saving to the extent of 29 to 32 % and lengthens the irrigation interval. The plant growth on mulch is often at least twice as that on bare soil.
6. Root pruning eliminated: Cultivation is not necessary except for the area between the mulched strips. Therefore, roots are not pruned.
7. Reduced weed problems: Black plastic mulch provides good weed control in the row. Clear plastic will require use of a herbicide or fumigation.
8. Increased growth and yield.

The experimental results indicated the usefulness of bio-mulch in saving large amount of water and increased productivity (Das and Goswami, 2007). The experiment consisted of five organic mulches *viz.*, azolla, rice chaffs, saw dust, Subabhul green leaves and FYM. The rice chaff mulching with intermittent application of water produced almost similar rice yield (4.93 t/ha) as that of continuous submergence of water without any mulch (5.26 t/ha). Thus, this treatment produced 6% less yield but saved almost 30 % water compared to the continuous submergence. Other bio-mulches also showed the similar results (Table 5).

Conclusions

1. Organic water management mainly involves conservation and sustainability of natural resources and thus can be considered as irrigation practices to produce agricultural products at reasonable cost ensuring favourable microbial health of the soil and without degradation to natural resources.
2. Manage irrigation according to the soil moisture levels and crop needs.
3. Manage soil to increase the soil's ability to hold and retain water through an appropriate soil water conservation practices.
4. Conserve water and reduce water loss by evaporation through mulch, cover crop and surface residues.

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Table 1. Effect of soil salinity on microbial activity.

Sr. No.	Ec, dS/m	CO_2 in mg / 100 gm soil
1.	0.5	24
2.	2.0	20
3.	3.5	16
4.	5.0	10
5.	6.5	7

(Source: Ckar et al, 2002)

Table 2. Gel, root weight and biological yield of *Aloe vera* under different fertilizer treatments at 120 DAS

Treatments	Gel yield * (g/plant)	Roto yield * (g/plant)	Biological yield * (g/plant)
Control	36.0	4.0	75.0
$N_{40}K_{20}P_{40}$	43.0	6.3	97.3
$N_{80}K_{40}P_{80}$	43.0	6.3	97.3
$N_{120}K_{60}P_{120}$	61.4	7.2	129.9
Vermicompost + vermiwash fertigation	59.5	9.8	121.0
F.Y.M.	52.6	5.9	116.7
C.D. at 5 %	2.64	0.18	2.79

DAS = Days after sowing (Source : Shah *et al.*, 2005)

* Fresh weight

Table 3. Micronutrient content of *Aloe vera* leaves at 120 DAS

Treatments	Micronutrient content					
	Mg (%)	Zn (ppm)	Cu (ppm)	Mn (ppm)	Fe (ppm)	Co (ppm)
Control	0.708	75	6.2	450	119	Trace
$N_{40}K_{20}P_{40}$	0.764	67	5.8	340	331	Trace
$N_{80}K_{40}P_{80}$	0.832	77	6.4	393	250	3.0
$N_{120}K_{60}P_{120}$	0.848	58	5.8	394	213	4.8
Vermicompost + vermiwash fertigation	1.44	86	9.0	492	154	6.4
F.Y.M.	1.48	79	8.2	239	139	9.6

DAS = Days afer sowing (Source : Shah *et al.*, 2005)

Table 4. Average changes in discharge rates with fertilizer injection, relative to changes in discharge rates for un-injected controls

Emitter	Fish protein % change	Poultry protein % change
Bowsmith Blue Fanjet	-2.1	0.9
Bowsmith Turflow Gripper dripper	-8.3	0.8
Netafim, 1 gph pressure compensating dripper	1.5	-0.3
Netafim 0.5 gph button dripper	0.3	1.9
Bowsmith S-series dripper	-1.8	0.8
Netafim 1 gph button dripper	-0.2	2.5
T-Tape low flow (12" outlet spacing)	-2.0	NT*
Netafim Typhoon tubing (0.45 gph emitters, 18" spacing)	-7.1	NT*

*NT = Not tested

(Source : Schwankl and Mcgourty, 1992)

Table 5. Yield performances of summer rice as influenced by different bio-mulches under limited water supply condition

Treatments	Grains panicle^{-1}		Chaffs (%)		1000 grain weight (g)		Grain yield (t ha^{-1})		Straw yield (t ha^{-1})	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
CS	129	128	22	21	23.1	22.0	5.26	5.15	6.41	6.33
RS	65	64	43	44	17.2	17.4	3.27	3.07	4.42	4.19
AZ	89	87	25	24	19.6	19.5	4.23	4.04	4.95	4.76
RC	101	100	28	28	20.9	20.9	4.93	4.83	5.66	5.60
SD	100	99	29	29	20.7	20.5	4.91	4.77	5.76	5.64
GL	84	82	25	25	19.1	18.9	3.94	3.65	4.90	4.66
F.Y.M.	98	97	25	25	20.5	20.3	4.85	4.69	5.71	5.70
CD at 5 %	12.2	11.2	1.31	4.13	0.40	0.60	0.24	0.17	0.44	0.20

CS = Continuous submergence; RS = Rotational submergence; AZ = Azolla;
RC = Rice chaffs; SD = Saw dust; GL = Green leaf and
FYM = Farm yard manure

(Source : DAS and Goswami, 2007)

Soil resources and organic farming

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India is endowed with a vast and rich diversity of natural resources particularly soil, water, climate and agro-biodiversity. To realize the optimum potential of the agricultural production system on a sustained basis, the efficient management of natural resources is of a paramount importance in organic farming. India with a geographical area of 329 M ha presently supports 17 % of the worlds population on merely 2.5 % worlds land area and 4 % of worlds fresh water resources. As per estimates of NBSS and LUP 187.7 M ha land area (57 % of the total geographical area) is degraded. The water erosion causes about 5334 million tonnes top fertile soil is being eroded annually resulting in the loss of total food production of around 30 million tonnes per year. The soil resource base is also shrinking at an alarming pace of 0.25 M ha per annum due to rapid industrialization and urbanization. As per soil taxonomy the Histosols are considered as organic soil with 20-30 % organic matter content. These soils are covered only 1 % of the world land area confined with cold and wet region.

Organic farming involves a philosophy of improving soil fertility, protecting crop plants and animals through natural methods and system design maintaining the rural environment.

Soil organic matter is central to nutrient storage and cycling in the soil and to providing nutrients to crop and pasture plants at right time in their growth cycle. Soil organic carbon dynamics is of a paramount importance for sustaining long term soil quality and productivity under intensive cropping. It is a well recognized fact that soil organic matter (SOM) is of fundamental importance in soil fertility. It is also a storehouse of all essential plant nutrients and provides energy material for the soil organisms. It also acts as a sink for green house gases between the land surface and the atmosphere.

Although amount of SOM in soils of India is relatively low (ranging from 0.1 to 1.0 % and typically less than 0.5 %), its influence on soil fertility and physical condition is of great significance. The conversion of land from its natural state to agriculture generally leads to loss of SOM. The maintenance of SOC in tropical soils to a desirable levels of 0.5 to 1.0 per cent is extremely important for sustainable crop production.

The addition of organic matter @ 5 t ha^{-1} stubble either every year or alternate year alongwith Leucaena lopping improves the infiltration rate of Vertisols. The bulk density was significantly reduced and water stabble aggregates were increased with stubble incorporation alongwith Leucaena loppings. Soil available water content was significantly enhanced with crop residue incorporation. Wheat straw incorporation @ 10 t ha^{-1} conserve more moisture by regulating the temperature. Organic matter in the form of crop residues serve as major source of replenishing fraction of organic matter and subsequently affect aggregation, porosity and other soil properties. Decomposition product of polysaccharides of organic matter bind discreet structural unit which allow more water to infiltrate and reduces the runoff.

Organic matter is basic source of several nutrient elements. Almost 95 % nitrogen and sulphur resides in organic matter, nearly 70 % of zinc and copper and 60 to 80 % of soil phosphorus is of organic form. Organic matter decomposition produce lignin which shields the nutrients and avoid immobilization in soil. Organic matter addition accelerated availability of iron, zinc and manganese on submergence, reduction in ammonia volatilization losses and buffering of soil pH.

Organic farming promotes and enhances agro-ecosystem health including biodiversity, biological cycles and soil biological activities. Building up the biological fertility and recycle of waste and manures within the system are the concepts of organic farming. Organic farming principle includes biodiversity, integration, sustainability, natural plant nutrition, natural pest management and integrity.

Soils under organic farms showed lower bulk density, higher available water holding capacity, higher microbial biomass carbon and nitrogen and higher soil respiration activities compared to conventional farms.

Soil organic matter induced series of changes in soil physical properties *viz;* crusting strength compaction, reduction in bulk density, water holding capacity, infiltration rate, hydraulic conductivity, proper soil water ratio and oxygen exchange. Addition of organic manures significantly increased the germination and emergence of field crops, improved the soil aggregation, increased water retention, storage capacity and CEC. Thus, organic farming system shows distinct improvement in physico-chemical and biological properties of soils and enhances the soil resource quality.

The decline in partial factor productivity and compound growth rates of major crops under intensive cropping systems and low nutrient use efficiencies are results of deterioration in soil quality.

Soils of India and their distribution

Soil order	**Area (Mha)**	**Per cent**
Inceptisols	95.8	29.13
Entisols	80.1	24.37
Alfisols	79.7	24.25
Vertisols	26.3	8.02
Aridosols	14.6	4.47
Mollisols	8.0	2.43
Ultisols	0.8	0.24
Oxisols	0.3	0.08
Non classified (uncultivable)	23.1	7.01
Total	**238.7**	**100**

Soil Resources

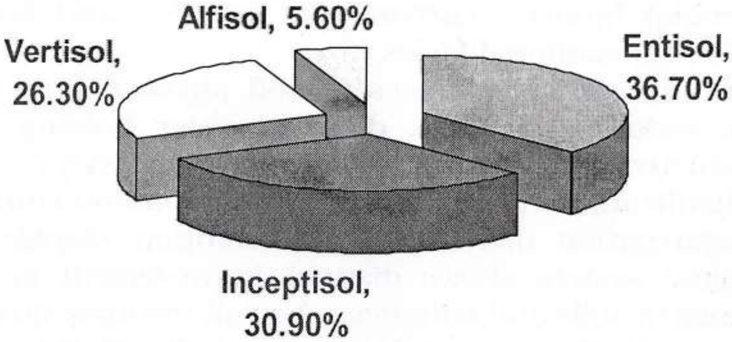
- Alfisol
- Aridisols
- Inceptisol
- Entisol
- Vertisol

Major constraint in soil management

- Low O.M. and fertility
- P deficiency
- Physical degradation
- Accelerated erosion
- Human induced soil degradation
    - Deforestation

- Over grazing
- Loss of top soil
- Salinity and sodicity
- Water logging
- Hard setting soils

Soils of Maharashtra



Key characteristics of organic farming are concept of fertilizing the soil rather than the crop, maintenance of SOM to sustain soil fertility, encouraging soil biological activity, use of Insoluble nutrient sources : flows and flux regulated by microbes, use of legume, recycling crop residue and manures, use of deep and shallow rooted crops in sequence, crop rotation and nutrients through rocks and minerals

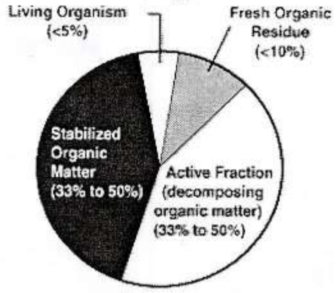
Suitable states for organic farming

States	Total (NPK) kg ha^{-1}
Arunchal Pradesh	2.98
Assam	4.25
Meghalaya	18.05
Mizoram	5.85
Nagaland	1.46
Orissa	51.59
Sikkim	5.01
Tripura	34.74
Himachal Pradesh	47.00
Kerala	56.74
Andaman and Nicobar Island	10.92
Madhya Pradesh	53.42
Chhattisgarh	65.19
Rajasthan	31.33
Goa	34.08
Dadra and Nagar Haveli	42.25
Uttara khand	88.93
Pandichery	1086.30

Edaphic factors as influenced by organic farming are crusting, reduction in bulk density, water holding capacity, infiltration rate, hydraulic conductivity, proper air water ratio and oxygen exchange

SOIL ORGANIC MATTER

- All living or dead patrs of plant and animal origin
- Non-living OM
  - Dissolved in soil water
  - Particulate OM:25%
  - Humus:50%
  - Inert ,Charcoal,Peat-10%



Chemical and microbiological properties of soil from farmers fields under organic and conventional farming systems

Characteristics	Organic sources		INM	
	Depth (cm)		Depth (cm)	
	0 - 7.5	7.5 – 15.0	0 - 7.5	7.5 – 15.0
I. Soil Chemical Analysis				
pH (1:2.5)	7.25	7.25	7.41	7.43
Organic carbon (%)	0.60	0.58	0.53	0.52
Available N (kg ha^{-1})	256	255	224	222
Available P2O5 (kg ha^{-1})	49	49	42	41
Available K2O (kg ha^{-1})	458	459	477	470
Mineral N (ug g^{-1} soil)	70.37	66.00	57.33	54.66
II. Soil Microbiological analysis				
Soil microbial biomass C (mg kg^{-1} soil)	272	264	235	229
Soil microbial biomass N (mg kg^{-1} soil)	39	37	34	31
Dehydrogenase activity (ug TPE g^{-1} soil 24 hr^{-1})	54	51	45	42
Acid phosphatase activity (ug TPE g^{-1} soil 24 hr^{-1})	629	613	603	590
Azotobacter (103 g^{-1})	12.7	10.5	6.3	5.3
P – solubilizing bacteria	9.1	8.8	6.5	6.2

Soil fertility evaluation in organic vs. conventional farms

Parameter	**Organic**		**Conventional**	
	Range	**Mean**	**Range**	**Mean**
Organic carbon (%)	0.19-0.92	0.57	0.30-0.95	0.54
Macro nutrient status				
Available N (kg ha^{-1})	92.0-269.9	154.6	109.9-234.8	156.3
Available P (kg ha^{-1})	6.98-25.53	12.10	7.88-22.40	11.20
Available K (kg ha^{-1})	188.2-887.8	468.3	202.3-879.5	454.1
NH_4N (ppm)	2.72-19.20	6.79	3.30-13.63	6.03
NO_3 N (ppm)	3.24-23.76	9.63	2.88-20.88	8.38

Soil fertility evaluation in organic vs. conventional farms

Parameter	Organic		Conventional	
	Range	Mean	Range	Mean
Heavy metals				
Cadmium (ppm)	0.20-0.34	0.26	0.18-1.80	0.29
Lead (ppm)	1.26-5.96	3.00	1.36-4.16	3.00
Biological activity of soil				
Dehydrogenase activity (µ g TPE / g soil / 24 h)	8.2-246.7	67.3	12.7-155.3	61.7
Phosphatase activity (µ g p – nitro phenol / g soil/ h)	23.2-192.9	100.2	28.6-174.8	94.2
Soil respiration (CO2 – C mg ha^{-1} soil)	132-900	403.4	120-936	393.2

Yield of cotton under different system (kg ha^{-1} for cv. LRA 5166)

Year	Organic	Non – organic
1993-94	464	1159
1994-95	530	652
1995-96	849	651
1996-97	898	623
Soybean – as rotational Crop		
1998-99	2769	1199

Effect of different organics and fertilizer on active pool of nitrogen

Sr. No.	Treatment	SMBN (mg kg^{-1})			Water soluble N (mg kg^{-1})		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
1	Control	10.96	10.35	8.75	4.22	3.99	3.64
2	50 kg N ha^{-1} through urea	15.45	14.7	13.75	6.15	5.81	5.34
3	25 kg N ha^{-1} through *Leucaena* loppings + 25 kg ha^{-1} through urea	12.55	11.75	15.75	5.11	4.34	3.78
	CD at 5 %	1.09	0.75	1.39	0.28	0.26	0.32

Influence of crop residue incorporation on the properties of vertisol

Treatment	Bulk density (Mg m^{-3})	Water soluble aggregates > 0.25 mm	Water retention characteristics (%) 33 kPa
T_1 : Subabul lopping 5 t ha^{-1} every year	1.24	48.83	33.05
T_2 : Sorghum stubble 5 t ha^{-1} every year	1.17	50.61	33.77
T_3 : 50 % subabul lopping + 50 % stubble	1.27	51.13	34.83
T_4 : control	1.35	43.16	29.74
SE m (±)	0.019	0.288	0.246
CD (P=0.05)	0.057	0.851	0.731

Crop residue recycling for carbon sequestration
Effect of different organics and fertilizer treatments on soil microbial biomass carbon, water soluble carbon, water soluble carbohydrates, HA-C content, FA-C content

Sr. No.	Treatment	SMBC (kg ha^{-1})	WSC (kg ha^{-1})	WSCH (kg ha^{-1})	HA-C (%)	FA-C (%)
1.	Control	557	49.7	1293	6.25	8.05
2.	50 kg N ha^{-1} through urea	704	141.2	1193	7.44	9.72
3.	25 kg N ha^{-1} through CR + 25 kg ha^{-1} through urea	982	183.5	1187	15.97	17.81
4.	25 kg N ha^{-1} through FYM + 25 kg ha^{-1} through urea	894	164.0	1331	13.51	15.51
5.	25 kg N ha^{-1} through CR + 25 kg ha^{-1} through *Leucaena*	1217	203.7	1399	16.15	17.99
6.	25 kg N ha^{-1} through *Leucaena* loppings + 25 kg N ha^{-1} through urea	616	126.7	1229	6.31	8.32
	C.D. at 5 %	144	6.6	10.8	0.37	0.72

SMBC – Soil microbial biomass carbon
WSC – Water soluble carbon
FAC – Fulvic acid carbon
WSCH – Water soluble carbohydrates
HA-C – Humic acid carbon

Effect of organic and fertilizer nutrients sources on biological properties of soil under sole sorghum system

Sr. No.	Treatment	Total Bacteria (x 10^6 / g of soil) cfu	Total fungi (x 10^4 / g of soil) cfu	'P' Solubilizing fungi (9 x 10^4 / g of soil) cfu	Azotobacter count (x 10^2/ g of soil) cfu
		S	S	S	S
1	Control	32	24	10	09
2	50 kg N ha^{-1} – Urea	41	31	20	08
3	25 kg N ha^{-1} – Urea	46	29	18	07
4	15 kg N ha^{-1} – Compost and CR + 10 kg N ha^{-1} – Leucaena	62	32	18	22

Nutrient ($N+P_2O_5+K_2O$) uptake in some high intensity cropping sequences in India

Cropping sequence	Yield Mg ha^{-1}	Nutrient uptake kg ha^{-1} yr^{-1}	Nutrient addition kg ha^{-1} yr^{-1}	Nutrient deficit kg ha^{-1} yr^{-1}
Rice – Wheat	8.8	665	400	265
Pigeonpea – Wheat	4.8	630	300	330
Maize – Wheat – G. gram	8.2	645	400	245
Rice – Wheat – G. gram	11.2	735	475	260
Rice – Wheat – Cowpea (f)	9.6 + 3.6 (f)	815	475	340
Soybean – Wheat	7.7	550	300	250
Maize – Wheat	7.7	555	400	155
Rice – Rice	6.3	440	350	90
Soybean – Wheat – Maize (f)	5.8 + 5.1 (f)	930	500	430

f = fodder

Agronomic methods

Contour cultivation

Ploughing, harrowing and sowing operation: across the slope and along the contour, which reduces the length of slope in various compartments and create the barriers and reduces the runoff and soil loss.

Organics for saving of fertilizers

- Green manuring of either cowpea or blackgram in *kharif* followed by *rabi* sorghum.

Conclusion

- ➢ Adoption of appropriate soil and crop management can arrest degradation of fragile soil resources and sustain soil productivity.
- ➢ Crop, land and water management practices should be aimed at improving soil organic matter through carbon sequestration.

Organic farming and climate change

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Climate Change

1. Carbondioxide

The concentration of carbon dioxide in the atmosphere was in a steady state at 280 ppm till the pre-industrial period 1950. It is rising since then at the rate of 1.5 to 1.8 ppm per year. The concentration of carbon dioxide in atmosphere increased from 280 ppm before 1950 to 370 ppm in 2000. It is likely to be doubled by the end of 21st century and in 2005 concentration CO_2 was 380 ppm. Over the same period, the atmospheric concentrations of methane and nitrous oxide have increased by 151 and 17 per cent, respectively. This resulted in an increase in global temperature by 0.6^{0}C, causing the global warming. As a result of the warming, the global mean sea level has risen by 10 to 20 cm (Rao, 2003).

2. Temperature

The Intergovernmental Panel on Climate Change (IPCC) projected the rate of warming for the 21st century to be between 1.8 to 4.0^{0}C. The high global mean average temperatures were recorded consecutively for 16 months during the years 1997 and 1998 (Rao, 2003).

From the past 150 years most warmest 12 years were found to be 1995 to 2006. If the temperature will increase then it will affect the wheat and maize production. The potato yields will also be affect. Even if 1^{0}C increase in temperature it will slide down the wheat production by 50 lakh tonnes (Rai, 2007) and will also affect the gram production. Therefore, there is a great need to develop the varieties of wheat and gram which will favourably respond to warm temperatures and resistance to climate variability.

3. Ozone layer

The global average thickness of ozone is 300 Dibson units, which is equivalent to 3 mm. The ozone losses are caused by chlorine and bromine compounds, which are released by chlorofluorocarbons and halons (Rao, 2003).

4. Earth's orbital variations

In the impact on climate, Earth's orbital variations are in some sense an extension of solar variability, because slight variations in the Earth's orbit leads to changes in the distribution and abundance of sunlight reaching the Earth's surface. Such orbital variations, known as Malankovitch cycles, are the highly predictable consequence of basic physics.

5. Fossil, fuels and desertation

Beginning with the industrial revolution in the 1850s and accelerating ever since, the human consumption of fossil, fuels has elevated CO_2 levels from the concentration of 280 ppm to more than 380 ppm today. These increases are projected to reach more than the 560 ppm before the end of the 21st century. The fossil and fuel combustion and the deforestation each significantly produces more carbon dioxide (CO_2).

6. Aerosols

Anthropogenic aerosols, particularly sulphate aerosols from fossil fuel combustion, are believed to exert a cooling influence.

7. Cement Manufacturing

Cement manufacturing is one of the largest cause of man-made carbon dioxide emission. The cement-making is responsible for approximately 2.5% of total world wide emissions from the industrial sources.

These are some of the major reasons for the climate variability, the climate change and the global warming. These changes have affected the sustainability and also may reduce the productivity of the major cereal crops (wheat and maize) and the potato production in India.

The effects of changes in climate on production level can be estimated, using the same approach.

8. Precipitation, CO_2 concentration and temperature

Climate change will modify the magnitude of the yield reduction due to water stress, changes in CO_2 level will affect the growth rate, the changes in temperature will influence the length of the phonological ges. When evaluating the impact, the effects of each individual factor and the possible interactions and feedback mechanisms should be taken into consideration.

Also the adaptations to mitigate the possible negative effects can be defined in terms relevant to the semi-quantitative approach; the introduction of varieties with a different phonological pattern, the use of manures and fertilizer to optimize the efficiency of nutrients.

9. Effect of global warming on crop yield

This semi quantitative approach makes the use of both knowledge of basic phonological, physiological, morphological and physical process. The analysis starts from a non-limiting production level attainable production, determined only by the crop characteristics, radiation and temperature, followed by the introduction of various yield limiting and reducing factors. For most countries the crop yields are expected to decrease mainly as a result of decreasing precipitation levels (Jan and Frits, 2006). There is a possibility of burning the organic matter of soil and thereby reduce the percentage of organic matter of soil. The cereal crop yields of wheat and maize are likely to be sliding down. There is also a possibility of reduction in the yield of potatos.

10. Effect on crop pest and pathogens

Pest control in organic farming begins by taking the right decisions at right time, such as growing crops that are naturally resistant to the diseases and the pests or choosing the proper sowing times that prevent the pest and the disease outbreaks. The careful management in both time space of planting not only prevents the pests but also increases the populati of natural predators that have natural capability to control insects, diseases and weeds. The global warming may cause rapid growth of pest and pathogens which increase the pest and disease problems.

11. Effect of organic farming on crop pest and disease

The organic crops have been shown to be more tolerant as well as resistant to the insect attacks.

The soil-borne root diseases are generally less severe on the organic farms than the conventional farms, while there is no consistent differences in foliar diseases between the two systems. The successful control of root diseases in organic systems is likely to be related to the use of long and diverse crop rotations, crop mixtures and the regular application of organic amendments.

12. Area of organic farming in India

Only 35% of India's total cultivable area is covered with the fertilizers where irrigation facilities are available and in the remaining 65% of arable land, which is mainly rain-fed, negligible amount of fertilizers are used. The farmers in these areas often use organic manure as a source of nutrients that are readily available either in their own farm or in their locality. The north-eastern region of India provides considerable scope and opportunity for organic farming due to the least utilization of chemical inputs. It is estimated that 18 million hectare of such land is available in the North-East, which can be exploited for the organic production. With the sizable acreage under naturally organic/ default organic cultivation, India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the worlds organic market. There is a need for putting up a clear strategy on organic farming and its link with the markets.

The application of organic manure is the only option to improve the soil organic carbon for the sustenance of soil quality and the future agricultural productivity.

13. Solar radiation and organic farming

Integrated over the whole solar spectrum reflection coefficients range from about 10% for soils with high organic matter content to about 30% for the desert sand (Monteith and Unsworth, 1990). Even a very small amount of organic matter can depress the reflectivity of a soil.

The soil organic matter lowers the thermal conductivity and the heat capacity because of its influence in increasing the porosity to increase the soil productivity.

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Session-II
Recycling of crop residues and animal waste for organic farming

Organic farming in rainfed agriculture : Opportunities and constraints

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Rainfed agriculture

Rainfed agriculture covers about 64% of the net sown area. 91% coarse cereals, 90% pulses, 85% oilseeds, 65% cotton are rainfed. Farming systems are diverse and complex in rainfed agriculture. Livestock farming is an important component in all the production systems. In rainfed agriculture, there is erratic rainfall, low biomass production, droughts and degraded soils, these are the key bio-physical constraints. There are poor resources and risk averse farmers. This is a key socio economics constraint.

The context

There is a emerging nutrient deficiencies even in low intensive rainfed areas. In rainfed agriculture, history of mixed farming, use of legumes in rotation and livestock are an integral component of the farming system. In this system there is strong linkage between the drought coping mechanisms and the organic farming. Mainly extensive areas under low external input use and default organic farming. Many recommended practices of certified organic farming are integral to rainfed farming.

Current status

Historically rainfed farming has been organic in true sense. However, the production levels were quite low but sustainable. There is increased cropping intensity and the use of HYV necessitated external input use. Fertilizer use in drylands is around 30kg/ha as against 100 kg/ha of national average. Farmer level surveys indicated that 0-26% farmers do not use any chemical fertilizers in different districts/crops. Input use largely governed by risk. Non-use of fertilizers is more common than pesticides. 25 % farmers adopt traditional practices of mixed cropping / residue management /mulching etc.

Lessons from past research

Long term data indicate advantages of organics (eg. FYM) both from soil health maintenance and economics point of view. In most cases 5-10t FYM/ha/year is required to replace chemical fertilizers. Its availability is a constraint. In rainfed agriculture, legumes in cropping systems are grown with well documented residual effects. Other options like green leaf manuring, mulch com manuring are effective, but more quantities needed. No data for long term application of smaller quantities. Non competitive production is an issue. Bund farming (eg. *Glyricidia*) emerging as an acceptable strategy. Legume cover cropping using post rainy season rainfall has potential: open grazing and incorporation are the key constraints. By application of biofertilizers- available strains provide upto 10-15kg N/ha equivalent benefit, PSB found more effective, 25% P requirement met in most cases. Better results noticed where integrated with moisture conservation. Still adoption is very low. Now a days vermicomposting picking up momentum. It is largely limited to horticultural/ cash crops. Aerobic on-farm/ phosphocomposting not very popular. Water is a limitation. Good progress in non chemical approaches for pest management. Appears more feasible than meeting the nutrient needs non chemically

Summary

Upto 2 years seed yield and dry matter production was more under the conventional management followed by the organic and control. Runoff and nutrient

loss were relatively less from organic plots as compared to conventional and control. No discernible changes in soil quality parameters noted in 2 years. Seeds contained relatively more linoleic acid in organic management.

Rainfed Crops with Potential

Crop	Scope/Opportunity	Potential Area
Cotton	Demand for organically produced lint. To cut down on chemical use	Maharashtra, A.P., Karnataka, Gujarat
Sesame	Demand for organic sesame seed for medicinal and confectionary uses	Gujarat, Rajasthan
Niger	Demand for organic niger seeds for bird feed in Europe	Tribal areas of different states, in particular Orissa and hhattisgarh
Lentil	Preference for Indian lentil in world markets; organic product to fetch price premium	U.P.
Safflower	Growing market for safflower petals as natural food dye and herbal products	Maharashtra
Finger millet	Scope to export fingermillet flour as health food ingredient	Karnataka, Orissa, Jharkhand
Medicinal herbs	Need for residue free crude drugs	All over India
Ginger/ Turmeric	Demand for residue free spices/natural colors	Orissa
Groundnut	To produce residue/toxin free table varieties	Gujarat
Soybean	Demand for organically produced DOC for livestock feed	M.P.

Observations from field visits

Some farmers (mostly progressive) who practiced for 3-5 years are excited about the prospects. Success stories are documented. Typical economics figures are not available. Family labour costs are not included. Desire to do something different and be known as pioneers is the major driving force than economic returns. However, they became successful models and could motivate others.

Strategies and approaches

Bridging the weakest link; generating validated field data on production packages and viability – major expectation from NARS. Region specific strategy to generate inputs (eg. 750-1200 mm regions to focus on biomass production/ recycling and 300-750 mm regions on FYM/ livestock. Integrate with soil and water conservation – the bed rock of organic farming. Aim at shorter conversion periods and smaller yield reductions during conversion. Overcoming the constraints of certification costs by group formation and concentrate on improving critical yield limiting factors with the farmers who use little or no chemical inputs.

Crop residues : A major source for organic farming

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Agriculture has always been in a transformation mode. Prior to 1966, organic manures were the main source of plant nutrients with the farmers of India. With the introduction of high-yielding dwarf cultivars of field crops (for example wheat and rice), the need for plant nutrients was substantially augmented which could not be met by organics alone because of their low nutrient content. The farming practices that are governed by the principles of ecology have proved to be highly productive and sustainable in several parts of the world.

Several organic materials are available such as farmyard manure, green manure, city refuse, compost, forest litter, sewage sludge, industrial waste water, domestic waste water etc. to be used as organic manures. However, many of them have one or the other limitations for their purposeful use.

For stable economic growth, resources must be used carefully and technologies for effective recycling of waste and residues are to be evolved. Emphasis needs to be placed on farming systems in which soil organic matter is managed through its in-*situ* production using leguminous cover crops, green manures, external addition through lopping and other available organic resources. So with the immense realization that the crop residues are an important natural renewable resource of plant nutrients, which can be used in conjunction with other organic manures and chemical fertilizers for improving the soil health and the productivity, crop residue management aspects have a greater role to play in sustaining the crop productivity and the soil properties.

Crop residues

Crop residues are the parts or portion of a plant or crop left in the field harvesting, or that part of the crop that is not used domestically or sold commercially or discarded during the processing.

Crop residue management

Crop residue management (CRM), a cultural practice that involves fewer and/or less intensive tillage operations and preserves more residue from the previous crop, is designed to help protect the soil and the water resources and provide additional plant nutrients and environmental benefits. CRM is generally cost effective in meeting conservation requirements and reducing the fuel, machinery and the labour costs while maintaining or increasing crop yields. In short, it involves use of the non - commercial portion of the plant or crop for protection or improvement of the soil.

Availability and resource benefits of crop residues

Although more than half of dry matter produced annually in cereals, legumes, root and tuber crops is the inedible phytomass (above ground plant parts), hardly any nation keeps statistics of the crop residues produced as part of the total crop production. The residual phytomass could be calculated from the studies of harvest index or the ratio of crop yield to the rest of crop's above ground phytomass. However, variability of environmental and agronomic factors precludes an exact calculation of the country's crop residue production. From India's annual crop production figures, the estimated residue production from major food crops that are grown on nearly 68 per cent of the country's gross sown area, comes to about 392.58 million tonnes which is nearly 80 per cent of the annual aggregate of crop harvest of major crops

(487.34 mt). Based on recent calculations, the total N, P_2O_5 and K_2O removed by crop residues amounts to approximately 2.321, 0.732 and 4.898 M t per year.

Crop residues from different cropping systems

There are only 10 cropping systems, which are significant as far as crop residues contribution is concerned in India. These are rice-wheat, rice-rice, rice-groundnut, rice-rapeseed and mustard, maize-wheat, cotton-wheat, pearlmillet-wheat, sorghum-wheat, soybean-wheat and sugarcane-wheat.

Rice-wheat cropping system accounts for nearly one-fourth of the total crop residue production in the country. The other cropping systems contribute only marginally. For instance, rice-rice system produces 8.7% of total crop residue production whereas the rice-groundnut and rice-rapeseed & mustard produce 4% each. Pearlmillet-wheat, sugarcane-wheat, cotton-wheat, maize-wheat, soybean-wheat and sorghum-wheat systems produces each between 2 to 3% of the total crop residue production (Sarkar *et al.*, 1999).

Utilization of crop residues

Crop residues are utilized for different purposes since the inception of agriculture. As the civilization advanced, scenario of utilization pattern has also changed. During early days, rice and wheat straw were used for various agricultural and horticultural uses, as feedstuffs, for pulp and paper industry, as fuel and chemicals, for building and allied purposes and for craftwork and packaging. Most of the crop residues are used as animal feed or fuel in rural areas.

Practices of crop residue management

A. *In-situ* burning

The burning of plant biomass is a major source of air pollutants, including carbon dioxide, nitrous oxide and smoke particles. Biomass burning from agriculture crop residues can emit substantial amounts of particulate matter and other pollutants into the atmosphere. With the wide adoption of combined harvesters, large quantities of crop residues are left in the field, which are rather difficult to remove. For quick preparations of field for the next crops, farmers generally prefer to burn the residues in the field. Particularly in rice-wheat dominated areas surplus straw is always available. These surplus residues are disposed off by burning *in-situ*, which results in unavoidable waste of large amounts of essential plant nutrients, organic matter and causes the environmental pollution.

The heat from burning the straw can penetrate in to the soil even up to 1 cm, elevating the temperature as high as 33.8 to 42.2° C. About 32-76% of the straw weight and 27-73 % N are lost in the burning. Bacterial and fungal populations are decreased immediately and substantially, only on top 2.5 cm of soil upon burning. Repeated burning in the field permanently diminishes the bacterial population by more than 50% and also decreases the soil respiration but the fungi appeares to recover. Long-term burning reduces total N and C and potentially mineralizes N in the 0-15 cm soil layer (Biederbeck *et al.*, 1980).

As a result of burning, a number of gaseous and non-gaseous products evolve. It is estimated that 11.5 billion tonnes of CO_2 is released from biosphere into the atmosphere by normal burning on site. Of this crop residue shares 1.83 billion tonnes of CO_2 production/annum (Perry, 1982). Enhanced CO_2 emission contributes to the global warming. Incomplete burning of organic material produces carbon monoxide, a poisonous gas. Its inhalation may sometimes be fatal. Burning of crop residue produces lot of this gases.

The ash production due to the burning of the crop residue decreases effectiveness of applied herbicides in the burnt plot because burnt residue absorbs the herbicide (Ramusseen and Smiley, 1989). Besides gaseous loss of carbon, hydrogen and oxygen through CO_2, H_2O and hydrocarbons most of the nitrogen is volatilized as nitrogen oxide and sulphur lost as sulphur dioxides on burning (Ramusseen & Smiley, 1989). As a result, the nutritional value of burnt residue declines to a great extent.

B. *In-situ* incorporation

Practically it is convenient for the farmers to burn the left over straw in the field as compared to mixing it into the soil (incorporation) or physical removal from the field. The crop residues are incorporated in soil before sowing of the succeeding crop. The period available for decomposition of crop residues is important so as to ensure mineralization of nutrients. The crop residues having wide C: N ratio decomposes slowly in the soil. However, their decomposition is highly influenced by the soil properties, temperature and moisture regime. Sur and Sinha (1982) found longer period for mineralization of rice straw in comparison to that of leguminous green gram, which requires shorter time for decomposition. During decomposition process, soil microorganisms assimilate the carbon of the waste material for the production of new cells. This therefore, leads to decline in availability of plant nutrients due to immobilization. Under water logged conditions the decomposition of crop residue leads to the formation of volatile acids (acetic and propionic acid), which can be phytotoxic (Lynch, 1977).

Many field experiments have demonstrated the beneficial role of straw incorporation on the yield of crops in comparison to removal of residue.

The decomposition of crop residues is a complex microbial process controlled by a number of factors. Among these, biochemical composition of residues exerts an important influence on the decomposition process (Heal *et. al.*, 1997). Besides the C: N ratio of the plant material , many studies have shown that the other biochemical characteristics like initial N concentration, lignin, polyphenols and soluble C compound present in residues are also the key indicators of decomposition.

Residue decomposition occurs in several stages involving chemical and physical transformations. Generally residues with low N content or high C:N ratio has slow decomposition rate (Parr and Papendick, 1978).

C. Composting from crop residues

Composting is the biochemical breakdown of organic substances to humus like substance with narrow C: N ratio, less bulky and comparatively stable than the parent compound. In situations, disallowing adequate decomposition period for the soil incorporated residues; the residues should be managed through composting during the crop season. Composting of two parts of organic residues with one part of fresh animal dung has been assessed to be an efficient method of compost making. On the other hand, residues of N_2-fixing leguminous crops, relatively rich in N, have tested potential for beneficial recycling in the crop sequences even without being subjected to pre-cropping decomposition.

It is observed that C:N ratio of 30 (26 - 40) of raw material is most favourable for efficient composting. When the organic materials are poor in nitrogen, i.e. C:N ratio is wide such as in cereal residues of wheat, paddy, sorghum, pearlmillet, maize, sugarcane trash (C:N ratio 60-90), stalks of cotton, jute and sawdust (C:N ratio <100), microbiological activities diminish, as they do not get sufficient amount of nitrogen. Consequently several cycles may be required to degrade carbonaceous materials and this may prolong the period of composting. On the other hand, if C:N ratio is low i.e.

less than 30, the proportion *of* nitrogen is in excess *of* the requirement of microorganisms, consequently, the process of decomposition is faster (Yadav *et al.* 2005)

D. Crop Residue as surface mulch

Mulching of crop residue is an age-old practice. The reflectivity of heat and water transmission characteristics of mulched soil are quite different than its bare counterpart. Soil loss through erosion is reduced considerably by mulching and so also its energy balance and hydrothermal regime. Proper use of crop residue is an effective mean for reducing runoff, erosion and transport of sediment to stream (Verma *et al*, 1979). The beneficial effect of crop residue mulch on soil moisture and temperature changes, influences the different plant processes like seed germination, seeding emergence and the root growth which in turn determine the growth and the yield of crops (Prihar and Arora, 1980).

Although organic mulches also supply nutrients to the soil as they decompose, many require the additional nitrogen during the decomposition process. This is especially true of mulches containing the high amounts of cellulose, such as straw and leaves. During the decomposition soil micro organisms cannot get enough nitrogen from these materials to adequately break them down, so they absorb additional nitrogen from soil reserves, making it temporarily unavailable to the crop, leading to possible nitrogen deficiency.

Factors affecting decomposition of residues

Depth of incorporation, soil and climate are the main factors responsible for decomposition of the residues. Weight loss and nutrient release are commonly used to describe the decomposition rate of the plant residues. Usually the annual decomposition of straw ploughed under field condition is about 60 % (Wessen and Berg, 1986). The weight loss generally proceeds more rapidly in the upper ploughed layer than in the lower ploughed layer. Kanal (1995) found that drastic fluctuations in temperature and moisture cause greater variation in the decomposition rate in the upper ploughed layer than the lower layer. Microbes present in soil and in crop residues also influence the decomposition. The major influences include the following

i. Size of the residue

Properly managed crop residues bring about considerable improvement in soil fertility and in crop productivity. But, most organic residues available for land application need some kind of shredding for convenient incorporation in the soil, such as rice straw, sugarcane trash, sunflower and safflower stover etc. need the chopping for proper microbiological decomposition. At the same time, effective mechanical means to accomplish this task are generally not available, though efforts have been made in recent years to fabricate suitable machine tools for chopping of plant materials. Such cost-effective machinery is required in order to make plant residue recycling a popular practice.

Machine harvested straw (wheat, rice) needs some kind of shredding for convenient incorporation in to the soil. The smaller the size, the greater is the surface area for microbes to act more efficiently.

ii. Time of incorporation

Adequate decomposition of the incorporated materials is essential for obtaining good benefits, not only by way of crop nutrition but also in terms of the improvements in soil fertility and tilth. If sufficient time is available between residue incorporation and the sowing of succeeding crops, significant beneficial effects are observed on the yield of succeeding crop (Pandey *et al*, 1985). Studies have shown that 30 days might be an appropriate pre-cropping period for decomposition of crop residues from crop production point of view. The large quantity of fertilizer N is converted into organic form in a short period of time when applied at the time of residue incorporation (Toor & Beri 1991; Patil & Sarkar 1993). Despite adequate application of fertilizer N, Pathak and Sarkar (1994) found some harmful effects of rice straw incorporation on nitrogen use efficiency and the yield *of* wheat crop.

iii. Amount of residues

Amount of crop residue added to the soil has a direct influence on the C: N ratio of the soil, which determines the decomposition kinetics of the residues. Higher amount of residue incorporation leads to more microbial biomass that assimilates more N for immobilization. On the other hand, it also requires more N, time and oxygen to decompose. Several studies at various locations have indicated that the addition of 5 tonnes or less quantity of residue is an appropriate amount for its effective utilization. The results of some experiments conducted at PAU have shown that the application of 4 t ha^{-1} of wheat straw before rice and 4 t ha^{-1} rice straw before wheat, proved beneficial in improving the yield rather than single application 8 t ha^{-1} of residue of rice/wheat to either wheat or rice (Sidhu and Beri, 1989 and Beri *et al*, 1995).

iv. Decomposition of repeatedly added crop residues

Continuous addition of the dead organic materials to the soil in form of stubbles, leaves, crop residues and microorganisms are subjected to decomposition by the external factors. Addition of large amount of residue to the soil inevitably, increases the biological activity in the soil and this may influence the rate of decomposition of organic materials remained from previous additions, which are technically known as *"the priming effect"* (Jenkinson, 1966 and Sorenson, 1974). The overall pattern of decomposition of residues was similar, whether the soil was amended with one or several successive additions (Sorenson, 1979).

v. Decomposition of residue by macro and microorganisms

On incorporation in the soil, the organic materials are subjected to intense biodegradation by the intervention of soil biota including earthworms, bacteria, fungi, actinomycetes and protozoan species. The microbial numbers and microbial activity are greatly enhanced even when organic materials are used as soil mulches (Singh, 1991). Though major role in the overall process of decomposition is played by microbiota, macrobiota such as earthworms also contribute significantly to the breakdown of plant residues (Mackay and Kadivko 1985; Ramesh and Gunathilagaraj 1996). In fact, in recent years, the role of earthworms has come as a added prominence in the quick processing of organic wastes into compost. This technology is known as vermicomposting. Earthworms degrade all types of organic wastes such as agricultural waste, animal droppings, weeds, industrial effluents, forest leaf litter etc. The studies conducted at UAS, Dharwad on suitability of crop wastes indicated that the paddy straw, sugarcane trash, maize vegetable waste etc., favour faster development of earthworms.

Most of the decomposition of the added organic materials takes place within two to three weeks and the process gets almost stabilized in four to five weeks. The residues rich in lignin viz, stalks of cotton, pigeonpea etc, *vis-a-vis* other waste would take relatively more time to degrade. This aspect is important to decide the optimum time period that must be allowed for the decomposition of the added organic matter before the succeeding crop is planted in the soil. Straw populated with organism is capable of decomposing readily available substrate.

vi. Decomposition of the residues in tropical /subtropical soils

Under tropical environments, the rate of decomposition of residues is generally very high due to high temperature and microbial activity. Under such environments the recovery of N by the plants was 25% after 130 days. Rice residue, which is low in N, absorbed N from soil and from added fertilizer during its decomposition (Tadakatsu and Yoshida, 1977).

vii. Tillage and residue decomposition

Deep tillage helps in the rapid decomposition of crop residues as it comes in intimate contact with soil having fovourable hydrothermal regime. On the other hand, the residues left on the surface are subjected to maximum fluctuations in moisture and temperature. In many cases of surface applied residues, the moisture is a limiting factor whereas, in other cases, the temperature is either too low or too high for the decomposers to act efficiently. Beneficial effects of conservation tillage over conventional tillage have been observed (Jat *et al.*, 2001) wherein growth of wheat was better where sowing was done with zero and strip-till drills in standing residues of rice, compared to incorporation of residue with conventional methods of tillage.

Effect of residue management of crop yields and soil properties

Various experiments on crop residue management are being carried out in varied agro-climatic zones having diverse soil conditions and management practices. At Ludhiana, incorporation of rice straw either 20 or 40 days before sowing of wheat produced grain yields of wheat comparable to the complete removal or burning of the residue (Bijay-Singh e*t al*, 1999). Application of 25% of the total N at the time of residue incorporation (to hasten decomposition) of straw led to high N losses. Rice grain yield, N uptake and recovery efficiencies were also not influenced by the rice residue management treatments applied to preceding wheat (Bijay-Singh *et al.*, 1999). According to Singh and Yadav (2006) rice residue incorporation gave significantly a higher yield over residue-removed and residue-retained treatments. Also, incorporation of rice residue led to higher nitrogen uptake and N-use efficiency registered was 12.6 and 2.3 per cent more over rice-residue retained and rice residue removed treatment, respectively. Addition of soybean straw in combination with $3/4^{th}$ recommended fertilizer dose recorded sorghum yield levels and available nutrients status of soil comparable to recommended fertilizer dose. Soybean straw incorporation significantly increased the organic carbon status of soil as well (Anonymous, 1999). The studies on soil microbial population under different residue management practices (burning, removal and incorporation) showed that the bacterial and fungal population after harvest of rice and wheat was higher under residue incorporation followed by burning and removal (Sidhu *et al.* 1995).

The generation of substantial quantity of microbial biomass in soil is an important consequence of crop residues incorporation. The residue incorporation into soil always leads to increased bacterial and fungal activity. Enhanced growth and nitrogen fixing activity of asymbiotic and associative nitrogen fixing bacteria is another practically significant change brought about in soil on the addition of crop residues. Beri *et al.* (1992) reported that soil treated with crop residues inhabited 5-10 times more aerobic bacteria and 1.5 to 11 times more fungi than those residues which were either burnt or removed.

Conclusion

Crop residue addition has many benefits. With the present estimate, It has a nutrient potential equivalent to 3.724 M t of N + P_2O_5 + K_2O half of which will be of immediate benefit replacing about 10 % of the total fertilizer nutrient consumption at present and the rest half will serve as a reserve for subsequent seasons. Besides the chemical influences, it benefits the soil physically and biologically with resultant increase in crop production. Thus it can sustain the agricultural production. The crop residues also have certain limitations. Its adequate decomposition is essential for obtaining good benefits, decomposition is a problem for residues with high C:N ratio. Its decomposition under anaerobic condition causes the nitrogen loss through denitrification and production of phytotoxic acetic acid. Of course, comparing to the benefits, such negative influences is negligible if residue is properly managed. The crop residues be utilized through proper recycling in soil rather than burning unnecessarily.

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Synergies between livestock production and organic farming

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"Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasises the use of management practices in preference to the use of off-farm inputs, taking into account the regional conditions require locally adapted systems. This is accomplished by using, where possible, the agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system" (FAO/WHO Codex Alimentarius Commission, 1999).

Organic farming and productivity

A 22-year farm trial study by Cornell University published in 2005 concluded that the organic farming produces the same corn and soybean yields as conventional methods, but consumes less energy and contains no pesticide residues. However, a prominent 21-year Swiss study found an average of 20% lower organic yields over conventional, along with 50% lower expenditure on fertilizer and energy, and 97% less pesticides. A major US survey published in 2001, analyzed results from 150 growing seasons for various crops and concluded that the organic yields were 95-100% of conventional yields and overall result remained "inconclusive". In livestock sector also the following case studies have been reported from different countries.

Table . Production performance of dairy animals under conventional and organic production systems in selected countries.

Production	Conventional	Organic Production system
Switzerland		
No. of herds	40	17
No of cows per herd	24	27
Milk (kg/cow/year)	7280	6550
Concentrate	680	450
France		
No of cows	32	35
Farm land (ha)	35	37
Milk production	7260	5130
Fat corrected	8900	6000
Concentrate	1150	570
Concentrate (g/kg milk)	128	95
Feeding cost (Euro/lt	20.4	19.3
Sweden		
Milk fever	4.7	4.5
Mastitis	9.1*	14.7
Trodden teat	0.3*	1,8
Retained placenta	0.1*	2.3
Ketosis	0.1	1.74
Hoof disorders	1.1	1.4
All disorders	20.6**	33.1

In fact, many multiple cropping systems, such as those developed by small holders and subsistence farmers, show the higher yields in terms of total harvest per unit area. These yield advantages have been attributed to the more efficient use of nutrients, water and light and a combination of other factors such as the introduction of new regenerative elements into the farm (e.g. legumes) and fewer losses to pests and diseases. It can be concluded that the increased yields on organic farms are more likely to be achieved if the departure point is a traditional system, even if it is degraded. The results will vary depending on management skills and ecological knowledge, but this can be expected to improve as human capital assets increase.

Indian Scenario

In India there is an increased emphasis on the organic agricultural production. The major initiative towards orienting Indian agriculture towards organic production was taken by APEDA in 2000 by setting up of standards for organic crop and livestock production and accreditation bodies. As a result some of the commodities are being produced and marketed /exported as organic. As per an FAO study of mid-2003, India has 1426 certified organic farms producing approximately 14,000 tons of organic food annually.

The organic farming products are those which have been produced, stored, processed, handled and marketed in accordance with the precise technical specifications (standards) and certified as "organic" by a certification body. The organic label applies to the production process, ensuring that the product has been produced and processed in an ecologically sound manner. The organic label is therefore a production process claim as opposed to a product quality claim.

Livestock farming is an integrated component of organic production system as livestock is the key intermediate link between the utilization of crop residues or fodder produced at the farm and the recycling of the nutrients as manure. Animal dung, crop residues, green manure, bio-fertilizers and bio-solids from agro-industries and food processing wastes are some of the potential sources of nutrients of organic farming. While animal dung has competitive uses as fuel, it is extensively used in the form of farmyard manure. The development of several compost production technologies like Vermi composting improves the quality of composts through enrichment with nutrient-bearing minerals and other additives. These manures have the capacity to fulfil the nutrient demand of crops adequately and promote the activity of beneficial macro-and micro-flora in the soil.

The basic requirement in organic farming is to increase input use efficiency at each step of the farm operations. This is achieved partly through reducing losses and adoption of new technologies for enrichment of nutrient content in manure. Technologies to enrich the nutrient supply potential from manure, including farmyard manure three to four times are being widely used in organic farms. According to a conservative estimate, around 600 to 700 million tonnes (mt) of agricultural waste is available in the country every year, but most of it is not used properly. We must convert waste into wealth by converting this biomass into bio-energy, nutrients to starved soil and fuel to farmers. India produces about 1800 mt of animal dung per annum. Even if two thirds of the dung is used for biogas generation, it is expected to yield about 440 mt per year of manure, which is equivalent to 2.90 mt N, 2.75mt P_2O_5 and 1.89 mt K_2). The application of organic manure is the only option to improve the soil organic carbon for sustenance of soil quality and future agricultural productivity.

Key characteristics of organic agriculture

- Protecting the long-term fertility of soils by maintaining organic matter levels, fostering the soil biological activity and the careful mechanical intervention;
- Providing crop nutrients indirectly by using relatively insoluble nutrient sources which are made available to the plant by the action of soil microorganisms;
- Nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation, as well as effective recycling of organic materials including crop residues and livestock wastes;
- Weed, disease and pest control relying primarily on the crop rotations, natural predators, diversity, organic manuring, resistant varieties and limited (preferably minimal) thermal, biological and chemical intervention;
- The extensive management of livestock, paying full regard to their evolutionary adaptations, behavioural needs and animal welfare issues with respect to nutrition, housing, health, breeding and rearing;
- Careful attention to the impact of the farming system on the wider environment and the conservation of wildlife and natural habitats.

In India the use of organic manures predominantly the livestock wastes in subsistence farming is an age old practice. The organic manures improve physical, chemical and biological properties of the soil. Addition of organic manure improves structure aeration, water holding capacity of soils reduces phosphorous fixation in acidic soil forms chilates with metallic ions and reduces their toxicity in crops. Farm Yard Manure is an important source of plant nutrients. FYM is composed of dung, urine, bedding and straw. FYM contains approximately 5-6 Kg N, 1.5-2 Kg phosphorus and 5-6 Kg potash/ ton. It builds up soil health considerably.

Techniques for effective utilization of animal wastes

- Composting
- Biogas production (Anaerobic fermentation)
- Aerobic Oxidation in Ditches/Lagoons/ Lakes
- Direct application
- Use as Fish Feed in Fish ponds
- For growing Algae (Diluted Slurry)

Composting

The process of decomposing organic wastes (organic biomass, cow dung or biogas slurry) is called composting. The decomposed materials are called compost.

Methods of composting

There are various methods of composting which are as under.

1.	Indore method	-	Pit Method
2.	NADEP compost	-	Tank Method
3.	Bio dung compost	-	Heap Method
4.	Bio-digested slurry	-	Biogas Plant
5.	Vermicompost	-	Earth worm
6.	Bangalore method	-	Anaerobic composting
7.	Coimbatore method	-	Semi - Aerobic compost
8.	Super compost	-	Addition of Super Phosphate

Vermicompost: It is 5 times richer in N, 7 times in P, 11 times in K, 2 times in Mg, 2 times in Ca than ordinary soil. It is a rich source of vitamins and growth hormones like gibberling which regulate the growth of plant and microbes. The compost prepared by using earth wiring is called vermi-compost.

- Vermicompost is the excreta of Earthworm which is rich in Humus
- Artificial rearing or cultivation of Earthworms
- Earthworm eat Cow Dung or FYM along with other farm wastes and pass it through their body & in the process convert it into Vermicompost

Advantages of Vermi Compost

- Eco-friendly natural fertilizer
- Improves soil aeration, texture, tilth and water retention capacity of soil
- Improves nutrient status of soil both macro and micro nutrients
- Promotes better root growth and nutrient absorption
- It does not have any adverse effect om soil, plant and environment

Organic/Bio-manure

- Contains micro and macro nutrients such as Nitrogen, Phosphorus potassium & fair amount of Manganese, Zinc, Copper and Iron.
- It increases the microbial activity in soil
- Improves soil structure, water holding capacity, seed germination and reduction of soil erosion
- It is extremely essential for better crop productivity and maintaining the fertility of soil to ensure sustainable production

Farm Yard Manure (FYM): It is an important source of plant nutrients. FYM is composed of drug, urine, bedding and straw. FYM contains approximately 5-6 Kg N, 1.5-2 Kg phosphorus and 5-6 Kg potash/ ton. It builds up the soil health considerably.

- Decomposed mixture of cattle dung and urine with straw and litter used as bedding material and residues from the fodder fed to the cattle.
- The waste material of cattle shed consisting of dung and urine soaked in the refuse of the shade is collected daily and placed in trenches about 6-7 m long, 1.5-2m broad, 1m deep.
- Each trench is filled upto a height of about 0.5 m above the ground level.
- The heap is to be made dome shaped and plastered over with cow dung earth slurry.
- It becomes ready to apply after 3- 4 months
- 7- 8.5 cubic meter of manure (5- 6 tones or 10-12 cart loads) per year per head of cattle.
- Well rotten FYM contains

Recycling livestock waste through BIOGAS system

- The technology is particularly valuable in agriculture, waste treatment or animal processing units where there is excess manure (e.g. cattle, pig, chicken) or farm waste
- Small scale farmers that keep zero grazed pigs >10 or dairy cows > 3 are good candidates for installing household biogas unit
- Besides being rich in plant nutrients (nitrogen 1.5-2.0 %, P_2O_5 1.0 % and K_2O 1.0 %), it is also a good source of micronutrients like Zn, Fe, Cu and Mn.

- One ton of biogas slurry on dry weight basis will provide approximately 18 kg of nitrogen, 10 kg of P_2O_5 and 8 kg of K_2O which is equivalent to 40 kg of urea, 63 kg of single super phosphate and 14 kg of murate of potash.

Cow dung meal

- It can be used at 10 % level in growing ration in replacement of maize
- In layers 10% inclusion of cow dung manure satisfactorily supported egg production, egg weight, body wt, hatchability and feed consumption.

Dried poultry manure

- Rich in Nitrogen (60- 90 % of urinary nitrogen as uric acid) and energy. Digestibility ranges from 70 –75 %
- It can be used at 10 –15 %level in chick and broiler rations with good results.

To conclude, the organic farming needs to be promoted on a large scale as it has immense potential and productivity is likely to be only marginally affected. It is likely to be more profitable in many regions of the country. Wherever organic crop production has been promoted it needs to be integrated with organic livestock production for the recycling of nutrients for sustaining the productivity levels under organic management.

Recycling of organic wastes for organic farming

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Recycling of organic matter and nutrients embedded in waste materials of farm, city and agro-industries etc. has become an issue of global importance. Often, there is the desire and frequently the economic necessity, to integrate the use of wastes in agriculture to supplement the nutrient requirement of crops in a beneficial manner. By doing so, we not only aim to conserve the natural resources but also bridge the gap between demand and supply of fertilizer essentially required for food security of our country. In addition, organic matter added through waste has well proven beneficial effects on soil health and quality. Therefore it is essential to develop cost effective, eco-friendly and appropriate technology that maximize the economic value of the nutrients contained in organic wastes for sustainable development with minimizing the adverse impact on natural resources. Recycling the organic wastes such as crop wastes animal manures FYM poultry manures etc. aimed to enhance the crop growth whereas municipal solid wastes and agro industries wastes regarded primarily as waste and safe disposal and not the crop production.

It is in this context of composting of crop residues and the wastes of city and agro-industries has often been proposed as an appropriate technology.

Composting for sustainability

Overwhelming evidence have been gathered from long term fertilizer experiments to demonstrate the significance of organic manures/compost for sustaining the high productivity levels of crops under different agro climatic zones (Swarup *et al.*, 1998). In fact recycling of crop residues and use of compost in agriculture reveals to be a sustainable practice. The use of compost supplements the nutrient requirement of crops as well as avoid expensive energy required for safe disposal of wastes. The preparation of compost from city wastes and utilization in crop production avoid an improper fate of wastes, with indirect benefit for the human society; the epidemic at Surat and Delhi in last couple of years are examples of this benefit. The low cost of compost is useful to the farmer, as well as to human society.

Composting

Microbial decomposition of crop residues and wastes of municipal and agro-industries is a highly complex process in which diverse group of microorganisms work in cooperative manner. Composting can be defined as the biological decomposition and stabilization of organic substrates, under conditions that allow the development of thermophilic temperatures as a result of biologically produced heat, to produce a final product that is stable, free of pathogens and plant seeds and can be beneficially applied to the land.

The compositing plant itself is a biological fermentation facility, designed to take feedstock and process them through microbiological means to produce desired product. As the quality of product depends upon the raw materials. It is therefore essential to understand and learn more about the nature and characteristics of waste available as feed stock for compositing. Microbial decomposition is a natural process in which microorganisms breakdown complex organic-mineral compounds present in wide range of organic wastes or bio-solids in the presence or absence of oxygen. This process has been producing humus in soils for millennia. The scientists have to develop appropriate compositing technologies for wide range of bio-solids in order to produce nutrient rich compost and to hasten the process itself to enable the transformation of voluminous wastes materials into valuable products. Nevertheless, more still remains to be learn about how certain changes promote the rate of decomposition process and how they affect quality of compost produced.

Organic wastes available for recycling

A number of waste materials are produced at farm and in city. Rapid industrialization has also contributed to the production of number of organic wastes in large volume. We all are familiar with the farm waste materials.

Some of the organic wastes produced in agro-industries are listed in Table 1 which have potential for use in agriculture. It is evident that nitrogen content in these wastes is far greater compared to common residues available at farm. This characteristic alone has promoted their utilization in agriculture, despite certain problems of heavy metals associated with their use.

Crop residues

Residues left over in field after harvest of crops at threshing floor are the main source for recycling the organic matter and nutrients in agriculture. These residues have many competitive uses such as fuel and cattle feed. For example, there was an estimated demand of 583.6 million tones of dry fodder against the supply of only 398.8 million tones for the vast cattle population in the country (Singh, 1997). The projected demand of dry fodder for cattle population has been estimated to be 632.6 million tones against the availability of 523.6 million tones from expected increase in the production of food grains. Beside use of residues as cattle feed, emerging scarcities of the conventional plant resources for industrial use have further begun to draw upon the crop residues as raw materials for certain industrial purposes. Like bagasse is now being used as raw material in paper manufacturing and co-generation of electricity. Due to these economically viable competitive uses, a small fraction of crop residues is presently available for recycling in agriculture.

Reliable estimates of the annual availability of crop residues in the country are lacking. No sample survey data to provide information on the availability of crop residues and their competitive use are presently available. However, Bhardwaj (1995) made an attempt to arrive at estimates of the crop residues of some principal crops on the basis of yield data of 1991-92. Estimates of residues availability was computed on the basis of the ratio between residues to economic produce yield (Table-2). It was assumed that not more than one-thirds of total crop residues were available for recycling. Bhardwar (1995) reported that of the total 5.6 million tones of N + P_2O_5 +K_2O available in the form of crop residues, only 2.4 million tones of nutrients are the actual recyclable quantity of the crop residues with fertilizer equivalent value of 1.23 million tones in agriculture. Based on these estimations, Sekhon (1997) projected that roughly 4.82 and 5.79 million tones of total N + P_2O_5 +K_2O will be potentially available from crop residues by the year 2011 and 2025 with utilizable value of 2.21 and 2.66 million tones, respectively. Damoder Reddy and Subba Rao (1998) also estimated that about 37.6 million tones of crop residues are available annually in the country. They assumed that roughly 50% of the available residues are utilized as cattle feed and fuel. Remaining residues if recycled has potential to provide roughly 3.8 million tones of total nutrients per annum which account for roughly 25% of total annual fertilizer NPK consumption in India.

In all the estimations available so far, residues to economic yield ratio of 1-5 for rice, wheat, sorghum, maize etc. have been used. Inclusion of crop residues of wheat, sorghum, pearl-millet and maize etc. as residues available for recycling in agriculture is often questioned because of their use as precious feed for cattle. We all are aware of the fact that cereals breeding programmes has greatly emphasized on increase in harvest index with the result that in high yielding varieties, proportion of straw to grain yield has lowered considerably. It is evident that grain yield has increased considerably but straw/Stover yield have decreased. The straw to grain yield ratio of some varieties of rice, wheat, maize, sorghum and finger millet are given in Table 3. It is evident that ratio used for estimating crop residues availability in the country in earlier estimations were on higher sides for paddy and wheat crops.

Availability of crop residues on the basis of food grain production and residue to grain ratio of HYV, it has been estimated that about 265.4 million tones of residues are available at present (Table 4). Residues of wheat, sorghum, maize, pearl millet etc. are primarily used as cattle feed. In situations of combine harvest of wheat, however, significant proportion of wheat straw is left over in field. This residue is often burnt *in situ*. Residue of rice is, however, available for recycling in agriculture. Katyal and Reddy (1997) however observed that especially under rain fed ecosystem crop residues found more completive use other than application in fields. Under irrigated ecosystem also limited amount of crop residues are presently available for recycling. The sugarcane trash is also available in an enormous quantity in India. It contributes about 8 to 12 per cent of millable cane and on an average a hectare of the sugarcane crop leaves behind 9 to 10 tones of trash. The scientists showed its utilization for soil improvement or crop yield (Table 5-8) through direct incorporation or by composting (Gaur 1986; Shinde *et al.* 1985; Rasal *et al.* 1988).

Plantation Crops

Plantation and spice crops are important commercial crops grown in Assam, Kerala, Karnataka, Tamil Nadu and West Bengal. Large quantities of biodegradable wastes viz., coir dust, husk, dried leaves, pruning, coffee husk, tea wastes, oil palm wastes etc. are available for recycling of organic matter and nutrients. Recycling of these wastes after composting have potential to supplement the nutrients requirements of crops. Nair *et al.* (1997) reported that 165 thousand tones of N + P_2O_5 + K_2O can be supplied through wastes of plantations crops (Table 9).

Very large quantities of wastes and organic materials are also generated from the processing of palm oil and rubber. Palm oil mill effluent is rich in nitrogen and contains 1,194 mg N/L with solid contents of 67,000 mg/l.

In Malaysia and Thailand, Lim (1998) reported that land application of POME and rubber effluent by the furrow system improved yields in oil palm and rubber fields, while application by sprinklers and flatbed systems led to increased oil palm yield (Table 10). The yield increases have been attributed to the nutrients in the effluent and better soil chemical and moisture retention properties.

The soil-plant system is effective in removing N in the effluent. Results from field monitoring also indicate little to nil groundwater contamination from the application of moderate amounts of rubber effluent and POME. Uncontrolled application could, however result in excessive amounts of the effluent being leached into the groundwater and in surface runoff.

Mulching with pruning and wastes of plantation crops at a rate of up to 40 t ha^{-1} have improved oil palm growth and yields. Yield increase due to mulching exceed the effects of fertilizers alone. In cocoa and coconuts, the principal waste materials are the cocoa pods and coconuts husks and recycling of these nutrient rich materials in the fields is also beneficial to the crops.

Fruits and Vegetables

India produces around 33.0 million t of fruits (Chadha and Bhargava, 1997) and 50 million t of vegetables annually. It is estimated that roughly 10 to 15 per cent of total produce is available either as residues or biodegradable wastes for recycling in agriculture (Nand *et al.*, 1966). In addition, processing of fruits and vegetables results in the production of around 5.0 million tones of solid wastes (Table 11). Most of these wastes are lignocellulosic in nature and contain macro and micro-nutrients (Table 12). A number of them are deficient in nitrogen and also contain some toxic materials. Tomato processing wastes are rich in hemicellulose and proteins. All these are biodegradable and have potential to supply organic matter and nutrients in agriculture after composting.

Leather industry

The vast cattle population in India provide sufficient raw materials for the leather industry. There are roughly 3000 tanneries processing about 6000 tonnes of hides and skins annually. Large amount of solid and liquid wastes are generated in tanneries containing heavy metals as well as plant nutrients. Solid wastes contains very high concentration of nitrogen because of protein (>40%), lipids and carbohydrate contents (Table 13). It is estimated that about 0.1 million tones of solid wastes are generated in tanneries annually. Co-composting of these solid wastes with crop residues of high C:N ratio could provide good quality compost for use in agriculture. Problems of heavy metals associated with leather industry wastes could be effectively managed through co-composting and bioremediation.

Poultry

Poultry industry has achieved significant growth in the last two decades. Presently, there are about 60,000 poultry farms India today ranks 5^{th} in the world in respect of table egg production with 30,000 million eggs/annum and 22nd in respect of poultry meat production.

Poultry sector not only produce nutritive egg and meat but also generate wastes of high economic value like poultry manure and hatchery wastes. It is estimated that the fertilizer value of manure from only 3 birds on deep litter is superior in value from one cow. Average daily fresh manure production for broilers ranged between 70-80 kg/1000 kg live weight.

Poultry manure and litters contain high amount of N, P and other nutrients (N 3.5%; P 1.6%; K 1.8%). Use of such litter as soil amendments for agricultural crops provide appreciable quantities of all important plant nutrients. As an example, the application of 9 M/ha and other micronutrients. Direct application of poultry manure often provides more nutrients than required by the crops, as there is no synchrony in nutrients release and crop uptake.

The majority of N excreted in poultry manure is in the form of uric acid, that is rapidly converted to urea and NH_4-H. This is responsible for higher losses of N from poultry manure during storage and handling. Estimates of N loss range from 10 to 80% of the excreted N (Sims and Wolf, 1994). Maximizing the nutrient value of poultry wastes, therefore requires the use of practices like Co-composting with high C:N ratio crop residues or municipal solid wastes that will optimize N conservation.

Poultry waste also contains a large and diverse population of viruses, bacteria, fungi and protozoa. Typical total viable counts of 10^8 to 10^9 (CFU/g dry wt.) in wastes have been reported (Nodar *et al.*, 1990). Some of the microorganisms are diseases causing. Direct application in soil therefore poses a serious health problem. The most frequent pathogen commonly found are clostridium spp. and Salmonella spp. (Alexander *et al.* 1968).

Co-composting of poultry liter/manure is very effective process for eliminating the pathogens from poultry wastes. The implications of long term use of poultry manure on the economics of soil fertility management and potential impact of excessive nutrients on soil health needs further studies.

Fermentation and Pharmaceutical industry wastes

India has made rapid progress in the production of drugs and other chemicals using fermentation processes of different substrates. After production of useful products, the left out materials contain large amount of organic matter and minerals in solid and liquid form. It is estimated that with one Kg of antibiotic produced through fermentation, there is generation of around 7000 to 8000 litter of waste water with solid content ranging between 40000 to 50000 mg/l and BOD load of about 30000 to 60000 mg/l (Bewick and Biol, 1980). This wastewater also contains around 2-6% N (Dry weight basis) beside nutrients essentially required for plant growth. Presently this water is subjected to wastes water treatment plants and discharged in sewage water. Judicious use of this waste water for enriching the compost prepared from crop residues and city wastes could enhance the manurial value of the compost.

Sugar Industry Wastes

Sugar industry is one among the largest agro-industry in India. Presently over 448 sugar mills and 283 distilleries are working in different parts of the country. The products of this industry are sugar and alcohol. Both the products contain only carbon, oxygen and hydrogen. Thus entire nutrients harvested in the form of sugarcane ultimately find their way into wastes, either solid or liquid. Solid wastes of sugar mills are press mud is of low density, soft amorphous waste containing sugars, fibers, wax and minerals. It contains N, 1-2%; P,1.0-2.0% and K, 0.3-1.8% (dry wt. Basis). The pressmud production in India has increased from 32.0 lakh tonnes in 1985 to 100 lakh tonnes in 2005. It is estimated that by 2010 AD, sugar industry will produce around 110 lac, tones of press mud with potential to supply 42 thousand tones of nitrogen 55 thousand tones of phosphorus and 30 thousand tones of potassium. The benefits of press mud use in agriculture for increasing crop productivity and improvements in soil fertility are well documented (Yadav, 1995)

Bagasse is another solid waste produced in sugar industry. This is primarily used as captive fuel for generation of electric energy and as raw material for paper industry. The ash produced after burning the bagasse in furnaces also contains N, 0.06%, P_2O_5, 0.9% and K_2O, 1.0%. Unlike coal ash of thermal power stations, bagasses ash is free from heavy metals. In 1995-96 ash production from bagasse was estimated to be 5.0 lac tones which has increased to 8.0 lac tones in 2005-06. By 2010 AD bagasse ash production in India is expected to reach the level of 10 lac tones. At the present level of ash production, there is a possibility of providing around 6 thousand tones of phosphorus and 5 thousand tones of potassium for agriculture through use of bagasse ash.

Liquid wastes

Sugar industry liquid wastes are of two distinct types. One produced during processing of cane and other produced during fermentation of molasses for an alcohol production. A sugar mill with 5000 TCS capacity generates around 2500 M^3 of effluent per day. This effluent contains biodegradable organic carbon and minerals. These substances contribute towards high BOD and COD load of effluent (Table 14). The organic load in effluent is due to sugars and other biodegradable materials. Besides these organic substances, it also contains nitrogen phosphorus; potassium and other minerals. There is however, no heavy metals in it. Therefore, it is safe to use in agriculture for increasing the availability of nutrients and organic matter. The use of sugar mill effluent for composting of solid wastes will not only make available water and nutrient but also conserve the natural resources.

Distillery effluent

Alcohol production from molasses results in the production of effluent with very high BOD and COD load and minerals (Table 15). It is called as spent wash or vinasse or distillery effluent. About 16 litters of effluent is produced for each litter of alcohol produced from molasses. In 2000 around 12216.0 lac litter of alcohol was produced in the country which is estimated to increase to 15000 lac liter by 2010 AD. Production of spent wash will increase with the increase in the alcohol production. The spentwash contains organic matter and minerals like nitrogen, potassium and sulphur etc. It has a potential to supply around 61 thousand tones of nitrogen and 52 thousand tones of potassium.

City Wastes

Rapid increase of urbanization and industrial growth in the last two decades in India have resulted in daily generation of huge amounts of city wastes. It has been estimated that each urban resident generates roughly 500 to 1000 gm of solid wastes every day. Amount of solid waste generated from major cities of India are given in Table 16. Modern societies have now realized the importance of recycling the nutrients present in wastes for sustainable development and conservation of resources and abetment of environmental pollution. Therefore, Got. And municipalities have developed facilities for conversion of wastes into valuable manures for use in agriculture. In fact, recycling of organic matter and nutrients present in city and agro-industrial wastes into agriculture is the necessity of both modern society and agriculture. It follows a simple to rectify : What comes from soil must be returned to soil.

The solid wastes generated in urban areas contain high percent of biosolids like food and yard wastes, paper, wood, plastic etc. The main components of MSW and of wastes from specific producer like restaurants, canteen, foodstuff etc. Except MSW, wastes generated from canteen, hotels etc. contain very high % of compostable materials, which reach 90% of the waste production. The main chemical constituents in solid wastes generated in city is given in (Table 16). Nitrogen content of wastes other than MSW and yard waste is around 2%. Low C: N ratio make composting a fast process and quality compost is produced in four to six weeks time.

Heavy metals in city wastes compost

Compost prepared from municipal wastes often contains high concentrations of heavy metals like As, Cd, Cr, Cu, Hg, Ni, Pb and Zn. These metals get accumulated in soil and also absorved by plants and enter into food chain. Thus, posing a serious threat to the human and animal health.

The nature of the heavy metals in municipal refuse influences the quality of compost; fine fractions of refuse (<20 mm) are primarily responsible for most of the heavy metal burden. In addition, batteries (Hg, Cd, Zn), Leather (Cr), paint (Cr, Cd, lead), plastics (Cd) and paper (Pb) are some of the major sources of heavy metal in solid wastes of urban areas.

Methods of Composting

Conventionally, two methods of composting are well known in India. A brief description of these methods is given below :

Indore Method: This method was worked out by Sir Albert Howard, a British agronomist in India, working at Indore in Madhya Pradesh during 1924-30. The

Indore method is an aerobic process and hence precludes an adequate supply of oxygen during the decomposition process. The waste organic materials such as straw, garbage, leaves and plant clippings are laid in a heap or pit in alternate layers with animal manure and soil. The heap is turned thoroughly at intervals of 3, 6 and 12 weeks. The finished compost is ready in about three months if the materials are properly shredded and layered. Generally, it takes about four months for the compost to be ready.

Bangalore Method

This method was worked out, primarily to overcome some of the disadvantages of the Indore methods and secondly to process night soil and city refuse. This method is also known as hot fermentation methods, as heat loss during decomposition is considerably reduced. To carry out composting by the Bangalore methods, trenches of about 1 m depth, 1.5-2.5 m width and of any length are made. If materials is limited, one can go in for pits of 1 m depth, 1.5 m width and 3-4 m length. The compostable refuse is dumped into trench or pit and spread out with rakes or forked shovels to make a layer of about 15 cm thickness. Night soil or dung is then placed over the refuse in a layer of about 5 cm. The process is repeated until the trench or pit is filled up to about 30 cm above the ground level and a final layer of compostable material is placed on the top. At each layering, water is sprinkled over the materials to make it optimally moist. The aboveground material is made into a dome shape and covered with about 2.5 cm mud-plaster. If all operations are properly carried out, the compost is ready in about five to six months, a period of about one and a half times longer than that for aerobic composting by the Indore method.

Modifications of methods

Several modifications of the original methods of composting have been attempted by different workers at one place or the other in order to speed up the process. The Chinese high temperature composting method is a combination of the aerobic and anaerobic methods in which hollow bamboo pipes are inserted into the heap vertically and horizontally. In two to three days, the temperature of the heap rises to 60-70^{0}C. The poles are then removed and the heap is plastered with mud. The plaster is broken after 15 days and the heap is turned thoroughly. If need be, moisture is adjusted to appropriate levels. The heap is replastered and left for natural decomposition. The compost is ready in about two months.

Some quicker aerobic composting methods like windrow have been suggested for fast decomposition of municipal wastes and co-composting of agro-industrial wastes. In a compost windrow, air is heated due to microbial metabolism and rises, pulling in fresh air via a chimney effect. This passive aeration can be enhanced by strategically placing perforated pipes in the pile to increase airflow through the pile. This is because air flow, substrate degradation and heat removal are coupled. Consequently, it is difficult to accurately predict how pile dimensions, the number and placement of perforated pipes and the feed composition will affect the composting process.

Microbial diversity during the composting process

A large variety of mesophilic, thermo tolerant and termophillic aerobic microorganisms (including bacteria, actinomycetes, yeast's, molds and various other fungi) have been extensively reported in composting and other self-heating organic materials at temperatures between 20-60^{0}C. Many factors determine the microbial community during composting. Under aerobic conditions, the temperature is a major factor determining the type of microorganism, species diversity and the rate of metabolic activities. At an early phase of the composting process (temperatures between 20-40^{0}C) mesophilic/ thermotolerant fungi, principally yeasts and molds and acid producing bacteria are the dominant active degraders of fresh organic waste. Actinomycetes develop far more slowly than most bacteria and fungi and are rather ineffective competitors when the nutrient levels are high. Mesophilic microorganisms are partially killed or are poorly active during the themogenic stage (temperatures between 40-60^{0}C), where the number and species diversity of thermophilic/ thermotolerant bacteria, actinomycetes and fungi increase. The optimal temperature for themophilic fungi is 40-55^{0}C at temperatures above 60oC the number and the species diversity of microorganisms decreases and the degradation process becomes slow. Thermophilic bacteria are very active at 50-60^{0}C and at temperatures above 60^{0}C the degradation process is performed essentially by these microorganisms.

Factors controlling microbial activity during composting

Microbial activity and quality of compost produced depend on feed stock and composting process. Chemical nature of feed stock, especially C:N ratio is the primary characteristic which influence upon the process of composting. The C:N ratio may be adjusted by adopting the principals of Co-composting in which materials having high C:N ratios are mixed in a predetermined ratio with materials containing high amount of nitrogen. Thus, the favourable C:N ratio of $\leq$ 30 is achieved to speed up the process. Co-composting of leguminous crop residues or poultry manure with straws of cereals produce a quality feed stock for compost preparation. There are three factors to control composting process *viz.*, aeration, temperature and moisture content.

Aeration

Aeration controls the internal environment of the composting process. Air requirements differ depending upon the stage of composting. In early stage, air requirement is highest. Therefore, turning programmes during early phase have been recommended to provide adequate supply of air. Temperature inside the pile has normally been taken as turning indicator. It is recommended that as soon as 55-60^{0}C a temperature is achieved in the pile core, the material be turned. This, under certain situations would lead to very frequent turning in the early stage, which would not be economically viable. Therefore, it is necessary to optimize the turning of materials with economics of compost production. In one rationally based system, turning every 3-4 days for the first 2-3 weeks and on a weekly basis thereafter has been recommended for quick decomposition of biosolid (Stentiford, 1998).

Temperature

Temperature determines the rate at which biodegradation process take place during composting. The operating temperatures are selected to maixmmize, Sanitisation (High temperature is more effective) and Stabilizaiton (High temperature inhibits the process). In general, three temperature regimes are established in composting process 55^{0}C–to maximize sanitisation, 45-55^{0}C–to maximize the biodegradation rate and 35-40^{0}C–to maximize microbial biodiversity for stabilization i.e. maturity phse.

For sanitisation, certain standards have been fixed in European countries (Table 18). It is evident that the temperature of 55-65^{0}C for a period of 2-14 days is sufficient for killings pathogens and weeds in feedstock. Continuation of thermophilic period for a longer duration would prolong the period required for degradation of wastes. During this thermophilic stage degradation rate is minimal.

Moisture

Provision of optimum moisture in the substrate material is essential for the metabolism of microorganisms. Moisture content of 55-65^{0}C is generally considered optimum to start with. Excess moisture creates anaerobic conditions in the heap and brings about putrefaction.

Microbial enrichment of compost

Several fungi and bacteria have been screened out from soil and decomposing plant residues and evaluated for their biodegradative activity on the waste materials. It is evident from the published records that the main target of isolations was the fungi. Most of the organisms were mesophilic fungi, but a few thermophilic strains such as *Aspergillus fumigatus* and *Humicola lamuginosa* also proved beneficial as inoculants. Out of the collection of mesophilic fungi, some of the strains, namely, *Trichurus spiralis, Paecilomyces fusisporous, Aspergillus awamori* and a few species of *Asperigillus, Penicillium, Trichoderma* and *Humicola lamuginosa* proved superior over other (Mishra *et al.*, 1981).

Aspergillus awamori, which had earlier been isolated to be good phosphate dissolving fungus (Bardiya and Gaur, 1974; Goyal *et al.*, 1983) was utilized frequently as inoculants. *Paecilomyces fusisporus* was found to be an efficient degrader of lignocellulosic wastes on the basis of cellulase activity and humus formation (Kapoor *et al.*, 1978). Several other studies found microbial inoculation with selected fungal strains useful in the composting of various plant residues (Table 19 & 20).

Effect of inoculants has also been compared with the input of fresh cattle dung to the compostable materials at the rate of 8-10% on dry weight basis. While in most cases, microbial inoculants gave better results than the uninoculated materials, comparisons with cattle dung were almost consistent. Thus, selected microbial inoculants or cattle dung appeared to be competing alternative. However, microbial inoculations could be useful under the conditions where animal dung is not available; but under situations, where animal manures or other such biologically active materials are available for co-composting, special microbial inoculants may not be required.

Inorganic additives

For improvement in nutritional value of compost, inorganic additives like rock phosphate and pyrites have been added. Mathur *et al.*, (1980) reported that addition of Mussorie rock phosphate at the rate of 5-25% in the composting materials was able to increase the plant-available phosphorus in the compost. They also found that solubility of phosphorus in rock phosphate increased with the addition of pyrite, a mineral containing iron and sulphur. Subsequently, Mishra *et al.*, (1982) and Rasal *et al.*, (2002) produced compost with the incorporation of 25% rock phosphate in the compost materials, employing decomposition period of 90 days in aerobically managed pits. The compost was found to be appreciably rich in citric-soluble phosphorus and came to be known as phosphocompost.

As phosphocompost was relatively poor in nitrogen, attempts were made to improve the nitrogen content along with phosphorus enrichment. Paddy straw was composted with 25% rock phosphate, 10% pyrite and urea-nitrogen. Pyrite, being sulphur containing mineral, is oxidized to sulphuric acid by sulphur oxidizing bacteria which help in the retention of ammonia. This signified the rolé of pyrite as an inorganic additive to the compost. Greater solubilization of rock phosphate was also observed when pyrite was added during the composting.

Vermicomposting

Involvement of earthworms in composting, in association with usual microorganisms, constitutes worm-composting or vermicomposting as it is generally called. Earthworms do miraculous preliminary work in homogenizing organic materials, thus creating favourable condition for their actual decomposition by microorganisms. At the same time, wormcast is reported to be rich in nutrient elements (Jambhekar, 1992). Obviously, these casts contribute to the value of the compost. Besides earthworms basic capacity to macerate organic residues, it has been reported that vermicompost is richer in plant nutrients than the ordinary compost. However, there are claims to the contrary too. Worm-worked composts differed from simultaneously produced wormless composts only in their early finishing and physical structure but no significant differences were noticed in their nutrient composition. Shinde *et al.*, (1992) analysed vermicomposts made from the processing wastes of vegetable market with the help of three different species of earthworms. They also analyzed samples of two vermicomposts marketed by a private organization and compared them with well-decomposed farmyard manure. No significant difference was found between the nutrient content of vermicomposts and farmyard manure. An enormous quantity of organic wastes are available at farm or agro industries processing units for recycling for soil and crop improvement. If these wastes are being utilized through direct incorporation or through composting the nutrient requirement of the crops can be made to a great extent. The physico chemical and biological properties of the soil will also be improved through which nutrient efficiency can be enhanced. Natural resources can be harnessed for crop production and goal of organic farming can be achieved.

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Table 1. Nitrogen concentration in selected organic wastes produced at farm and agro-industries.

Organic wastes	Total N (%)*
Animal	
Diary	2.5
Poultry	4.7
Swine	4.4
City	
Aerobic digestion	5.1
Anaerobic digestion	2.5
Composted	1.2
Municipal refuse	1.0
Agro -Industry	
Tannery Sludge	4.5
Fermentation wastes	7.6
Papermill sludges	0.4
Poultry processing	8.0
Food processing	2.0
Commercial composts	1.4
Textile processing	5.2

* From different sources.

Table 2. Estimates of the annual availability and nutrient potential of crop residues

Crop	Residue (million tones)	Nutrient (%)			Nutrient Potential (million t)	
		N	P	K	Total	Utilizable
Rice	110.50	0.61	0.18	1.38	2.40	0.80
Wheat	82.63	0.48	0.16	1.18	1.50	0.50
Sorghum	12.54	0.52	0.23	1.34	0.26	0.09
Maize	11.97	0.52	0.18	1.35	0.25	0.08
Pearl millet	6.97	0.45	0.16	1.14	0.12	0.04
Barley	2.48	0.52	0.18	1.30	0.05	0.02
Finger millet	5.35	1.00	0.20	1.00	0.12	0.04
Sugarcane	22.74	0.40	0.18	1.28	0.42	0.42
Potato tubar	7.87	0.52	0.21	1.06	0.14	0.14
Groundnut	10.80	1.60	0.23	1.37	0.34	0.34
Total	**272.63**				**5.61**	**2.47**

1. One-third of the total NPK potential assuming that two-third of the total residue is used as animal feed on national basis.

Table 3. Residues to grain yield ratio of certain varieties of crops.

Crop	Variety	Residue to yield ratio	Source
Paddy	Desibasmati	1.50	Dinesh Chandra (1984)
	Semi tall	1.35	
	Semi dwarf	1.28	
Wheat	Sujata	1.65	Sing *et al.*, (1994)
	RR 21	1.26	
	HD 2329	1.10	
	HD 2428	1.10	
	HD 2285	1.10	
Maize	GS-2	2.27	Harika & Sharma (1994)
	Vijay	0.94	
	GFS-2	0.78	
	Africantall	8.50	
Sorghum	CSH-10	3.30	Murthy *et al.*, (1994)
	CSV-10	3.60	
	CSH-12 R	1.85	
	CSV-14 R	2.20	
Finger miller		2.4	Subba Rao *et al.*, (1994)

Table 4. Estimates of annual availability of crop residues.

Crop	Production* (million tonne)	Ratio	Residue Production (Million tonne)
Rice	82.12	1.3	106.75
Wheat	66.05	1.2	79.26
Sorghum	8.33	3.0	24.99
Maize	11.09	2.0	22.18
Pearl millet	7.64	2.0	15.28
Sugarcane	262.19	0.25	5.54
Groundnut	7.58	1.50	11.37

* Fert. Stat. 1997-98

Table 5. Physico-chemical properties as influenced by direct in corporation of sugarcane trash

Trash t/ha	W.N.C. (%)	Organic total			
		Carbon (%)	Nitrogen (%)	C:N ratio	IR (mm/hr)
Initial soil	62	0.69	0.058	11.8	9.11
0.0	63	0.74	0.073	10.1	10.60
2.5	66	0.83	0.084	9.9	13.72
5.0	68	0.92	0.096	9.6	15.62

Table 6. Effects of sugarcane trash incorporation on yield of different crops (q/ha)

Trash t/ha	Crop			
	Sugarcane	Wheat	Gram	Mung
0.0	1048.5	23.17	13.01	10.86
2.5	1102.6	24.89	14.50	11.47
5.0	1145.4	26.06	14.89	11.99
S.E. ±	10.6	0.321	0.38	0.195
C.D. at 5%	31.8	0.916	1.13	0.585

Table 7. Chemical composition of composts after 4 months

Type of compost	Organic C (%)	Total N (%)	C:N ratio	Avail P (ppm)	Citrate soil P (%)	% loss in wt.
Original trash	43.45	0.35	124.10	-	-	-
Ordinary	38.28	0.78	49.07	10.7	0.026	26
Enriched	34.45	0.98	35.15	15.2	0.031	32

Table 8. Effect of sugarcane trash compost on yield of Wheat and gram (q/ha)

Type of compost	Crop	
	Wheat	Gram
No compost	24.94	15.33
Ordinary	28.07	18.18
Enriched	32.88	19.09
S.E. ±	1.33	0.33
C.D. at 5%	3.99	1.01

Table 9. Quantity of nutrients supplied by organic matter ('000 t)

Crop	Present			2000 AD			2025 AD		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Groundnut	51.00	4.35	32.40	79.15	7.60	49.45	460.72	44.24	287.85
Arecanut	5.60	3.06	7.48	6.84	3.74	9.14	15.78	8.63	21.00
Cacoa	0.54	0.165	1.49	1.04	0.319	2.86	16.17	4.96	44.77
Coffee	4.158	0.206	1.08	4.71	0.233	1.223	7.92	0.392	2.06
Total	61.30	7.78	42.45	91.74	11.89	62.7	500.61	58.23	355.83

Table 10. Optimum rates of land application of POME on oil Palms

Effluent Type	Application system	Optimum rate (rain equivalent per year (cm)	Application frequency (time Y^{-1})	Yield increase (%)
Untreated	Flatbed	3.3	4	8
	Tractor/tanker	4.6	12	12
Treated	Flatbed	6.7	4	23
	Sprinkler	2.5	6	18
	Flatbed	6.6	4	14

Table 11. Annual production of fruit and vegetable processing wastes in India

Fruit/Vegetable	Name of waste	Approximate waste content (%)	Potential quantities of wastes ('000 tonnes)
Mango	Peel and stone	45	3144.4
Banana	Peel	35	832.3
Citrus	Peel, rag & seed	50	606.0
Potato	Peel	15	415.3
Apple	Peels, Pomaces & seeds	-	412.0
Tomato	Skin, core & seeds	20	90.3
Pineapple	Skin and core	33	24.7

Source : Nand *et al.*, 1996

Table 12. Chemical composition of food processing wastes

Waste	Composition (%)			
	Total solids	Nitrogen	Ash	C:N
Mango peel	26.4	0.56	3.5	71.0
Tomato peel & seeds	29.5	4.20	4.3	13.0
Pineapple waste	93.4	0.85	7.8	45.0
S.E. ±	**88.3**	**1.09**	**5.8**	**39.0**
C.D. at 5%	**88.0**	**2.22**	**6.4**	**19.44**

Table 13 : Chemical composition of solid wastes of leather industry

Parameter	Value
pH	9 - 10.2
DM (%)	46.0 - 67.9
Nitrogen, N (%)	10.0-13.1
Carbon, C (%)	27.4-36.4
Chlorides, cl (g/kg)	2-4
Phosphates PO_4 (g/kg)	0.36-1.80
Chromium Cr^{3+} (g/kg)	2.8 -11.0
Fats (g/kg)	27.5 - 32.1

Table 14. Chemical composition of sugar mill effluent

Character	Untreated	Treated
pH	4.6 -5.0	7.0-7.2
E.C. (dS/m)	1.5-1.6	1.2-1.0
Total solids (mg l^{-1})	3600-4000	300-400
BOD (mg l^{-1})	3000.0-50000.0	100.0-250.0
Nitrogen (mg l^{-1})	15.0-25.0	10.0-20.0
Phosphorus (mg l^{-1})	50.0-150.0	40.0-120.0
Potassium (mg l^{-1})	1500.0-30000.0	1200.0-1800.0
Iron (ppm)	15.0-25.0	2.0-5.0
Manganese (ppm)	0.2-0.5	0.1-0.2
Copper (ppm)	0.5-1.10	0.2-0.5
Zinc (ppm)	2.0-4.0	1.0-1.5

Table 15. Chemical composition of spent wash before and after biomethanation

Character	Biomethanation	
	Before	After
pH	4.5 -5.9	7.0-7.5
Total solids (mg/10)	76,800-80,000	30,800-40,000
Total -N (mg/N/1)	3126.60-3500.0	2000.0-2500
Phosphorus (mg P/1)	4.0-5.0	2.00-3.00
K (mg K/1)	2500-3000	2000-2500

Table 16. Soild wastes generation in Indian cities

Cities	Mt day^{-1}
Mumbai	6050
Delhi	4000
Calcutta	4000
Bangalore	2000
Chennai	4000

Table 17. Chemical analysis of compostable materials (dry weight except for pH and moisture content)

Parameter	Domestic Wastes	Restaura nt Waste	Canteen Wastes	Yard Wastes	MSW
Moisture (%)	66.5	61.5	78.2	33.0	42
Organic carbon (%)	35.1	41.40	40.83	41.6	22.7
Total Nitrogen(%)	2.1	4.1	2.8	1.3	1.3
C:N Ratio	16.9	10.0	14.8	40.4	17.4
Phosphorus (%)	0.42	0.25	0.196	0.17	0.37
Potassium (%)	1.30	0.60	1.26	1.15	1.03

Table 18. Sanitisation requirements for composting in certain European Countries

Country	Temperature (%)	Exposure (days)
Austria	65	6 (of 2 x 3)
Belgium	60	4
Denmark	55	14
France	60	4
Italy	55	3
Netherlands	55	2

Table 19. Role of microbial inoculants and rock phosphate (MRP) in composting

Treatment	Sugarcane trash*			Mixed farm wastes**		
	Total N (%)	C:N ratio	% Wt. loss	Total N (%)	C:N ratio	% Wt. loss
Control	1.25	26	53	1.33	23	42
1% P_2O_5 as MRP	1.36	23	57	1.45	21	51
MRP+ *Azotobacter* (AC)	1.40	23	56	1.56	19	53
MRP + *A.awamori*	1.35	21	54	1.60	18	59
RP+AC+*A.awamori*	1.51	18	61	1.63	18	59
Original material	0.32	123	-	0.75	60	-

* 4th mpnths decomposition time, *** 3 months decomposition time

Table 20. Speed and quality of compost as affected by bioinoculants

Bio-inoculants	Total N (%)	C:N ratio	% Weight loss	Total N(%)	C:N ratio	% Weight loss
Control	1.03	23.0	52	1.25	25.2	57
Trichurus spirals	1.31	18.3	60	1.48	19.0	65
Penicillium digitalum	1.18	20.3	55	1.31	20.2	61
Paecilomyces fusisporus	1.31	19.3	59	1.40	21.2	63
Aspergillus niger	1.28	20.0	57	1.45	21.1	65
Cattle-dung (10% on dry basis	1.30	19.4	56	1.46	18.5	60
Original material	0.58	58.4	-	0.36	12.4	-

A study of production technology of phosphomanures and effect of phosphorus through phosphomanures on the different cropping systems

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Phosphorus is an essential major nutrient required for plant growth. At present subsidized cost of single super phosphate is Rs. 19.50 per kg of P_2O_5. Recently, efforts were made, in India, at Pune to develop the technology for preparation of phosphocompost using crop waste, rock phosphate and iron pyrite but the time required is almost four months.

In India as organic manures are available in the form of FYM and compost with farmers and city compost with corporations, press mud in sugar factories in ample quantity. Further, abundant mineral rock phosphate is available, in India in Rajasthan and Bihar State, Iron pyrite is also cheaply available in India. Therefore, experiments were made during 1997 and 1998 to develop a production technology of phosphomanures which would found alternative source to SSP.

MATERIAL AND METHODS

Materials required (6:3:1:0.01)

I. Six organic manures with P_2O_5 content used for production of Phosphomanures.

Manures : FYM : (0.82 %), Compost (0.98 %), City compost (0.67 %), Vermicompost (0.85 %), Pressmud (3.83 %) and Poultry manure (2.73 %).

II. Rock Phosphate (20 %) : Needs acid treatment.

III. Iron Pyrite : In the process of acid formation during composting oxidation reduction of iron pyrite, phosphate changes to monocalcium by destroying apetite bond.

IV. Microbial culture : *Aspergillus awamori* :

Helps in decomposition of organic manure and solubilize phosphorus from organic manures and rock phosphate.

Methods

i. Six treatments of organic manures were replicated four times.
ii. The pits 1 M x 1 M x 1 M were prepared of cement concrete.
iii. For preparation of one quintal of phosphomanure from each treatment of dry manure, rock phosphate, Iron pyrite and microbial culture was used 60, 30, 10 and 100 kg respectively.
iv. Rock phosphate and Iron pyrite were mixed together and water was added to form the slurry. The slurry solution was kept in plastic drum for 24 hrs.
v. Microbial culture was mixed with organic manure treatment wise.
vi. While filling the pits a layer of 15cm of dry organic manure followed by layer of slurry of rock phosphate and iron pyrite were placed alternately.
vii. Turning and sprinkling of water was done weekly.
viii. Phosphomanures were ready within 6 weeks.

RESULTS

Table 1. The following quantities of materials were used for preparing the phosphor-manures.

Materials used	Rock phosphate (kg)	Iron pyrites (kg)	'P' solubilizing culture (kg)	Decomposing culture (kg)
FYM	300	100	1	-
Compost	300	100	1	1
Press-mud	300	100	1	-
Vermincompost	300	100	1	-
City-compost	300	100	1	1
Poultry-manure	300	100	1	-

Wt. of material used was 600 kg.

Table 2. Analysis of phosphomanures at the time of application

Material	P_2O_5 (%)	N (%)	C:N ratio	pH
Phospho F.Y.M.- PF,	6.55	1.30	1.2	6.7
Phospho compost .PC	8.33	1.40	1.22	6.6
Phospho pressmud-PPrM	6.25	1.5	1.17	6.1
Phospho vermicompost-PV,	5.72	1.03	1.25	6.7
Phospho citycompost-PCC,	6.55	1.8	1.17	7.0
Phospho poultrymanure-PPoM,	7.14	2.8	1.86	7.0
Single superphosphate -SSP	16.0	-	-	-

Table 3. Effect of different sources of phosphorus on growth, contributory characters and yield of *kharif* greengram

Treatments	Plant height (cm)	Grain yield (q/ha)	Bhusa yield (q/ha)
PC	32.66	18.23	21.94
PF	29.00	17.91	21.44
PV	28.00	15.77	18.36
PPoM	29.33	17.93	21.50
PCC	28.00	16.17	18.93
PPrM	29.33	17.68	20.83
SSP	28.66	16.45	19.19
S.E. ±	0.97	0.02	0.04
C.D. at 5%	N.S.	0.06	0.12

Table 4. Growth, yield contributing character and yield of second crop wheat

Treatments	Plant height (cm)	Grain yield (q/ha)	Bhusa yield (q/ha)
PC	75.53	54.06	65.53
PF	73.11	48.08	59.36
PV	73.42	49.12	54.14
PPoM	74.78	51.88	62.48
PCC	73.61	50.16	54.91
PPrM	74.43	51.50	67.76
SSP	74.50	50.79	61.97
S.E. ±	0.24	0.14	0.20
C.D. at 5%	0.75	0.43	0.80
Sub-plot (rabi)			
Po	70.15	38.09	51.45
P1	74.04	54.29	60.06
P2	78.41	60.03	66.48
S.E. ±	0.12	0.13	0.10
C.D. at 5%	0.35	0.39	0.40
Interaction			
S.E. ±	0.33	0.369	0.42
C.D. at 5%	NS	1.04	NS

N.S. = Non-significant

Table 5. Effect of phosphomanures on growth and yield of *kharif* groundnut

Treatments	Plant height (cm)	Pod yield (q/ha^{-1})	Creeper yield (q/ha^{-1})
C	26.67	18.07	16.48
SSP	31.08	24.86	24.34
PC	32.24	27.75	27.10
PCc	29.60	21.64	20.04
PF	32.94	28.27	27.56
PVc	30.35	24.22	22.10
PPr	31.43	25.93	25.09
PPo	31.89	26.95	26.23
S.E. ±	0.61	0.18	1.5
C.D. at 5%	1.85	0.53	4.5

Table 6. Effect of phosphomanures on growth and yield of second crop wheat

Treatments	Plant height (cm)	Mean grain yield (q ha^{-1})	Mean straw yield (q ha^{-1})
C	70.36	40.25	59.09
SSP	75.44	49.83	68.49
PC	76.49	53.54	72.42
PCc	73.54	47.19	64.46
PF	75.98	51.62	70.87
PVc	74.53	48.12	65.73
PPr	74.99	48.89	66.07
PPo	75.60	52.48	71.06
S.E. ±	0.23	0.19	0.28
C.D. at 5%	0.69	0.58	0.84
Sub-plot (*rabi*) :			
Po (0 kg ha^{-1})	70.04	39.38	57.45
P1 (30 kg ha^{-1})	75.56	52.82	66.91
P2 (60 kg ha^{-1})	78.38	59.50	73.56
S.E. ±	0.12	0.33	0.46
C.D. at 5%	0.34	0.96	1.32
Interaction :			
S.E. ±	0.35	0.95	0.72
C.D. at 5%	NS	NS	NS

N.S. = Non-significant

Table 7. Growth contributory characters and yield of pigeonpea as affected by different treatments at harvest

Treatments	Plant height (cm)	Grain yield (q ha^{-1})	Stalk yield (q ha^{-1})
C	85.27	12.93	25.75
SSP	93.27	19.41	37.20
PC	109.23	24.56	40.60
POC	92.50	18.64	36.72
PF	100.60	20.07	38.42
PVC	92.97	18.86	36.91
PPRM	101.23	21.67	38.79
PPOM	104.90	23.55	39.68
S.E. ±	0.31	0.10	0.49
C.D. at 5%	0.94	0.30	1.50

Table 8. Yield and yield contributing characters of second crop wheat

Treatments	Plant height (cm)	Grain yield (q/ha^{-1})	Straw yield (q/ha^{-1})
Source of P_2O_5 for pigeonpea			
C	59.71	48.33	67.51
SSP	63.42	49.47	69.31
PC	64.92	51.26	74.14
PCc	63.01	48.57	68.04
PF	63.56	49.60	69.57
PVc	63.15	49.37	69.04
PPr	63.62	49.73	69.84
PPo	63.81	49.80	70.30
S.E. ±	0.21	0.02	0.05
C.D. at 5%	0.63	0.07	0.16
Levels of phosphorus to wheat			
Po (0 kg ha^{-1})	58.87	34.10	53.12
P1 (30 kg ha^{-1})	63.53	54.52	76.16
P2 (60 kg ha^{-1})	67.05	59.92	80.37
S.E. ±	**0.11**	**0.04**	**0.06**
C.D. at 5%	**0.34**	**0.13**	**0.18**
Interaction (Main x Sub)			
S.E. ±	0.31	0.14	0.15
C.D. at 5%	NS	0.42	NS
Mean	6.15	49.51	69.71

In the first experiment conducted during 1997-98 on greengram-wheat sequence the application of 50 kg P_2O_5/ha through phosphocompost to greengram resulted in to achieving significantly maximum grain yield of 18.23 q/ha and when tested for residual effect wheat produced significantly maximum grain yield (60.03 q/ha).

While in case of second experiment conducted during 1998-99 on pigeonpea wheat cropping sequence supply of 50 kg P_2O_5/ha to pigeonpea produced significantly maximum grain yield of 24.56 q/ha and when tested for its residual effect produced significantly maximum grain yield of wheat 51.26 q/ha.

In an experiment conducted during 1998-99 on supply of 50 kg P_2O_5 through phospho FYM to groundnut produced significantly maximum dry pod yield of 28.27 q/ha and creeper yield of 27.56 q/ha of groundnut in *kharif* and when tested for residual effect on wheat then the wheat produced significantly maximum grain yield of 53.54 q/ha. Thus, phosphocompost and phospho FYM were found effective in increasing the yield in different crop sequences.

Conclusion

1. The phosphomanures are found alternative to single super phosphate besides the supply of nitrogen, potash and micro nutrients therefore it was found most useful to pulses and legumes.
2. The residual effect of Phosphomanuers was found beneficial to second crop in the cropping system.
3. To reduce the cost of input and also the production cost, the phosphomanuers will be beneficial.
4. The Phosphomanures will improve the fertility and productivity of soil.
5. The phosphomanures will increase the activity of microorganisms in the soil and will improve the soil health.
6. The phosphomanures are economical, therefore it will increase profitability.
7. The phosphomanures will help for sustainable crop production in the cropping system.
8. The dose of one tone of Phosphomanure/ha supply 70 kg P_2O_5, 20 kg N and 16 kg K_2O/ha satisfy the need of pulses, legumes and initial dose for cereals and other crops. Therefore will help to minimize the use of chemical fertilizers to a great extent.

Session-III
Crop production through organic resource

Use of biocontrol agents and bio-pesticides for pest management in organic farming

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Pest management methods can be categorized as cultural, biological and organically accepted alternatives to chemical control.

1. Cultural methods

Cultural methods include all crop production and management techniques which are utilized by the farmers to increase the yield. These techniques are field sanitation and crop residue management, tillage, application of manures and soil amendments, crop diversity and crop rotation, trap cropping, intercropping, strip farming etc. The other cultural practices are crop and variety selection, seed quaty and seed rate, proper sowing / transplanting time etc.

Managing the growth environment

Forecasting of probable pest outbreaks / pest incidence helps in deciding the planting dates of crop. Record keeping provides data base for prediction in advance of the season. Healthy soil are important in crop health. Trap strips, roghuing, crop competition, water management and weed management helps in growing pest free healthy crops.

Cultural alternatives

Crop rotation is the best approach in pest management because it reduces the availability of host plants to pests. Physical control methods such as tillage, mowing, chopping and flaming help is destroying the inactive / hibernative stages of pests. Sanitation removes the non-crop hosts and infected hosts. Pruning and canopy management or physically manipulating the structure of the host plant helps in better aeration and photosynthesis. Optimum irrigation and well drained soils are always beneficial for better crop growth and ultimately less pest incidence. The other important strategies of pest management are choice of field, location, planting date, vigorous and pest resistant cultivars, optimum plant density etc.

Pests can also be managed by enactment of legislation and relations of entry, establishment and spread of pests. The legislation also includes mandatory host-free zones, pest-free zones, crop terminations, seed indexing and detection, inspection, notified pests, quarantine pests etc.

2. Physical and mechanical control

Physical and mechanical control methods include hand collecton and destruction of pest (manual) burning the crop residues to destroy inactive stages, solarization to kill disease causing organisms flaming etc.

Direct control

Monitoring of pest population with the help of pheromone / stricky / light traps helps in pest control decisions. Biological control, it adopted at night time prevents the build-up of pests and maintains the pest populations at low leels. Natural enemies – parasitoids, predators and parasitoids are extensively used in organic farming. It necessary, need-base application of biopesticides and botanicals can also be applied.

Biological alternatives

Parasitoids and predators are the biocontrol agents which either parasitize or predate on the pests. Pathogens cause diseases in pest and check the pest population. Bio-control agents can be collectd, reared and released in the fields. The exotic parasitoids and predators can be introduced. The microbial biopesticides are the formulations containing pathogens. Similarly, beneficial or antagonistic organisms can also retry well used.

Natural mulches, lining mulches, trap crops and cover crops are used to enhance the population of natural enemies.

Advantages of bio-control

1. Bio-control is exercised in a wide range of area and is safe
2. Application of biotic agents is easy
3. The biotic agents survive in nature till the pest is prevalent
4. Farmer does not require any special treatment procedure
5. No waiting period for harvesting
6. Biological agents viz., baculoviruses, parasitoids and predators may be multiplied at farmer's level

Entomopathogens and their application rate with host insects

Entamopathogen	Application rate	Host Insect
Bacillus thurungiensis	108 – 109/ ha	Plutella xyloatella
Erynnys ello		
B.bassiana	108 – 109/ ha in 10-40 litres of liquid	Heliothis virescens Mosic sp
Cyclas formicarius *Lissorhoptrus breviorstris*		
Verticillium lecanii	1011 – 1012 spores/ha applied in liquid preparation	Bemesia tabaci

Baculoviruses and Bt based insecticidal formulations

Microbe	Formulation	Product
A. Bacillus sp.		
1. Bacillus thrunginess var kurstki (BTK)	a. Emulsified suspension	Dipel L (abbot)
	b. Wettable powder	Thrucide (sandoz)
	c. Aqueous solution	Thrucide (sandoz)
	d. Wp flowable concentrate	Bactospeine (Biochem product)
	e. Liquid concentrate	SoK-Bt (VP. John)
	f. Flowable concentrate	Foray, Biobit
2. B.thringenisi var isralensis (Bti)	a. WP	Bactimos
	b. Flowable concentrate	-
3. B. thoringiensis var tenebrionis	a. Flowable concentrate	Novodar (Nova-nor disk)
4. B.popiliae	a. Ready to use spore powder (100 million viable spores/g of inert powder)	Doom
5. B.sphaericus		Japidemic
B. Baculoviruses		
1. Nuclear polyhedrosis virus (NPV)	a. WP (4 million PIB/g)	Elcar mamestrin

2. Granuiosis virus (GV)	-	Agrovir, madex capex, granupon

Spiders and their preys

Spider	Preys on
Wolf spider (Lycosa pserdonnulata)	BHP, Green leaf hopper (GLH), White backed plant hopper (WPH) caseworm, leaf folder and whorl maggot
Four egged spider (Tetragnatha spp)	BHP, WPH, Zigzagleaf hopper (ZLH) and rice white leaf hopper (WLH)
Sac spider (Clubiona japonicola)	BPH, WPH,ZLH, WLH
Orb spider (Araneus inustus)	Leaf folder, BPH, WPH and whorl maggot
Dwarf spider (Callitrichia formosa)	BPH, WPH ZLH, whorl maggot
Lynx spider (Xyopes jaranus)	BPH, GLH,WPH caseworm, leaf folder and whorl maggot
Orb spider (Argiope catenulata	LH,BHP, WPH, ZLH, caseworm, stemborer and whorl maggot
Jumping spider (satticids spp)	GLH,BPH,,ZLH, WPH, Cutworm and army worm, leaf hopper stem borer moths

3. Organically accepted chemical alternatives

Some of the organically acceptable chemical alternatives are ecoming popular. They are some horticultural oils and soaps containing fatty acids. The botanicals such as pyrethrum, neem, rynia etc. are used because they contain toxic substances. The semio-chemicals for e.g. pheromones, allomones and kairmones including sex attractants and repellents produced by insects affect the behaviour of other insects. Some inorganic or elemental compounds such as elemental sulphur and copper formulations are best suited in organic farming.

Botanical pesticides

1. Azadirachta indica
2. Annona squamosa
3. Ryania speciosa
4. Pongomia glabra
5. Acorus calamus
6. Anethora sowa
7. Ageralum conyzoids
8. Madhuca longifolia

Botanical for storage pest control

1. Leaves of neem *Azadirachta indica*
2. Leaves of fenugreek *Trigonella foenumgreekum*
3. Leaves of *Artemisia absinthium*
4. Powdered neem leaves and rhizomes of turmeric repel the rice weevils
5. Turmeric powder, mustard oil and common salt – Protect rice grains
6. Neem seed powder one or two per cent mixed with wheat controls – rice weevil khapra beetle
7. Mixing of wood ash, tobacco or sowchaust in maize seeds keeps free from infestetaion

Biofertilizer – Essential components of organic farming

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Introduction

The soil fertility is the only important issue to be considered for sustainability. Biological routes of improving soil health and fertility of optimum crop production form vital components of integrated plant nutrient supply system (Yadav *et al.*, 2003). The farmers all over the world are turning increasingly towards the organic farming or in true sense biological agriculture as they increasingly encounter the hazardous effects of chemical fertilizers and their prohibitive costs. The organic farming includes all those sources of nutrient supply to soil through organics, avoiding the use of inorganic chemical fertilizers and plant protection chemicals. The organic farming aims at preserving the natural and ecological balance according to the environmental standards. Amongst the various components of organic farming, the use of biofertilizer is the main and an essential component.

Biofertilizers are simply the fertilizers prepared from bioagents containing especially microbial cells. These are the microbial preparations containing live cells of bacteria/cyanobacteria/fungi, which most effectively either fix atmospheric nitrogen, or solubilize insoluble phosphate in soil or decomposes cellulosic organic farm wastes. Biofertilizers include N fixing bacteria *viz.*, *Azotobacter, Azospirillum, Acetobacter, Rhizobium* (Tilak, 1993); phosphate solubilizing bacteria and fungi (Wani, 1980; Gaur, 1990); phosphate mobilizing vesicular-arbuscular mycorrhizae; organic matter decomposing cellulolytic fungi, etc. Biofertilizers *viz.*, *Azotobacter, Azospirillum, Rhizobium,* Phosphate solubilizing bacteria/fungi and vesicular-arbuscular mycorrhizae had beyond doubt proved to enhance growth, nutrient uptake and yields of crop plants inoculated. Biofertilizers, besides their major role of nutrient supply, render the protection to crop plants against most of the soil borne plant pathogens.

Biofertilizers are grouped in three categories depending on kind of beneficial activity carried out by the microbial agent used in their production. These include: (1) N fixing biofertilizers, (2) Phosphate solubilizing biofertilizers, and (3) Decomposing cultures (Tilak, 1993). Besides these, the microbes, which oxidize sulphur, are also known but their commercial preparations, as biofertilizers have not been yet developed and popularized. Carrier based inoculum of the above three types of microbial preparations have been commercialized on large scale. Depending on the medium/carrier used in their production, biofertilizers may also be grouped as (1) Lignite based biofertilizers, (2) Jowar grain based biofertilizers and (3) liquid biofertilizers. Recently few private firms have come forward with the manufacture of liquid biofertilizers, which have limited use in their applications. Inamdar *et al.*, (2000) have claimed the shelf life of cyst bioinoculants for over two years besides the high nitrogen fixing ability of *Azotobacter* strains and the cyst based Azotobacter in the liquid inoculant has been exploited for preparation of liquid biofertilizers.

Supplementation N-Fertilizers through Nitrogen Fixing Biofertilizers:

Soil microorganisms especially species few bacteria, actinomycete, and blue green algae possess a catalyst called nitrogenase which reduces atmospheric N_2 to NH_3 . The NH_3 formed in soil is further converted to nitrate form by nitrifying bacteria and thus crop plants utilize nitrate formed. In legume plants, NH_3 formed as an activity of *Rhizobium*, is directly utilized by thehost crop converting it into amino acids by GS, GOGAT pathways. The nitrogen-fixing organisms including the secies of *Rhizobium*, *Azotobacter*, and *Azospirillum* (Wani and Konde, 1986) are used in commercial production of biofertilizers. The blue green algae *viz.*, *Aulosira*, *Tolypothrix*, *Calospora*, *Anabaena*, *Nostoc*, *Cylindrosporium* fix atmospheric nitrogen in paddy soils. Recently, *Acetobacter diazotrophicalis* is reported to be potential nitrogen fixer in sugarcane. Actinomycete *viz.*, *Frankia* fixes the nitrogen in tree legumes. The use of host specific *Rhizobium* biofertilizers is most often ignored which results in poor performance. The carrier based preparations of nitrogen fixing bacteria known as biofertilizers are commercially prepared and utilized as a general practice in present era. Through the extensive field trials conducted on the nitrogenous biofertilizers, it is beyond doubt proved that at least 25% of chemical nitrogenous fertilizers could be replaced by use of biofertilizers. Integration of other organic sources along with biofertilizers thus could lead to minimize the use of inorganic nitrogenous fertilizers in the organic farming system.

Availability of Soil P through Phosphate Solubilizing Biofertilizers:

Phosphorus added through chemical fertilizer gets fixed in bound form, which is not available to crops resulting in P deficiency and reduced plant growth. In acid soils P is fixed as Fe- or Al-phosphate, while in alkaline conditions it is converted to Ca-phosphate, an unavailable form for crops. To benefit fully from added P fertilizers in soil, new technology has come forward in the form of use of phosphate solubilizing biofertilizers. These are prepared from phosphate solubilizing bacteria (PSB) or fungi (PSF). The bacterial isolates reported as phosphate solubilizers include *Pseudomonas striata*, *Pseudomonas rathonis*, *Bacillus polymyxa* and *Bacillus megatherium* var. *phosphaticum*. The fungal isolates reported to be efficient P solubilizers are *Aspergillus awamori* and *Penicillium digitatum*. The extensive field trials on use of carrier-based preparations of phosphate solubilizing biofertilizers indicated the beneficial effects on P uptake, growth and yield of a vast range of legumes, cereals and vegetable crops. Phosphatic biofertilizers have been reported more effective when used in combination with N fixing biofertilizers. Lignite based preparations of phosphatic biofertilizers are recommended for use as seed treatment, while sorghum-grain based phosphatic biofertilizers are used for addition in compost pit or added along with compost for horticultural crops. The vesicular arbuscular mycorrhiza (VAM) have symbiotic associations with roots of crop plants and function as mobilization of phosphate from distance soil to crop roots and also increasing the uptake of other nutrients by crop plants. The VAM species finding their utility in agriculture are *Glomus mosseae*, *Glomus fasciculatm*, *Gigaspora margarita*, *Acaulospora* spp. Large scale production of VAM biofertilizers has restriction due to the obligate symbiotic nature of mycorrhizae. Besides phosphate mobilization the VA-mycorrhiza help the crops by supplying other nutrients as well as protects the roots from attack of soil borne plant pathogens.

Compost Culture Decomposing Organic Residues

Daily a huge quantity of organic residues (plant, animal origin) is being added in soil. This must be decomposed for nutrient recycling and availability of nutrients for crop plants. The organic residues contain cellulose, lignin and other polysaccharides, which are difficult to degrade. The soil contains microorganisms, which possess enzymes *viz.*, cellulases and ligninases decompose the organic residues. The efficient organisms which decompose organic residues include fungi *viz.*, species of *Penicillium*, *Aspergillus*, *Trichoderma*, *Trichorous*, *Rhizopus*, *Trichothecium*; bacterial species of *Cytophaga*, *Sporocytophaga*, *Clostridium*, *Bacillus*.

Pseudomonas and actinomycetes *viz.*, species of *Micromonospora, Nocardia, Thermoactinomyces*, and *Streptosporangium*. The artificial grain based preparations of these microbes are prepared and these are known as compost cultures. These are used for decomposting the organic wastes in compost pit. For one metric ton of organic residues, 500 g grain based decomposing culture is sufficient. The use of compost cultures decomposes the organic residues. Artificially prepared compost by using compost cultures has narrow C:N ratio, and the composting process is rapid completed within 3 months as against 8-10 months by using conventional method.

Biofertilizers as an Essential Component of Organic Farming:

The soil health depends on activities of microorganisms present in it. The soil microbes play an important role in the nutrient recycling; mediate transformations of nutrients converting them into the form which is utilizable for crop plants. It is a general scientific saying that agriculture would not be possible without useful microbial culture in soil. This is mainly due to the number of activities performed by soil microorganisms which include biological nitrogen fixation, nitrification, phosphate solubilization and mobilization, sulphur oxidation, organic matter decomposition, recycling of nutrients like N. P. K, Fe, S, and other nutrients and also arresting soil borne plant pathogens.

Most of the microbes used in biofertilizer preparation are nutritionally heterotrophic requiring organic carbon and this property has led a positive correlation between the organic matter content of the soil with the efficiency of the biofertilizers. The soil microbial population increases with the increase in soil organic matter. The soils with low organic matter decreasing the microbial population could not sustain and its crop productivity property gets diminished. The types of organic residues amended in soil also have differential response. The organic amendments with higher C:N ratio like woody material get degraded slowly and the well decomposed organic amendments including FYM enhance the activities of biofertilizer agents in soil.

Once the inorganic fertilizers are applied, they undergo disintegration due to absorption, leaching, evaporation, etc. and finally get lost from soil and thereby demanding frequent application. Microbial population in soil is decreased due to application of inorganic fertilizers. Similarly, these fertilizers deteriorate the soil texture and soil becomes hard. The plants due to chemical fixation of nutrients in soil cannot use all the applied nutrients. Overall, the cost per unit of nutrient is more while using the inorganic fertilizers.

Microbial agent/s used in the preparation of biofertilizer secrete auxins and hormones thereby increasing the seed germination growth of crop plant. Once the biofertilizers are applied, they cannot be leached out, evaporated or lost but the useful microbes increase in number. Biofertilizer agents also exhibit fungicidal action. The application of biofertilizers does not affect the texture of soil but improves the structure and texture. Cost per unit nitrogen is less than chemically fixed nitrogen. Biofertilizers increase nitrogen fixation, phosphate solubilization, sulphur oxidation and supplies other macro and micro plant nutrients essential for balanced nutrient supply and growth of crop plants (Tilak, 1993). As well, they increase vegetative growth, increasing total dry matter production and increase yield producing quality product and are useful in maintaining and improving soil fertility.

Production and Quality of Biofertilizers:

Biofertilizer production in India during the year 2005-2006 was 19792 tonnes, while that was 2493 tonnes in Maharashtra. The biofertilizer produced in Maharashtra is sufficient only for covering its 10 per cent cultivable area of the State.

The use of biofertilizer so far reported is more in horticultural crops, rice and legume crops. Therefore it is necessary to increase the awareness of small and marginal farmers to use biofertilizers by providing facilities from State/ Central Government.

To achieve all benefits from the use of biofertilizers, it is necessary to have a quality biofertilizer. The reasons of poor quality biofertilizers are the use of ineffective microbial strain, insufficient number of viable cells, presence of contaminants, production by unskilled staff, poor shelf life and inadequate facilities. The quality control norms are specified only for *Rhizobium* and *Azotobacter* biofertilizers and that too, they are not compulsory for all the producers in India. This is the main constraint, which poses the problem of production of large quantities of poor quality biofertilizers in our country. It has become very necessary to control production of poor quality biofertilizers and to authorize Government Institutions/Agricultural Universities to check quality of biofertilizers produced and to discourage the manufacturers from producing substandard biofertilizer.

Recently, the Minister of Agriculture, Department of Agriculture and Cooperation, Government of India, New Delhi vide their order dated 24^{th} March, 2006 included biofertilizers under section 3 of the Essential Commodities Act, 1995 (10 of 1995), in Fertilizer (Control) Order 1985. In accordance with this the norms for considering quality control of *Rhizobium*, *Azotobacter*, *Azospirillum* and Phosphate Solubilizing biofertilizers have been specified (Yadav, 2006).

At present, it has been noticed that many certification bodies, accredited under the National Programme on Organic Production (NPOP), of Ministry of Commerce, Government of India are also certifying the organic or biological inputs including biofertilizers. Here it is clarified that that the certification bodies accredited under NPOP are authorized to undertake certification of organic production which is a process-certification and only guarantees that that the produce has been grown or processed as per the protocols laid under NPOP and do not guarantee the quality requirement of the product.

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Bioagents and biopesticides for organic farming

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The organic crop management with biological devices could satisfy the actual need of important components of biointensive integrated pest management (BIPM). The cultural control, mechanical control, NSE, parasites, predators and the microbial pesticides are highly potential components of organic plant protection. The biological control is utilization parasitoids, predators and pathogens of crop pests below the economic threshold level. The first sparkling success of biological control by use of 129 Vedalia, lady bird beetles *(Rodolia cardinalis)* against cottony cushion scale (*Icerya purchasi*) is well documented to safeguard the interest of citrus growers in California in 1888. In India after 1975 researches have amply proved that about 70-80% major pests of major crops could be suppressed by biocontrol .It is the ecofriendly, economic and effective method of pest suppression .The classical biological control rarely finds place in fast reviving plant protection system. The biopesticides (microbial pesticides) are practically most viable tools of biological management of pests and are indispensable in organic plant protection. These are formulated products using the pest pathogenic microbes which intervene in the life cycle of the insect pests and kill them by causing the diseases. At present their formulations contain pathogenic bacteria, viruses and fungi as bioingredient with carrier and adjutants. Neem based botanical is also included in bioinsecticide.

Parasitoids and Predators

In India, the parasitoids viz., Trichogrammatids(for Lepidopteron pests), *Cotesia, plutellae*(for diamond back moth), *Bracon brevicornis* (for black headed caterpillar), *Encarsia formosa*(for green house white flies) , *Epiricania melanoleuca* (for sugarcane pyrilla), *Copidosoma koehleri*(for potato tuber moth), *Telenomus remus* (for *Spodoptera*), *Chelonus blackburni*(for cotton bollworms and PTM), *Isotima javensis*(cane top shoot borer) , *Aphelinus spp*(for aphids), *Goniozus nephantidis*(for black headed caterpillar); predators *viz., Chrysoperla spp*(for sucking pests, eggs of Lepidopteran pests), *Cryptolaemus montrouziery*(for mealy bugs on fruit crops), *Dipha aphidivora*(sugarcane white wooly aphid), *Phytoseilus* mites(for mites); entomopathogenic nematode *Stenernema* carpocapsae (for Lepidopteran larvae) and weed feeders like Cochineal insects(*Dactylopius tomentosus*) for the cactus, Agromyzid seed fly(*Telenomia scupulosa*)for Lantana, *Zygogramma biclorata*(for *Parthenium hysterophorus*), *Neochetina bruchi*(for water hyacinth) and *Cyrtobagous salvinae* (for water fern) have been found to be usefull for biosuppression of crop pests and weeds.

Biopesticides

Biopesticides are formulated products using the pest pathogenic microbes. These intervene in the life cycle of the insect pests and kill them by diseases. At present their formulations contain pathogenic bacteria, viruses and fungi as bioingredient with carrier and adjutants.

Biopesticides stop crop damage quickly: Although the biopesticides do not show analogous knockdown effect on pests like toxic chemicals but the sick pest stops crop damage in 1-2 days, tend to move on to top portion of plants and thereafter the death initiates. The misconception that biopesticides are slow working is resulted in slow growth of biopesticides.

1. Bacterial Insecticides

***Bacillus thuringiensis* (*Bt*) (Bacillales: Bacillaceae)**: It is the most successful bioinsecticide contributing 80% share in the world biopesticide market and the only biopesticide produced by the multinational companies. Mostly Lepidopterous larvae Of >150 insect spp are susceptible to *Bt var kurstki*. It is pest specific and safe to the natural enemies of many crop pests and human like warm blooded animals with acidic gut contents. The proteinaceous, parasporal toxic crystal (δ- endotoxin) is secreted during the sporulation and it remains attached to the bacteria. On injection with food the crystal dissolves in the alkaline contents of larval midgut. It causes mouth and body paralysis mostly leading to death of insects. *Bt* is mass cultured artificially in 5 L to 2 lakhs L capacity fermenters. It is standardize on basis of IU/mg comparing LC_{50}/LD_{50} of new product with reference standard of known IU. Mostly *Bt* is available as 3-6.4% WP. It is recommended at 0.5 to1 kg/ha. There are over 30 manufacturers producing 6000 tones *Bt* /annum in India. It is sufficient in view of developments in *Bt* transgenic cultivars. Biobit® 15 Flowable Concentrate: Bt 15% and inerts 85%;.Biobit® Wetable Powder: Bt 29% and inerts 71% Halt 3%WP:Bt 3% and innerts 97%; Dipel® 6.4WP: Bt 6.4% and inerts 93.6% ;Dipel® 4L: Bt 1.76% and inerts 98.24%;Delphin® 85 WDG:Bt 85% inerts 15% are examples of Bt formulations.Considering results of trials for evaluation of *bt* formulations (Biolep , Dipel 8L, Delfin WG and Halt WP) satisfactory suppression of *Earias vittella* on okra , *Spodoptera litura* on castor , *H. armigera* infesting chickpea and *Leucinodes orbonalis* on brinjalby *Bt* was reported

Bt var tenebrionis or ***san diego/tenebrionis***

The strain formulations(Trident, M-One, M-Trak, Foil, Novodor, etc.) have been developed to control the Coleopterous pests (Colorado potato beetle, Elm leaf beetle, Cottonwood leaf beetle).

Pseudomonas fluoroscence

It is other bacteria formulated as 1.15% WP, produced and supplied in large scale as bionematicide, antagonist to fungal and bacterial plant pathogens and plant growth promoter in Maharashtra.

Viral Pesticides

More than 250 entomopathogenic viruses have been described. Among these the Baculoviruses are highly host specific. Nuclear Polyhydrosis Viruses (NPVs) and Granulosis Viruses (GVs) are chronically lethal to Lepidopteran insects. *Oryctes* Virus is pathogenic to rhinoceros beetle. NPVs are mass cultured in laboratory by feeding virus contaminated natural food or artificial diet to the pests. In India presently NPV of American bollworm (HaNPV), *Spodoptera* (SlNPV), groundnut red hairy caterpillar, *Amsacta* spp (ANPV), sunflower hairy caterpillar, *Diacrisia obliqua*(DaNPV) are used in some areas and are giving encouraging results. The pest died due to virosis initiates and accelerates epizootic in pest populations. It also spreads by useful insects, birds, air, rains and gives multifold suppression of pests benefiting the several farmers. Two to three sprays at weekly interval in a season are sufficient to protect crop from the pest. LE (larval equivalent) based dose concept is confusing. Hence, the viral POBs count based recommended dose/spray of $1x10^9$ POBs/ml of formulation (CIB standard) is 500 ml/ha for the management of pests . The virus infected insects stop feeding within a day and prior to death the larvae climbs to upper portion of the plants and hang upside down. Few small producers and SAUs produce and supply it. The granulosis virus (GV) effectively controls the sugarcane early shoot borer.

Table 1. Commercial Baculovirus products used in foreign countries

Crops	Pests	Virus used	Product
Apple, pear, walnut and plum	Codling moth, *Cydia pomonella*	Codling moth granulosis virus **CpGV**	Cyd-X
Cotton, corn, tomatoes	*Spodoptera littoralis*	**SlNPV**	Spodopterin*
Cotton and vegetables	*Helicoverpa zea* and *Heliothis virescens*	*Helicoverpa zea* **HNPV**	Gemstar LC, Biotrol, Elcar
Alfalfa and other crops	Alfalfa looper (*Autographa californica*)	**AcNPV**	Gusano Biological Pesticide
Vegetable crops, greenhouse flowers	Beet armyworm (*Spodoptera exigua*)	**SeNPV**	Spod-X
Forest Habitat, Lumber	Gypsy moth (*Lymantria dispar*)	***Ld* NPV**	Gypchek (1)

Fungal pesticides

Out of 750 species of insect fungi *Verticillium lecanii, Beauveria bassiana, Metarhizium anisopliae, Nomuraea rileyi, Hirsutella thompsoni* have huge potential for microbial control of sucking pests; caterpillars and beetle pests; beetles, termites and grasshoppers; Lepidopterous larvae and mites, respectively. The fungal pesticides on application initiate disease in insects and stop feeding creating instability within a day. The diseased insects show mobility to the top sides of plants. In humid climate the infective peg enter the insect body grow and form hyphal net, release toxins and kill them in 3-10 days. The toxins produced by *B. bassiana* (Beauvaricin, Bassianolide),*V. lecanii*(Dipicolinic acid and Cyclodidepsipeptide), *M. anisopliae* (Destruxins A, B, C, D, and E and desmethyldestruxin B) interfere in body processes. Mycosis and fungal toxins kill the insects. Out of 100 spp of the fungal antagonist *Trichoderma* the commonly used spp *T. viridae* and.*T. harzianum* give best for biological suppression of plant wilts caused by root rot fungi. The seed treatments or/and soil drench (1%) and canopy sprays (0.5%) check fungal diseases. It is produced by smallest scale biopesticide industries in Maharashtra. *Ampelomyces qusaqualis* 0.5% sprays helps to control DM, PM.and fungal leaf spots and is required to be commercialized developing formulations. *Gliocladium* sp is another root rot fungal antagonist but it lagged behind due to dominance of aggressive *Trichoderma* in agroecosystem. *Paecilmyces lilacinus* is promising against the root knot nematodes. Phule *Trichoderma*(+) a formulation first developed by MPKV, Rahuri (*Trichoderma+ Paecilmyces lilacinus*) is cheapest biofungicide cum bionematicide.

Neem seed extract (NSE)

Neem, *Azadirachta indica* A. Juss (Rutales :Meliaceae) is an indigenous versatile potential source for organic plant protection. .The 258 compounds found in neem comprised of: **Isoprenoids:** 24 diterpenoids and more than 100 triterpenoids. All show more or less insecticidal property . Out of these **Azadirachtin has** unique bitter, ecofriendly, effective, economical and 100 % biodegradable properties of plant based model pesticide

Others: Glycerides, polysaccharides, sulphurous compounds, flavonoids and their glycosides, amino acids, aliphatic compounds.

"**Azadirachtin**" has antifeedent, deterrent, insect growth suppressor, sterilent, chronically lethal, antibacterial and antifungal properties in diverse mode of action against300 species of pests. Half doses could be used safely with biopesticides (insect NPVs and fungi) for synergistic effects suited for organic farming. Neem seed extract (NSE) 2% (for delicate plants) to 5%(for hardy plants) is the best household preparation for pest suppression than the neem formulations. If PPM based concentrating of azadirachtin is discouraged, the fear of development of resistance is distantly obscure. Pollinators, parasitoids and predator on neem treated crop restart their activities within 1-2 day of deterrence. Neem has also systemic action and seedling can absorb and accumulate the neem compounds to make the whole plant pest resistant. In Maharashtra neem seed availability potential of is of 5 tonnes.

On the basis of available information for suppression of major crop pests and weeds biological packages are summarised.

Potent Bioagents and Biopesticides for Organic Suppression of Crop Pests and Weeds

Sr. no.	Bioagents	Bioagent Group	Doses	Target Pest
I.	**Cotton :**			
1.	*Trichogramma chilonis* Trichogrammtidae Hymenoptera.	Egg parasitoid	10 Trichocards (Each 1cc Card)	Boll worms
2.	*Chilonis blackburni* Cameron Braconidae Hymenoptera	Egg - Larval parasitoid	15,000	Boll worm
3.	*Chrysoperla carnea* Chrysopidae :Neuroptera	Predator	10,000 eggs/ larvae OR 1,000 adults	Sucking pests of cotton
4.	*HaNPV* Basculoviridae : Baculovirus	Virus	1 x 10^9 POB's /ml:500ml	*Helicoverpa armigera*
3	*Beauveria bassiana* Moniliaceae Moniliales	Fungal pathogen	2 kg	Lepidopteran borers

Sr. no.	Bioagents	Bioagent Group	Doses	Target Pest
II.	**Sugarcane :**			
1.	*Trichogramma chilonis* *Trichogramma Japonicum* Trichogrammatidae :Hymenoptera	Egg parasitoid	5 Trichocards (Each 1cc Card)	*Tissue borers*
2.	*Isotoma javensis* Ichneumonidae Hymenoptera	Larval parasitoid	125 adults/ha.	Top shoot borer
3.	*Epiricania melanoleuca* Epipyropidae: Lepidoptera	Ecto parasitoid	5000 pupae	*Pyrilla perpusiella*
4.	Chilo infuscatellusGV (CiGV) Baculoviridae :Bacuvirus	Virus	1 x 10^9 POB's /ml:500ml	Early shoot borer.
5.	*Chilohorus nigrita* Coccinellidae: Coleoptera	Predator	1500 beetles	Scale insect, *Melanaspis glamarata*
6.	*Bacillus popillae* Bacillaceae Eubacteriales	Bacteria	0.5 kg/ha	White grub *Holotrichia.*
7.	*Dipha aphidirora* (Pyralidae:Lepidoptera) *Micromus igotorus* Chrysopidae: Neuroptera	Predator	1000 larvae/ pupae	White wooly aphid
8.	*Metarrhizium anisopliae* Moniliaceae Moniliales	Fungal pathogen	2 kg.	*Pyrilla perpusiella*
III.	**Rice :**			
1.	*Trichogramma japonicum* Trichogrammatidae Hymenoptera.	Egg parasitoid.	5 Trichocards (Each 1cc Card)	Stem borer, leaf roller
IV.	**Gram / Pegeonpea (Tur) :**			
1.	*HaNPV*	Insect virus	1 x 10^9 POB's /ml:500ml	Tur pod borer gram pod borer
2.	*Bacillus thuringiensis (Bt)* Kurstaki Eubacterials	Bacterial pathogen	0.5 – 1.0	Tur pod borer
3	*Beauveria bassiana* Moniliaceae Moniliales	Fungal pathogen	2 kg	Lepidopteran borers

Sr. no.	Bioagents	Bioagent Group	Doses	Target Pest
V.	**Groundnut :**			
1.	*Verticillium lecanii* Moniliaceae Moniliales *Cheilomonus sexmaculatus* Fab. Coccinelidae Coleoptera	Fungal pathogen Predator	2-3 kg 500 adults	Aphids- *Aphis Cracesivora*
2.	*SlNPV : Spodoptera litura* Baculaviridae: Baculovirus	Virus	250 LE	Leaf eating caterpillar *Spodoptera litura*
3.	*Bacillus popillae* Bacillaceae Eubacterials	Pathogen	0.5 kg	White grub.
3	*Beauveria bassiana* Moniliaceae Moniliales	Fungal pathogen	2 kg	Leaf roller
5.	*Metarrhizium anisopliae* Moniliaceae :Moniliales	Fungal pathogen	10 kg	White grub.
VI.	**Castor :**			
1.	*Trichogramma chilonis* *Trichogramma achaeae* Trichogrammatidae :Hymenoptera *AjNPV* 1 x 10^9 POB's Bacculoviridae:Bacullovirus	Egg parasitoid nsect virus	5 Trichocards (Each1cc Card) 500 ml	Caster semi-looper, *Achaeae janata*
2.	*Telenomus remus* Scelionidae; Hymenoptera *SlNPV* ,1 x 10^9 POB's	Egg parasitoid Insect virus	50,000 500 ml	*Spodoptera litura*
VII.	**Tomato/Okra/Brinjal/Cauliflower**			
1.	*Trichogramma chilonis* Trichogrammatidae: Hymenoptera	Egg parasitoid	5 Trichocards (Each1cc Card)	Shoot & fruit borer
2.	*HaNPV* Bacculoviridae: Bacullovirus	Insect virus	250 LE	Tomato fruit borer, *H. armigera.*
3.	*Bacillus thuringiensis* Bacillaceae: Eubacterials	Insect pathogen	0.5-1.0 kg.	*L. Arbonalrs, H. Armigera,* DBM
4.	*Trichogramma pretisosum* Trichogrammatidae: Hymenoptera	Egg parasitoid	5 Trichocards (Each1cc Card)	DBM, *Spodoptera*

Sr. no.	Bioagents	Bioagent Group	Doses	Target Pest
5.	*Cotesia putellae* Encyrtidae Hymenoptera	Larval pupal parasitoid	50,000 adults	DBM cabbage butterfly
6.	*i.Copidosoma koehleri* Encyrtidae Hymenoptera *ii.Trichogramma chilonis* Trichogrammatidae Hymenoptera	Egg-Larval parasitoid Egg parasitoid	50,000 adults 5 Trichocards (Each1cc Card)	Potato tuber moth Cut worms.
7.	*Spodoptera litura* NPV (SlNPV) Bacculloviridae Bacullovirus	Virus	1 x 10^9 POB's /ml:500ml	*Spodoptera* on vegetables.
8	*Hirsutella thompsoni* Moniliaceae :Moniliales	Fungal pathogen	2 kg	Mites
VIII.	**Coconut :**			
1.	*Goniozus nephantidis* Bethylidae Hymenoptera	Larval parasitoid	500 adults	Coconut black headed caterpillar.
2.	*Brcon brevicornis* Braconidae Hymenoptera	Larval parasitoid	500 adults	Coconut black headed caterpillar.
3.	*Metarrhyzium anisopliae* Moniliaceae Moniliales	Fungal pathogen	80 ml/cubic meter manure	Rhinocerou s beetle *Oryctes rhinocerous*
4.	*Baculovirus oryctes* Baculovidae:Bacculovirus	Insect virus	1 x 10^9 POB's /ml:500ml	White grub.
IX.	**Fruit crops and Polyhouse crops (Rose & Orange)**			
1.	*Rodelia cardinalis* (Vedalia beetle) Coccinellidae :Coleoptera	Predator	Predator 150 beetles	Cottony coushion scale, *Iceria purchasi*
2.	*Cryptolaemus montrouzieri* Coccinellidae Coleoptera	Predator	1500 grubs or adults , 3-4 grubs / vine	Mealy bugs on fruit crops.

Sr. no.	Bioagents	Bioagent Group	Doses	Target Pest
3.	*Verticillium lecanii* Moniliaceae:Moniliales	Fungal pathogen	1 x 10^8 cfu/g 2-4 kg/ha	Scale insects, mealy bugs, white flies, thrips, mites, aphids
4	*Ampelomyces quasaqalis* Moniliaceae:Moniliales	Fungal pathogen	1 x 10^8 cfu/g 2-4 kg/ha	Fungal diseases of folliage
4.	i.*Paeclomyces lilicacinus* ii.*Trichoderma* spp, 1 x 10^8 cfu/g Moniliaceae:Moniliales ii. *Pseudomonas fluroscence* Bacillaceae: Eubacterials	Nematode trapping fungi Bacterial pathogen	5-10 g/kg seed or 5 kg/ha in soil as 0.5% suspension	Root-knot nematodes in various crops.
5	*Trichoderma viridae/hargianum+* *Paeclomyces lilicacinus* 1 x 10^8 cfu/g	Biofungicide Cum nematicide	5-10 g/kg seed or 5 kg/ha in soil as 0.5% suspension	Plant wilts caused by root rot fungi &root-knot nematodes in various crops
X.	**Weeds :**			
1.	*Neochetina bruchi* *Cyrtobagous salvinia* Curculionidae :Coleoptera	Leaf & bulb feeder Leaf feeder	5 weevils/ sq.mt. --	Water hysinth in stagnated water. waterfern
2.	*Zygogramma bicoloaratal* Chrysomellidae: Coleoptera	Leaf feeder	500 beetles as inundative release	Parthenium weed.
3.	*Dactylopius tomentosu s* *Cocheneal Insects –* Dactylopiidae: Hemiptera	Leaf feeder-sucking insects (desaper bugs)	1,000 adults	Prickly per cactus.
4.	*Telemenia scrupulosa* Tingidae:Hemiptera	Leaf feeder-sucking insects (desaper bugs)	1,000 adults	Lantana camera
5.	*Cactoblastis cactorum Berg* Pyrahidae: lepidoptera	Borer	1,000 adults	Cactus sp.

Availability and quality control of biopesticides

Timely availability of biopesticides and their quality parameters are major constraints .The progress of biopesticide production and supply is satisfactory. Mostly Small scale industries developing and producing the fungal and the viral pesticides in India .Tamilnadu, Maharashtra, UP, Karnataka and Andhra Pradesh are leading states in establishing the biopesticides production units.

State-wise laboratories undertaking production of bioagents/ biopesticides in 2003

Sr. No.	State/ UTS	Central sector	ICAR/ SAU's	DBT	State sector	Private sector	Total
1	Tamil Nadu	1	3	4	77	38	123
2	Maharashtra	1	7	3	3	23	37
3	Uttar Pradesh	2	1	2	16	14	35
4	Karnataka	1	7	1	11	10	30
5	Andhra Pradesh	2	2	2	15	7	28
6	Gujarat	1	1	1	2	15	20
7	West Bengal	1	-	-	14	3	18
8	Kerala	1	2	1	10	1	15
9	Rajasthan	1	-	1	9	2	13
10	Orissa	1	1	1	7	1	11
11	Punjab	1	1	1	4	-	7
12	Haryana	1	-	1	2	3	7
13	Madhya Pradesh	1	-	-	1	3	6
14	Bihar	1	-	-	1	4	6
15	Assam	1	1	1	2	1	6
16	J & K	2	-	1	2	-	5
17	Delhi	-	2	-	-	3	5
18	A & N Islands	1	1	1	2	-	5
Total units:		**368**					

Central and State sector, ICAR, DBT and SAU biocontrol labs producing small quantity of quality biopesticides; if exempted from registration provision of Insecticide Act 1968 considering their competency for teaching, research, extension ,quality tests and quality control; these labs will be pivots for hidden pressure on private sector for quality and price control of the products.

The mandatory establishment of regional mass production units of highly potent parasitoids(*Trichogrammatids*),predators (*Chrysoperla* and *Cryptolaemus*) of crop pests and weed feeder (*Zygogramma biclorata*) at each registered and working sugar factories, textile mills, fruit and vegetable growers association, interested 'Mahila Mandals'and saving groups providing 50-90 % subsidy by government will certainly increase the availability of bioagents.. In Maharashtra Panchayat level neem seed collection and powdering centre by Mahila Bachat Gats shall ensure coverage of about 10 lakhs ha cropped area/annum for potential utility of NSE in organic farming.

Value of chemical pestcides used in India

Group of chemical pesticides	**Quantity used MT (% of total)**	**Value (Crore Rs.) (% of total)**
Clorinated hydrocarbon and O.P	1,04,717 (85.59)	1228 (54.41)
Synthetic Pyrethroids	7,809 (06.38)	181 (08.02)
New :Neonicotinoids/IGRs etc	9,810 (08.02)	848 (37.51)
Total	**1,22,336**	**2257**

Maharashtra-Consumption:3500 tons a.i., Cost: 645 Crores

Estimated Requirement of most important bioagents and Biopesticides for Maharashtra

Sr no.	**Bioagens**	**Quantity /annum 2008-13**	**Cost (Crore Rs.) 2008-13**	**Increase Rate (%)**	**Target crop Pests (Considered Area coverage %)**
1	Trichocards (lakhs)	20-29.3	8--14.65	10	Borers-S.cane(50), Bollworms - cotton(25)
2	*Cryptolaemus* Beetles (lakhs)	100-146	2--2.93	10	Mealy bug-Grapes (65)
3	Mummified PTM larvae by *Copidosoma* (lakhs)	2-2.93	0.01--0.015	10	PTM-Potato (20)
	Total	--	10.01--17.59	10	

Sr no.	Biopesticides	Quantity/ annum 2008-13	Cost Crore Rs 2008-13	Increase Rate (%)	Target crop Pests with crop Area coverage (%)
1	HaNPV (KL)	250-304	22.5-27.45	5	*Helicoverpa*-Gram(20), Tur(20), Grapes(20), Tomato(50)
2	SlNPV (KL)	80-117	5.60-8.19	10	*Spodoptera*-G.Nut (10), Soya bean (10),Cabbage (10)
3	*Verticillium lecanii* (MT)	2450-4286	3.67-6.42	15	Sucking pests-Grapes(80), Cotton (25),Vegetables(70), G.Nut(10)
4	*Beauveria bassiana* (MT)	2215-2547	2.77-4.84	15	Flea beetle-Grape(80); Bollworms-Ctton(25);Defoliators-G.Nut(10), & Fruit borers-Vegetables
5	*Metarhizium anisopliae*(MT)	8-17.48	1-2.19	20	White grubs-S. cane(5)
6	*Trichoderma* (MT)	3560-4094	3.56-6.23	20	Plant wilts & Nematodes – Pomegranate & above all corps (65)
7	*Pseudomonas fluorescence* (MT)	3100-6428	3.87-8.04	20	Bacterial & fungal diseases, Biophytotonic -Above all corps (65)
8	*Paecilomyces lilacinus*(MT)	1000-1420	1.25-1.78	20	Root knot nematodes-Pomegranate, Grapes, Cucurbits, Tomato, Brinjal(20)
	Total Biopesticides	12663-19214	44.22-65.5	15	-----
	Total cost of Biopesticides +Bioagents		**54.01-83.09**	12.50	----

Quality control of biopesticides

It is more concern than their registration. At least one referral lab /3-4 districts is needed to test quality of biopesticides samples collected from open market by pesticide inspector with regional monitoring team. It is necessary to establish 10 biopesticide Quality Control Units in SAUs providing Rs. 10 lakhs/unit for infrastructure with recurring cost Rs.7 lakhs/ unit for pay and allowances of 1SRA, 2 Tech. Asstt. and 1 lab boy. The part of expenditure on quality control units is to be met by charging Rs. 200/q/annum of the production capacity of each small scale industry. Considering the past experience that the biopestcides are almost safe and produced by small scale industries; set up of State Bioinsecticide Board and

Registration Committee (SBB/RC) is necessary to speed up the registration process and to sustain mission of organic plant protection. The biopesticide production capacity of Maharashtra is around 3000 tones against requirement of about 12000 tones/annum for IPM and organic farming.

Conclusions and measures to popularize organic plnat protection

1. Biological control is inevitable component of organic plant protection and 80-90 % major pests of major crops are manageable by biointensive IPM.
2. Biopesticides are emerging as major driving force to chemical pesticides. *Bt*, fungal and viral biopesticides availability is increasing.
3. There is a need to establish around 100 Trichocard production units (5000 cads/unit/annum) in sugar factories in M.S providing 50% (Rs.5 lakhs/unit) subsidy by the Government.
4. Considering mealy bug problem on grapes in M.S. establishment of 10 units of *Cryptolaemus* production (2 lakhs *C. montrouziery* /unit/annum) are required at registered Grape Growers Associations providing 75% (Rs. 6 lakhs/unit) subsidy by the Government .
5. The quality control is of a more concern than registration of biopesticides. The establishment of 10 referral labs(one lab /3-4 districts) in SAUs in M.S. is required to test quality of biopesticides samples collected from open market by pesticide inspector with regional monitoring team charging quality control charges of Rs.200 / q /annum to small scale industries (SSI) by the State Government for production capacity of the SSI.
6. Biopesticide requirement of Maharashtra is 12000 tons against present production capacity of 3000 tons.
7. Considering past experience that biopesticides are almost safe and produced by small scale industries; set up of "State Biopesticide Board and Registration Committee (SBB/RC)" is necessary to speed up the registration process and to sustain mission of organic plant protection.
8. For promoting NSE use, "Mahila Bachat Gats" in villages (> 5000 population) could be encouraged to establish neem seed collection, powdering and sale units providing 90% subsidy of Rs. 1.80 lakhs/unit.
9. Distributing pamphlets/leaflets through 'Panchayats' to villagers for propaganda to conserve and augment naturally available bioagents. Planting shrubs and trees along the field bunds, few rows of cowpea, maize, mustard, setaria in crops and need based use of systemic insecticide as seed treatments and soil application.
10. Popularization of organic plant protection comprising cultural control, mechanical control, the use of NSE, parasitoids, predators and microbial pesticides through e-media.

Nutrient management for organic farming

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The food security, nutritional security, sustainability and the profitability are the main focuses of present and future development. The ecosystem has been under constant pressure of abiotic and biotic stresses all through the millennium. The excessive abiotic and biotic interferences and the unscientific exploitation without are adequate replenishment have caused considerable degradation of natural resources of land, water, vegetation and ground water. There has been an acute resource depletion of the already fragile ecosystem through over exploitation of resource by ever increasing/expanding human and live stock population and the development activities. The population pressure in India has forced to intensify agriculture. Ever widening gap between the demand and the supply of biomass due to increasing demographic pressures, decreasing per capita land availability and environmental quality concerns call upon sustainability of land productivity and environmental safety by scientists, administrators and environmentalists.

It is becoming clear that the food security to the teeming millions will not be possible unless the available resources are efficiently utilized for increasing the productivity. The genetic heterogeneity of earlier system of agriculture was fast replaced by genetic homogeneity, thereby enhancing the genetic vulnerability to both abiotic and biotic stresses. The high yield, high input and high intensity in agricultural production processes have been characteristic features of Green Revolution Model. The green revolution has shown significant spectacular increase in food production from about 50 Mt in 1950 to 203 Mt in 2000 AD in the country. The rate of population growth however, continues to be unabated. It is estimated that by 2020, India will need about 294 million tones of food grains i.e. about 94 Mt more than what is currently produced and this increase has to come from the increasing productivity per hectare of land. This will call for higher rates of nutrients applications. The founding father of the green revolution in India, Dr. Norman Borlog, has rightly stated that but for the use of chemical fertilizers, India and China would have needed two or three times more land under cereals to meet the food needs of 1991, if they used the technology of 1960 and not increase the fertilizer input to sustain its present level of production. Fertilizer has certainly played a critical role in India's green revolution, but per hectare consumption of fertilizer is still much less than the neighboring countries in Asia. This unfortunate situation is compounded by imbalance use of N, P_2O_5 and K_2O (nutrient consumption ratio 6.9:2.9:1). The fertilizer consumption is far below the actual nutrient removal from the farmer's field. India has a total organic nutrient source potential of 7.8 MT of total N + P_2O_5 + K_2O requirement of 45 Mt by 2025. As a country tempted on 'own' organic farming, it is obvious that the farming in India without adequate fertilizer input will prove fatal for both food security and environmental quality because of prevailing climatic conditions. The soils of India having low organic matter content are generally poor in fertility. These soils have consistently been depleted of their finite nutrient resource due to the continuous cultivation for many centuries.

The basic concept underlying IPNS is the maintenance or adjustment of soil fertility and of plant nutrient supply to an optimum level for sustaining the desired crop productivity through the optimization of the benefits from all possible sources of plant nutrients in an integrated manner.

The organic farming relies on crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes and aspects of biological pest control to maintain soil productivity and tilth, to supply the plant nutrients and to control insects, weeds and other pests. The concept of soil as a living system that promotes the activities of beneficial organisms is central to this definition. The organic agriculture does not imply the simple replacement of synthetic fertilizers and other chemicals with organic inputs and biologically active formulations. Instead, it envisages a comprehensive management approach to improve the productivity of soil. In a healthy soil, the biotic and abiotic components covering organic matter including soil life, processes in mutual harmony by complementing and supplementing each other. When the soil is in good health, the population of soil fauna and flora multiplies rapidly which, in turn, sill sustains the biochemical processes of dissolution and synthesis at a high rate. This rate of soil life and the associated organic transformations will enhance the regenerative capacity of the soil and make it resilient to absorb the effects of climatic vicissitudes and occasional failures in agronomic management.

Table 1. Major sources of plant nutrients

Sr. No.	Resources	Remarks
A.	Organic Manures –FYM, Poultry manure	Source of all nutrients present and effect on soil physical properties
B.	Crop Residues, Crop rotation	Source of all nutrients, most important for K, effect on soil properties and role of mulches.
C.	Green Manures-Agro-industrial waste	Source of all nutrients, most important for N and effect on soil physical properties.
D.	N fixing systems	Most important as contributors of N.
E.	Mycorrhiza, P – solubilising micro – organisms	Enhanced availability of soil and fertilizer P

Biofertilizers

Biofertilizers by rendering the unavailable source of elemental nitrogen, bound phosphates and decomposed plant residues into available forms help enhancing the soil fertility and crop yields. In India, during recent years due emphasis is being laid on biofertilizers. The response of biofertilizers has been spectacular in Southern India (Tamilnadu) with 30-50 % of farmers using bio-fertilizers. The most common inoculants used are Rhizobium and phosphate solubilizing bacteria (PSB) for legumes and Azospirillum and PSB for other crops. The acceptability of biofertilizers has, however, been poor with the farmers of northern India. The lack of availability and poor performance are stated to be the main reasons for low popularity of the biofertilizers.

The organic farming is not mere non-chemicalization in agriculture; it is a system farming based on integral relationship. So, one should know the relationship between soil, water, plant and micro-flora and the overall relationship between plant and the animal kingdom. It is the totality of these relationships, which is the backbone of organic farming. Organic farming does not totally exclude the elements of modern agriculture. Varying agro-climatic conditions do need input from the current technological advances. It is basically simple as it abhors the excessive ploughing, hoeing, weeding and application of plant protection chemicals and fertilizers. The principal elements to be considered while practicing organic farming are :

1. Maintaining a living soil.
2. Making available all the essential nutrients.
3. Organic mulching for conservation, and
4. Attaining the sustainable high yields.

The agricultural practices followed in organic farming are governed by the principles of ecology and are within ecological means. Limited experience shows that this form of natural farming is the basis of sustainable and could be highly productive.

Production system of organic farming depends on the use of crop residues, animal manures, green manures, off farm organic wastes, vrop rotation, biodynamics and biofertilizers.

Nutrition Components

A. 1. Organic manures - FYM, compost, oil cakes, green manures, poultry manures etc.
   2. Biofertilizers - Azotobacter, Rhizobium, PSB, Azolla, Blue green algae, Acetobacter
   3. Vermicompost
   4. Crop residues
   5. Animal residues
   6. Organic farm waste
   7. Industrial waste

B. Cropping systems – monocropping, crop rotation, intercropping, sequence cropping, mixed cropping

C. Mulching

Nutrient status of organic manures

Sr. No.	Sources	Per cent Nutrient		
		N	P_2O_5	K_2O
1.	Cattle dung	0.3-0.4	0.10-0.15	0.15-0.20
2.	Cattle urine	0.80	0.01-0.02	0.5-0.7
3.	Sheep dung	0.65	0.50	0.03
4.	Night soil	1.2-1.5	0.80	0.50
5.	Human urine	1.0-1.2	0.1-0.2	0.2-0.3
6.	FYM	0.5-1.0	0.15-0.20	0.5-0.6
7.	Poultry manure	2.87	2.00	2.35
8.	Vermicompost	1.20-1.16	1.8-2.0	0.5-0.75
9.	Rural compost	0.5-1.0	0.20	0.30
10.	Castor cake	5.5-5.8	1.80	1.00
11.	Groundnut cake	4.50	1.70	1.50
12.	Rapeseed cake	5.10	1.80	1.00
13.	Linseed cake	5.50	1.40	1.20
14.	Safflower cake	4.80	1.40	1.20
15.	Blood meal	1.12	1.20	1.00
16.	Horn and hoofs meal	1.30	0.30-1.5	-
17.	Fish meal	1-10	3-9	1.5

Projections of tapable nutrients from organic sources for Agriculture

Resources	Year		
	2000	2010	2025
Generators			
Human population (million)	1000	1120	1300
Livestock population (million)	498	537	596
Resources (considered tappable)			
Human excreta (dry) (million tonnes)	13	15	17
Live stock dung (dry) (million tonnes)	113	119	128
Crop residues (million tonnes)	99	112	162
Nutrient (potentials) (million tonnes N + P_2O_5 + K_2O)			
Human excreta	2	2.24	2.6
Live stock dung	6.64	7.00	7.54
Crop residues	6.21	7.1	20.27

Nutrient potential of biological wastes

Biological waste	Quantity avail. (M Mg yr^{-1})	Total N + P_2O_5 + K_2O (M Mg yr^{-1})
Cattle dung manure	279.8	6.88
Crop residue	273.3	7.15
Forest litter	18.7	0.24
Rural compost	285.0	3.71
City refuge	14.0	0.29
Press mud cake	3.2	0.17
Total		18.44

Incorporation of legumes in crop rotation for soil health

Residual effect of preceding legume on cereal yield in terms of fertilizer N equivalents

Preceding	Following	Fertilizer N equivalent (kg ha^{-1})
Berseem	Maize	123
Blackgram	Sorghum	68
Greengram	Sorghum	68
Greengram (monocrop)	Wheat	68
Chickpea	Maize	60-70
Cowpea	Maize	60
Groundnut	Pearl millet	60
Cowpea	Pearl millet	60
Chickpea	Pearl millet	40
Pigeonpea	Wheat	40
Cowpea (mobocrop)	Wheat	38
Lathyrus	Maize	36-38
Lablab bean	Maize	33
Greengram (intercrop)	Wheat	16
Cowpea (intercrop)	Wheat	13

Groundnut (intercrop)	Wheat	12
Groundnut	Wheat	60

Quantity of N fixed by legume

Crop	N fixed (kg ha^{-1})
Cowpea	80-85
Pea	52-57
Blackgram	50-55
Chickpea	85-100

Response of vegetable crops to PSB and VAM inoculation

Crops	Increase in yield (%)	Phosphorus economy (%)
PSB		
Garlic	14.2	25
Onion	9.6	25
Potato	30.50	-
Pumpkin	51.00	25
VAM		
Chilli	14.20	-
Onion	4.70	25
Potato	20.00	-
Tomato	14.20	-

Nutrient concentration of crop residues

Sr. No.	Crop residue	Nutrient per cent		
		N	P_2O_5	K_2O
1	Rice	0.61	0.18	1.38
2	Wheat	0.48	0.16	1.18
3	Sorghum	0.52	0.23	1.34
4	Maize	0.52	0.18	1.35
5	Pearlmillet	0.45	0.16	1.14
6	Sugarcane	0.40	0.18	1.28

Jivamrut

Cow dung	10 Kg	Per acre
Cow urine	10 litre	
Jaggery	1 kg	
Legume flour	2 kg	
Water	200 lit	

Bijamrut

Cow dung	1 Kg	Per acre
Cow / buffalo urine	1litre	
Cow milk	100 ml	
Lime	50 g	
Surface soil from banian tree	500 g	
Tricoderma	100 g	

Vermiwash

- 15 kg cow urine
- 5 kg sieved vermicompost
- 24 hour hanging
- Liquid – Vermiwash
- Solid – Used in field

} Per acre

- Liquid part spray three times with equal proportion through 200 litre water

Effect of different components on yield of vegetables

Sr. No.	Treatments	Green chillies (t/ha)	Onion bulbs (q/ha)	Okra fruits (q/ha)
1.	Control	1.5	42.9	25.9
2.	FYM (25 t/ha)	14.1	60.7	46.6
3.	Bio-gas slurry (10 t/ha)	12.4	60.7	46.9
4.	Goat Manure (10 t/ha)	15.8	52.4	43.0
5.	Poultry Manure (4 t/ha)	13.9	56.0	42.8
	S.E. ±	2.26	5.7	-
	C.D. (0.05)	4.80	12.2	NS

Conclusion

- Integrated use of quality organic resources of nutrient as per the need of crop is essential
- Understanding of nutrient flux with respect to crop demand is necessary.
- Optimization of organic resource input combinations specific to the agro ecological zones and cropping system needs to be estimated.

Session-IV
Transgenic crops and environmental aspects of organic farming

GM crops and organic farming

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World population was only 0.31 billion in 1,000 AD and increased at a slow rate up to 1,800 AD when it reached 1 billion mark (Table 1). It took 130 years after 1, 800 AD to double itself to 2 billion in 1930. However, it doubled again to 4 billion in 1974 i.e. only 44 years after 1930. It will again double to 8 billion by about 2025 i.e. by the end of the first quarter of the 21st century. The world population is currently increasing at the rate of 1.3% or about 73 million per year. Further, the increase in population is extremely unequal among the geographical regions, since 97.5% of the annual increase is occurring in developing countries where soil, water and other natural resources are under great stress. Two countries of Asia alone, namely China and India make up about 38% of the world population and they are the ones where population increase is the fastest.

Table 1. World population

Year (AD)	Population (billion)	Year	Population (billion)
1	0.30	1930	2.0
1000	0.31	1960	3.0
1250	0.40	1974	4.0
1500	0.50	1987	5.0
1750	0.79	1999	6.0
1800	1.00	2020	7.5
1900	1.65	2020	7.5
		2050	9.4
		2100	12.00

In the light of mounting population pressures and rising quality of life expectation, the food systems are challenged to meet the current global needs for the up coming future. In undeveloped and developing countries, an enormous increase in population has resulted in poverty, food insecurity and poor nutrition among the masses. The advances in scientific discovery and laboratory techniques has led to the ability of plant improvement through the use of biotechnology and genetic engineering by manipulating the existing genetic resources.

For the last decade and half, the conventional crops have genetically modified for a variety of reasons including the longer shelf life, improved nutritional value, enhanced agronomic traits such as herbicides resistance, microbial insect resistance and tolerance to various severe environmental perturbances (Engel *et al.* 2002,Konig *et al.* 2004). To enhance the food supply by increasing the crop yields, plants are continuously being bioengineered and/or genetically engineered (GE)/genetically modified (GM) and GM plants are prevalent worldwide and appear in many processed food products (Perr 2002). In 1996, GM crops were first introduced into the commercial market in the United States and were rapidly adapted by the farmers. Great success was achieved in increasing the agricultural productivity to fulfill the human needs during the 20th century due to the introduction of GM crops (Yan and Kerr, 2002; Rommens *et al.* 2004).

The adoption of transgenic crops and organic farming reduce the use of pesticide and insecticides in agriculture. Due to adoption of Bt cotton varieties, the considerable reduction in pesticide consumption has been noted. The transgenic plant species commercialized during last eight years are (http://www.isb.vt.edu/)):

1. Herbicide resistance (canola, soybean, cotton, rice, wheat, carnation, chicory, corn, sunflower, tobacco sugar beet)
2. Insect pest resistance (cotton, corn, tomato and potato)
3. Viral resistance (Papaya, squash and potato)
4. Slow ripening and softening (tomato and melon)
5. Improved oil quality (canola and soybean)
6. Male sterility (canola and corn)
7. Pigmentation pattern (carnation)
8. Reduced nicotine content (tobacco)

Area under GM crops in world

Different countries plant the GM crops since 1996. Although the first commercial GM crops were planted in 1994 (tomatoes), 1996 was the first year in which a significant area (1.66 million hectare) of crops was planted containing GM traits. Since then there has been a dramatic increase in planting. In 2005 these crops occupied an area of 87.16 million hectares in the year 2005 and were grown in 21 countries (Table 2) The US has the largest share of global GM crops planting (55% 47.4 million ha), followed by Argentina (16.93 million ha, 19% of the global total). The other main countries planting GM crops in 2005 are Canada, Brazil and China (Table 2). More recently, the significant and increasing areas have been planted to GM crops in newer adopting countries such as Paraguay, South Africa and India (and other countries such as Spain, Romania, the Philippines, Mexico and Uruguay) (Brookes and Barfoot, 2006).

Table 2. Global GM plantings by country 1996-2005 ('000 hectares)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
US	1,449	7,460	19,259	26,252	28,245	33,024	37,528	40,723	44,788	47,395
Canada	139	648	2,161	3,529	3,331	3,212	3,254	4,427	5,074	5,858
Argentina	37	1,756	4,818	6,844	9,605	11,775	13,587	14,895	15,883	16,930
Brazil	0	100	500	1,180	1,300	1,311	1,742	3,000	5,000	9,000
China	0	34	261	654	1,216	2,174	2,100	2,800	3,700	3,300
Paraguay	0	0	0	58	94	338	477	737	1,200	1,800
Australia	40	58	100	133	185	204	162	165	248	275
South Africa	0	0	0.08	0.75	93	150	214	301	528	595
India	0	0	0	0	0	0	44	100	500	1,300
Others	0.9	15	62	71	94	112	136	209	527	710
Total	**1,665**	**10,072**	**27,161**	**38,730**	**44,163**	**52,300**	**59,245**	**67,357**	**77,448**	**87,163**

Distribution of GM crops in different countries

On global basis the major GM crops area is under soybean, corn, cotton and canola. In 2005 soybean had the largest area (62%) followed by corn (22%), cotton (11%) and canola (5%) (Table 3). While, in USA the main GM crops were soybeans and corn, which accounted for 57% and 33% of total GM plantings, respectively. The balance came from cotton and canola. In Canada, canola planting was dominated with a share of 74%. The others crops were corn (14%) and soybeans (12%). In Brazil and Paraguay all planting were soybean and cotton was in China and Australia. In terms of production of GM crops, GM technology accounted for important shares of total production of the four crops (soybean, maize, cotton, canola) in several countries (Brookes and Barfoot, 2006).

In India except Bt cotton, no other transgenic or GM food crops have yet been commercialized with an area of 1.3 million ha during 2005-06 (Table 4). Though there are extensive efforts are in progress (Koundal, 2003).

Table 3. GM technology share of crop plantings in 2005 by country (% of total plantings)

Country	Soybeans	Maize	Cotton	Canola
US	93	52	79	82
Canada	60	65	N/a	95
Argentina	99	62	50	N/a
South Africa	65	27	95	N/a
Australia	N/a	N/a	90	N/a
China	N/a	N/a	65	N/a
Paraguay	93	N/a	N/a	N/a
Brazil	40	N/a	N/a	N/a
Uruguay	100	N/a	N/a	N/a

Note: n/a=not applicable

Table 4. Area under Bt cotton in India

Year	Area under Bt Cotton (ha)
2002-03	44,500
2003-04	100,000
2004-05	500,000
2005-06	13,00,000

ISAAA, 2006

Benefits of GM crops

The transgenic modification, traditional and modern applied to plant and animal food sources hold potentials for improving human nutrition and health provided that the capabilities for using GM crops are available in the developing as well as the developed countries.

Traditional plant breeding methods and transgenic techniques create new gene combinations with novel traits such as resistance to pests, diseases and herbicides although a greater degree of "genetic novelty" may be possible in transgenic plants as compared to traditional cultivars. The potential environmental benefits of such transgenic crops are as follow:

Reduce use of chemicals and increase in yield and income

Some of transgenic crops e.g. cotton, corn, soybean reduce the cost of production and increase the productivity. Monsanto developed a GM crop known as Bt cotton, which produces an insect control protein (Cry/AC) derived from the naturally occurring soil bacterium *Bacillus thuringiensis* subsp kurstaki (B.t.k.). The production of the cry/AC protein in the cotton plant provides protection against key Lepidopteron insect pests including cotton bollworm and pink bollworm (Wilson *et al.*, 1994, Betz *et al.* 2000). The primary benefits of bollgord cotton are reduced insecticide use, improved control of target insects/pests, improved yield, reduced production cost and improved profitability (Edge *et al.* 2001, Carpenter and Ganessi, 2001, Betz *et al.* 2000).

GMIR cotton has been planted commercially in India since 2002. In 2005 1.3 million ha were officially recorded as planted to GMIR cotton, which is equal to about 16% of total planting. The main impact of using GMIR cotton has been major increase in yield. The yield gains have resulted in important net gains to levels of profitability of $ 139/ha, $ 324/ha, $ 171/ha and $ 260/ha, respectively in 2002, 2003, 2004 and 2005 (Table 5) (Brookes and Barfoot, 2006).

Table 5. Farm level income impact of using GM IR cotton in India 2002-2005

Year	Cost saving (net after cost of technology ($/ha)	Net increase in gross margins ($/ha)	Increase in farm income at a national level ($ millions)
2002	-12.42	138.91	6.18
2003	-16.2	323.68	32.4
2004	-13.56	171.4	85.7
2005	2.54	260.47	338.6

Cattaneo *et al.* (2006) reported that the average number of insecticide applications in non-Tr cotton was 6.6, which was significantly higher than in Bt (3.4) and Bt Hr (2.8) cotton and at the same time higher lint yield was produced by Tr. Cotton than non-Tr. cotton. Similarly on global basis, the study on the farm benefits by different GM crops indicated that during 2005, farm income is enhanced to the tune of US$ 25 million to US $ 2281 million (Table 6). The largest gain in farm income has arisen from soybean followed by cotton (Brookes and Barfoot, 2006).

Table 6. Global farm income benefits from growing GM crops 1996-2005:million US$

Trait	Increase in farm income 2005	Increase in farm income 1996-2005	Farm income benefit in 2005 as % of total value of production of these crops in GM adopting countries	Farm income benefit in 2005 as % of total value of global production of these crops
GM HT soybeans	2,281	11,686	5.72	4.86
GM HT maize	212	795	0.82	0.39
GM HT cotton	166	927	1.16	0.64
GM HT canola	195	893	9.45	1.86
GM IR maize	416	2,367	1.57	0.77
GM IR cotton	1,732	7,510	12.1	6.68
Others	25	66	n/a	n/a
Totals	5,027	24,244	6.0	3.6

Between the developed and developing countries, the majority of farm income benefits (55%) have been earned by developing countries. The cost of accessing GM technology is lesser (13% of total farm income gains) in developed countries than that of developed countries (38%) (Table 7).

Table 7. GM crop farm income benefits 2005:developing versus developed countries: million US $

	Developed	Developing	% Developed	% Developing
GM HT soybeans	1,183	1,658	41.6	58.4
GM IR maize	364	53	86.5	13.5
GM HT maize	212	0.3	99.9	0.1
GM IR cotton	354	1,378	20.4	79.6
GM HT cotton	163	3	98.4	1.6
GM HT canola	195	0	100	0
GM VR papaya and squash	25	0	100	0
Total	**2,496**	**3,092**	**45**	**55**

Based on the global data from 1996-2005, it was reported that there were considerable reduction in volume and active in gradient of herbicide and insecticides used through GM crop technology (Table 8).

Table 8. Impact of changes in the use of herbicides and insecticides from growing GM crops globally 1996-2005

Trait	Change in volume of active ingredient used (million kg)	% change in ai use in GM growing countries
GM HT soybeans	-51.4	-4.1
GM HT maize	-36.5	-3.4
GM HT cotton	-28.6	-15.1
GM HT canola	-6.3	-11.1
GM IR maize	-7.0	-4.1
GM IR cotton	-94.5	-19.4
Total	**-224.3**	**-6.9**

Reducing toxic chemicals in the environment

The reduction in use of chemicals for pest control is the most evident environmental benefit cited for transgenic crop plants. Every year 971 million lbs of pesticides have been applied by US farmers, which may poison the soil, air, ground water and aquatic ecosystems (Brown 2001). Most transgenic crops viz. soybean; corn, cotton and canola contain the pest resistance gene(s) resulting in a significant drop in use of pesticides (Betz *et al.* 2000).

Environmental monitoring and remediation

Phytoremediation has been widely pursued in the recent years as a favourable clean-up technology and is an area of intensive scientific investigation. The transgenic plants have been proposed as a tool to detect and deal with the environmental pollution (Monciardini *et al.* 1998). *Arabidopsis thaliana* and *Tobaccum nicotiana* have been engineered with non plant trangenes to enhance phytoremediation effectiveness against such priority pollutants as Organomercurials (Bizily *et al.* 1999), trichloroethylene solvents (Dorty *et al.* 2000), nitroaromatic explosives (Free *et al.* 1999).

Potential risks associated with the cultivation of GM crops

The risks of GM crops deal with the ecology and toxicology of GM crops upon the release and use. The risks involved with cultivation and use of transgenic plants are:

Introduction of allergenic or harmful proteins into the food chain

Genetic engineering is capable of introducing allergens into recipient plants (Nordlee *et al.* 1996). Gene products that are not allergenic normally would not suddenly become allergenic when expressed in transgenic plants. If the gene product is a known allergen, then it will also be an allergen in a transgenic plant.

Detrimental effects on non-target species and the environment

Transgenic crops that express insecticidal transgenes to control agricultural pests may also affect non-target organism (Hilbeek *et al.* 1998, Saxena *et al.* 1999).

Increase invasiveness and weediness of crop plants

The relevance of assessing weedy characteristics when considering the invasiveness of GM crops has been the subject of much debate (Fitter *et al.* 1990). It is possible that release of GM crops would result in agricultural weeds and therefore may add to the burden of farmers.

Pest resistance

The release and wide spread cultivation of GM crops with pest or diseases resistance has raised concerns that this will impose an intense selection pressure on pests and pathogen population to adopt to the resistance mechanism. The resistance to transgenic proteins by insects pests may possibly limit the duration that an insecticidal transgenic variety can be feasibly grown, e.g. Diamond black moth, an important pest of *Brassica* crop was first known pest to develop resistance to Bt toxins applied as microbial formulation in open field populations (Tabashnik, 1994).

Impact on biodiversity

Fear for the loss of biodiversity is the focal point of opposition of several influential environmentalists group against GM crops. It was hypothesized that GM crops could be threat to the crop diversity or outgrow a local flora to the detriment of native species (Rissler and Mellen 1993) in Mexican maize land races. However, a large-scale systematic survey showed no evidence for transgenic introgression into the maize land races of Oaxaca, Mexico and is an important reference for local farmers, government agencies. The study also addresses socio-economic and ethical implications of use of GM crops thereon (Garcia *et al.* 2005).

Why Organic Farming?

Modern agriculture has been of great help in alleviating the hunger from the world, However, even now globally almost 800 million people still go hungry. India's own achievements in agricultural production after the Green Revolution that set in 1967-68 has been exemplary and mainly due to the increased use of the components of modern agriculture, namely, fertilizer, pesticides and farm machinery. Nevertheless over-use of pesticides specially in vegetables and fruits resulted in residues much above the safety levels (Carson, 1963; Times of India, 2004, HAU, 2003-2004) (Tables 9, 10 & 11) and this brought to the attention the ill-effects of modern agriculture; even the drinking water was not spared (Down to earth, 2000). The Indian data on pesticide residues are shocking because pesticide consumption in India is only 480 g/ha as compared to over 10,000/ha in Japan (Marwaha, 2005) (Table 12). Soon the ill effects of over- use of fertilizer nitrogen were recognized. These were nitrate enrichment of ground waters, river waters and estuaries and release of ammonia and nitrous oxide to the atmosphere, the formers added to the problem of acid rain, while the latter led to the reduction of ozone layer (Laegreid *et al.*, 1999, Curtzon and Enhalt, 1977). These ill effects of modern agriculture forced the people especially in the countries with high-income economies (European countries, USA, Canada, Australia etc.) to demand food grown without fertilizer and pesticides and this paved the way for organic farming.

Table 9. Pesticide residue persistence in agricultural produce and food commodities

Commodity	2001		2002	
Vegetables * (17 crops)	712	61 (12 % above MRL)[1/]	529	63.5 (8.5 % above MRL)
Fruits** (12 crops)	387	53 (Less than MRL)	329	47 (Approaches MRL)

* At Hisar all contaminated – 46% above MRL, Heplachlor and Cypermethrin
** Fields in Faridabad – Vegetables, fruits, flowers highly contaminated
[1/] Maximum residue limit Source: HAU (2003)

Table 10. Pesticide residue persistence in animal feed, fodder, animal products, irrigation water

Commodity	Samples (nos.)	Contaminated samples (%)	Major residue recorded	Year of testing
Feed and fodder	125	81.0	HCH, DDT Chloropyriphos, Endosulphan	2001
Milk	537	52.0	94 % HCH, 9 % Endosulphan DDT residue	2001
Butter	184	67.4	94 % HCH, 9 % Endosulphan DDT residue	2002
Irrigation water				
a. Surface water	258	60.0	HCH, DDT Endosulphan Chloropyriphos (4 above MRL)	2001
b. Canal	251	73.0		
c. Pond	10 10	All All		2001

Source: HAU (2003)

Table 11. Maximum residue limits (MRL) of pesticides on food commodities [Prevention of Food Adulteration Act (PFA), 1954]

Pesticide	Food itmes	Maximum residue (mg/kg)
Aldrin	Food grains, milk, vegetables	0.01, 0.15, 0.10[1/]
Captan	Fruits & Vegetables	15.00
Carbendazim	Foodgrains, vegetables, milk	0.50, 0.50, 0.10
Carbofuran	Foodgrains, fruits/vegetables, milk	0.10, 0.10, 0.05
Chloropyriphos	Foodgrains, fruits, cauliflower	0.05, 0.50, 0.01
DDT	Milk/milk products, fruits/vegetables	1.25, 3.50
Endosulfan	Fruits/vegetables	2.00
Heptachlor	Foodgrains, vegetables	0.01, 0.055

[1/] Given in the same order as food items

Source: HAU (2003)

Table 12. Average consumption of pesticides in some countries

Country	Consumption (g/ha)
Japan	10,770
Europe	2,500
USA	4,000
India	480

Source: Marwaha (2005)

What is Organic Farming ?

Organic farming is believed to be above 10,000 years old. There is no evidence of application of any plant nutrient, at that time because land area was very large compared to the population. That was the era of organic farming. A large number of terms are used as an alternative to organic farming. These are: Biological agriculture, Ecological agriculture, Organic-Biological agriculture and Natural agriculture. Organic farming implies the use of organic nutrients and adoption of natural methods of plant protection in place of fertilizers and pesticides. However, it is not simply replacing chemical fertilizers and other synthetic inputs with organic inputs. Instead, it envisages a comprehensive management approach to improve the health of underlying productivity of soil.

Thus Organic farming is an agricultural production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent feasible organic farming system rely upon crop rotations, crop residues, animal manures, legumes, green manures, mineral bearing rocks and aspects of biological pest control to maintain soil productivity and tilth to supply plant nutrients and to control insects, weeds and other pests. It has the following objectives:

- To produce food of high nutritional quality in sufficient quantity.
- To work with natural system rather than seeking to dominate them.
- To encourage and enhance the biological cycles with farming system-involving microorganisms, soil flora and fauna, plants and animals.
- To maintain and increase the long-term fertility of the soils.

- To use as far as possible, renewable resources in locally organic agricultural system.
- To work, as much as possible, within a closed system with regard to organic matter and nutrient elements.
- To give all livestock, condition of life that allow them to perform all aspects of their innate behavior.
- To avoid all forms of pollution that results from agricultural practices.
- To maintain the genetic diversity of the agricultural system and its surroundings, including the protection of plant and wild life habitats.
- To allow agricultural procedures as adequate return and substitution from their work including a safe working environment.
- To consider the wider social and ecological impacts of the farming system.

Why the global interest?

In 1993, the Swiss Government decided to disburse payments based on organic farming. As a result, the main food distributors having 60% of more market shares in agricultural produce began intensive marketing programmes focused on more natural food. Organically produced agricultural products have received global attention in the last four years specially due to its being a multi billion trade. Data on organic food markets in 2000 are given in Table 13. Austria had the highest percentage of its cultivated area under organic farming followed by Switzerland, Italy, Finland, Denmark, Sweden and Czech Republic (Table 14). India had the least percentage of cultivated area under organic farming. However, the European countries just mentioned are small in size and the absolute area under organic farming generally is too small. Australia has the largest area under organic farming followed by Italy, Argentina, Germany and USA in that order.

Table 13. Organic food markets in the world in 2000 AD

Country	Million US $	% of total for sale	Expected growth (% yr)
Australia	200-225	1.8-2.0	10-15
Denmark	350-375	2.5-3.0	10-15
France	800-850	0.8-1.0	10-15
Switzerland	450-475	2.0-2.5	10-15
Germany	2100-2500	1.6-1.8	10-15
Japan	2000-2500	-	-
UK	1100-1200	1.0-2.5	15-20
USA	7500-8000	1.5-2.0	20

Source: Bruulsema *et al.* (2003)

Table 14. Area under organic farming in relation to GDP and share of agriculture GDP

Country	Arable land (10^6 ha)	Area under organic farming	
		% of available	Land[2] (10^3 ha)
High income economics			
Austria	1.36	11.30	15.7
Switzerland	0.41	9.70	4.0
Italy	8.29	7.94	65.8
Finland	2.20	6.60	14.5
Denmark	2.28	6.51	14.8
Sweden	2.68	6.30	16.9
United Kingdon	5.75	3.96	22.8
Germany	11.79	3.70	43.6
Norway	0.87	2.62	2.3
Australia	48.30	2.31	111.6
Netherlands	0.92	1.94	1.8
Spain	13.74	1.66	22.8
Belgium	0.82	1.61	1.3
France	18.45	1.40	25.8
USA	176.02	0.23	40.5
Japan	4.42	0.10	0.4
Upper middle income economics			
Argentina	33.70	1.89	63.7
Hungary	4.61	1.80	8.3
Chile	1.98	1.50	3.0
Middle income economics			
China	142.6	0.06	8.5
Low income economics			
India	161.7	0.03	4.8

[1]Yr. 2002, [2]yr 2003

Source: Marwaha and Jat (2004) and FAI (2004)

Indian Scenario

Organic farming has received considerable attention in India and Ministry of Agriculture and Cooperation, Govt. of India constituted a Task Force on Organic Farming, which advocated to give boost to organic farming in the rainfed areas and in the north-eastern states where there is limited use of agricultural chemicals. Madhya Pradesh took early lead in this regard and Uttaranchal and Sikkim followed the suit and these states have declared themselves as organic states (Marwaha and Jat, 2004).

It is estimated that there is around 76,000 ha of certified organic food at the farm level and 2.4 million ha of certified forest area for collection of wild herbs in India (Bhattacharya and Chakraborty, 2005), but the actual area under organic is much more. In Maharashtra alone there are about 0.5 million ha under organic farming since 2003, out of this only 10,000 ha is the certified area. In Nagaland, 3,000 ha are under organic farming with crops like maize, soybean, ginger, large cardamom, passion fruit and chilli. The state of Rajasthan has 5,631 ha under organic farming with crops like pearlmillet, wheat, mungbean, guar, mustard and cotton.

For promotion of organic farming identification of potential areas and crop is crucial. As regards crops, the Government of India's priority is for fruits, vegetables, spices, medicinal plants, oilseeds, pulses, cotton, wheat and basmati rice. As far as potential areas are concerned three priority zones have been identified.

Category I: Areas where fertilizers and other agrochemicals consumption is very low. These are areas in Assam and other northeastern states, Jharkhand, Orissa, J & K, Himachal Pradesh, Karnataka, Madhya Pradesh, Chhatisgarh and Rajasthan.

Category II: Areas under rainfed farming.

Category III: Areas with irrigation and heavy use of fertilizers and other agrochemicals.

Organic standards:

Globally there are about 60 standards for organic foods. Details of 5 of these are given in Table 15.

Table 15. Some facts on international standards

IFOAM	• Established in 1972 • Headquarter in Germany • Umbrella organization for Organic Agriculture Association Developed international basic standards of organic agriculture • Established IFOAM accreditation programme (1992) to accredit certifying bodies • Set up International Organic Accreditation Service (IOAS) in July 2001
CODEX	• Codex Alimentarious Commission – a joint FAO/WHO • Intergovernment body • Established in 1962 • Produced a set of guidelines for organic production
EU regulation	• Laid out a basic regulation for European Union's organic standards in Council regulation NO 2092/91 (June 1991) • Regulations give guidelines for the production of organic crops in the European Community
Demeter	• Demeter International is a world wide net work of 19 international certification bodies in Africa, Australia, Europe • Developed guidelines for biodynamic preparation
JAS	• A set of guidelines 'Japan Agricultural Standards' for organic production

Source: Bhattacharya and Chakraborty (2005)

Under NPOP programme the Government of India has developed 'National Standards for organic export. The Ministry of Agriculture, GOI has in principle accepted these standard for domestic purpose also. The scopes of these standards are:

i. Lay down policies for development and certification of organic products.
ii. Facilitate certification of organic products confirming to the National Programme containing the standards for organic production.
iii. Institute a logo and prescribe its award by accredited bodies on products qualifying for bearing organic label. A National Steering Committee (NSC) comprising Ministry of Commerce, Ministry of Agriculture, APEDA, Spice Board, Coffee Board, Tea Board and various other Government and private organizations associated with the organic movement in monitoring the overall activities under NPOP has been constituted.

NPOP standard has already got equivalently with standard of EU Commission. Efforts for equivalency with US NOP is under process.

Certification/Regulatory mechanism

At present there are 12 accredited certifying agencies in the country (Table 16).

Table 16. List of accredited certifying and inspection agencies in India

S.No.	Name of certifying and inspection agencies	Address
1.	Association for promotion of Organic Farming (APOF)	Alumni Assoc. Building, Bellary Road, Hebbal, Bangalore-560024 Ph. 080-2356060
2.	Indian Society for Certification of organic products (ISCOP)	"Rasi Building" 162/163, Ponnaiyaraja-puram Coimbatore, Tamil Nadu-641001, Ph.0422-2471181
3.	Indian Organic Certification Agency (INDOCERT)	Thottumugham, P.O. Aluva-683105, Cochin, Kerala, Ph.0484-2630909
4.	Skal Inspection and Certification Agency	Mahalaxmi Layout, No. 181, 1st Main Road, Bangalore-560086
5.	IMO Control Pvt. Ltd.	26, 17th Main HAL, 2nd 'A' stage Bangalore-560008, Ph. 080-25285883
6.	Ecocert International	54A, Kanchan Nagar, Nakshetrawadi, Aurangabad-413002, Maharashtra 0240-2376336
7.	Bioinspectra	C/o Indocert, Thottumugham P.O. Aluva-683105, Cochin, Kerala Ph. 0484-2630908
8.	SGS India Pvt. Ltd.	250, Udyog Vihar, Phase IV Gurgaon-122015, Ph. 0124-2399757
9.	LACON	Mithradham, Chunangardi
10.	International Resources for Fair Trade (IRFT)	Sona Udyog Unit No. 7, Parsi Panchayat Road, Andheri (E), Mumbai-400069 Ph. 022-28235246
11.	One Cert Asia	Agrasen Farm Vatika Road Off Ton Rd., Jaipur, Rajasthan
12.	National Organic Certification Association (NOCA)	Pune

Source: Bhattacharya and Chakraborty (2005)

Steps involved in certification

1. Accreditation Agency
   IFOAM, Tea, Coffee, Spices and Coconut Board, Dte of Cashew and Cocoa, Coordinating Agency APEDA
2. Norms
   a. No chemicals for last 3 years
   b. Specific production methods
   c. Quality standards
3. Registration - 50% advance certification cost
4. Signing of MOU
5. Crop and farm plan
6. Inspection
7. Approval of the inspection report by the Certification Committee
8. Payment of the balance 50%

9. Certification
10. Issue of certificate

Market network:

India is in a very nascent stage when it comes to export of organic produce. During 2004-05 the total export was 6,472 metric tonnes at Rs 80-90 crores (Tables 17 & 18).

Table 17. India organic: An overview (2004-05)

1.	Area under certified	2.5 million ha
2.	Total certified product	115,238 metric tonne
3.	Total project certified	332
4.	Number of processing units	158
5.	Accredited Inspection and certifying agencies	11
6.	Number of products exported	35
7.	States involved in organic export:	
	Kerala	1232 metric tonne
	West Bengal	937 metric tonne
	Karnataka	476 metric tonne
	Tamil Nadu	471 metric tonne
	Punjab	541 metric tonne
	Himachal Pradesh	521 metric tonne
	Maharashtra	375 metric tonne
8.	All India total organic export	6472 metric tonne
9.	Premium collected against organic export	Rs 80-90 crores (tentative)

Source: Bhattacharya and Chakraborty (2005)

Table 18. Major organic products exported from India during 2005-06

Products	Production (MT)	Export quantity (MT)	Value (In Lakhs)
Honey	3746.8	2117.3	3904.8
Tea	14831.4	1875.0	3841.5
Spices	12010.6	543.9	374.6
Coffee	4183.0	167.2	136.1
Rice	8326.9	1630.15	893.2
Others	62072	1619	3666
Total	105171	7953	12816

Source-Menon(2007)

In addition to primary nutrients, organic manures have the advantage of supplying secondary and micronutrient and this gives them an upper hand and makes them more suitable for sustained production. Organic manures increase biological activity in soil by providing support for earthworms, micro-organisms, fungi and bacteria and this not only helps in nutrient cycling and increasing agricultural productivity but also stabilize soils against erosion and floods, detoxify ecosystems and may even help counteract climatic change by restoring soils capacity to carbon sequestration. The improvement in physical properties and nutrient status of soil has been found by various workers by the application of different organic sources (Table 24, 25, 26, 27).

Table 23. Projection on the tappable nutrients from different organic sources for agriculture in India

Resources	Year	
	2010	**2025**
Generators		
Human population (million)	1120	1300
Livestock population (million)	537	596
Resources (considered tappable)		
Human excreta (dry) (million tonnes)	15	17
Livestock dung (dry) (million tonnes)	119	128
Crop residues (million tonnes)	112	162
Nutrient (genetic potential) (Million tonnes N + P_2O_5 + K_2O)		
Human excreta	2.24	2.60
Livestock dung	7.00	7.54
Crop residues	7.10	20.27
Nutrient (considered tappable)		
Human excreta	1.80	2.10
Livestock dung	2.10	2.26
Crop residues	2.34	3.39
Total	6.24	7.25

Trappable = 30% of dung, 80% of excreta, 33% of crop residues
Source: Tandon (1997)

Table 24.Soil physical-chemical properties affected by recycling of crop residues in rice

Treatment	Bulk density g/cc 0-20 cm	Hydraulic conductivity (cm/hr)	Organic matter (%)	CEC (C mol/kg)	Max. WHC (%)
No crop residue	1.43	9.58	1.21	9.52	36.76
Wheat straw (5 t/ha)	1.34	11.66	1.45	11.83	50.60
Rice straw (5 t/ha)	1.33	11.99	1.47	12.35	51.06
CD (P = 0.05)	0.03	0.59	0.04	0.24	3.07

Das *et al.* (2001)

Table 25. Changes in soil physico-chemical properties of the experimental site after cropping

	Organic carbon (%)		Avaialble nitrogen (kg/ha)		Ca (%)		Mg (%)	
	BC	AC	BC	AC	BC	AC	BC	AC
Alley cropping								
Green leaf manuring	0.36	0.75	182	410	0.89	1.05	0.42	0.55
No green leaf manuring	0.36	0.78	182	385	0.85	0.98	0.39	0.48
Sole cropping								
Green leaf manuring	0.28	0.74	180	378	0.81	0.96	0.39	0.47
No green leaf manuring	0.38	0.65	180	321	0.76	0.96	0.37	0.47

Table 26. Chemical properties of surface soil as affected by different manures

Treatments	Soil properties		
	Organic carbon (%)	Avaialble N (kg/ha)	Available P (kg/ha)
Control	0.98	35.80	19.30
VC @ 200 g/plant	1.08	38.50	21.20
FYM @ 500 g/plant	1.05	42.70	25.70
VC @ 200 g/plant + FYM @ 250 g/plant	1.21	43.10	25.90
CD 5 %	0.005	6.05	5.75
Initial	1.05	42.10	23.40

Chaudhary *et al.* (2003)

Table 27. Physical properties of the surface soil as affected by different nutrient sources

Nutrient sources	BD (Mg m^{-3})	Total porosity (%)	Permeability ms^{-1} (x 10^{-5})
Control	1.41	46.79	1.05
VC @ 200 g/plant	1.30	50.94	2.02
FYM @ 500 g/plant	1.28	51.70	3.69
VC @ 100 g/plant + FYM @ 500 g/plant	1.24	53.21	4.49

VC @ 200 g/plant + FYM @ 250 g/plant	1.19	55.10	7.98
CD 5 %	0.006	1.655	0.05
Initial	1.38	47.90	0.05

Chaudhary *et al.* (2003)

Genetically modified crops and organic farming

In general crops are grown following either conventional chemical agriculture or organic farming or integration of both these types of cultivation. Organic farming indicates complete elimination of use of chemicals in crop production. In the similar ways G M crops also reduce the use of insecticides or pesticides. However, there is no information is available, which directs the elimination of use of insecticide/weedicide/pesticide completely by the adoption of G M crops.

In USA GM crops accounts for 60% of the total planting of soybean, corn and canola in 2003 (Table 28). Over the same period, the area developed to organic crops of the same three arable crops of which GM traits have been commercially introduced has also increased. In the USA the organic area of corn and soybean has increased from about 33,000 hectares in 1995 to about 109,000 hectares in 2001 (Table29).

Table 28. Area devoted to GM crops in North America 2003 ('000 hectares)

	Total crop area	GM crop area	GM share
USA			
Soybean	29807	24114	81
Corn	31998	12799	40
Canola	486	410	84
Canada			
Soybean	1047	500	48
Corn	1226	710	58
Canola	4689	3190	68
Total both countries	69253	41723	60

Sources: USDA, Agriculture Canada, ISAAA, University of Manitoba

Table 29. Areas of organic corn and soybean in the US (1995-2001: hectares)

	1995	1997	2000	2001	Total corn area (2001)	Certified organic as a % of total area
Corn	13213	17282	32531	37860	30655605	0.12 %
Soybean	19102	33243	55067	70606	29542695	0.24 %

Has the growth of the GM crop area impeded the development of organic crops?

In North America, the trend in the planting of GM and organic crops suggests that the growth of the GM crop area has not impeded the development of organic sector (Table 30). In US organic areas of soybean and corn have increased by 270% and 187% respectively between 1995 and 2001, a period in which GM crops were introduced and reached 68% and 26% shares of total planting of soybean and corn. It was also reported that organic canola can and is co-existing without causing significant economic and commercial problems to organic growers. In the organic sector of USA, co-existence of GM crops and organic farming reflects the lack of clarification by the organic certification organization on what constitutes a violating organic principles where adventitious presence of GM events is detectable at very low levels even though the crop has been cultivated in accordance with organic principles.

Table 30. Organic and GM corn areas in the USA by state: 2001 (hectares)

	Total corn	Organic	GM area	% share of organic	% share of GM
Minnesota	2792390	7876	1005260	0.28	36
Iowa	4815860	6164	1541080	0.13	32
Wisconsin	1375960	5407	247670	0.39	18
Ohio	1375960	2276	151356	0.17	11
Nebraska	3318490	2047	1128290	0.06	34
Kansas	1335490	1200	507490	0.09	38
Missouri	161880	603	51800	0.37	32
Indiana	2387700	380	286520	0.03	12
Michigan	890330	1776	151360	0.20	17
Illinois	4411170	1754	705790	0.04	16
South Dakota	1537840	1278	722780	0.08	47
Other states	6253340	7101	1250670	0.11	20
U.S. Total	30656400	37860	7970670	0.12	26

Source: USDA

GM crops threat to organic farming

Lean (2002) advocated that organic farming will be forced out in Britain and across Europe if GM crops are grown commercially. It is because of that organic farms will become so contaminated by genes from the new crops and will become uneconomic due to more expenses to protect the crop from GM crop. He added that when contamination occurred every year through "the wide ranging cultivation of GM crops" in an area "organic farms will lose their organic status and face severe problems to grow their crops according to the regulation given by EU.

Similarly, both in North America and the EU perceive that organic agriculture cannot exist in the presence of GM crops. In the EU existence of GM and organic has also become a major focus of attention for many in the organic sector who wish to prevent and/or minimize the cultivate of GM crops in the EU (Brookes and Barfoot, 2004).

According to the United States Department of Agriculture (USDA) Agricultural Marketing Service legislation National Organic standard prohibit the use of GM varieties. However, the presence of detectable residue of a product of excluded methods alone does not necessarily constitute a violation of this regulation. As long as an organic operation has not used excluded methods and take reasonable steps to avoid contact with the products of excluded methods as detailed in their approved organic system plan, the unintentional presence of the products of excluded methods should not effect the status of an organic product or operation. In Canada also national standards contain some guidance on measures to take to minimize the possibility of unintended contact with prohibited substances like GMOs, such as the use of batter zone.

Kjellson G and Boelt B (2003) advocated the methods to minimize the consequences of biological dispersal of GMP to organic fields by modified cultivation measures.

- It is suggested that isolation distances between GM-crops and organic fields are established similar to those required for seed production.
- For dispersal-critical GM-crops, such as oilseed rape, beet and maize, the isolation distance should probably be increased (not be less than 2 to 3 km). This will not completely prevent GMP dispersal by pollen, but will reduce the extent greatly.
- The use of protective safety zones around organic fields is another possible way of reducing the risk of GM-pollen dispersal.
- Research and modelling of crop specific requirements for this need to be done. During crop rotation, it may, to some extent, be possible to use low-risk crops, which have no or only little risk of GM-contamination by pollen.
- The transition time for soil, used for GM-crop pro-duction, to organic cultivation should probably be extended for critical crops.
- Different cultivation techniques could also be used to reduce the GM seed bank in the soil and volunteers. Finally, it is suggested that organic farmers actively take position on the use of a concrete threshold limits for GM-content in organic products.

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Environmental and quality aspects of organic farming

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Global consumers are increasingly looking forward to organic food that is considered safe and hazard-free. The global market for organic food is expected to touch US$ 29 to 31 billion by 2005. The demand for organic food is steadily increasing both in developed and developing countries, with annual average growth rate of 20-25%. Worldwide, over 130 countries produce certified organic products in commercial quantities (Kortbech-Olesen, 2000).

In recent years, there is a lot of debate between the proponents of organic farming and a section of the community who questioned the scientific validity and feasibility of organic farming (Chhonkar, 2003).

Environmental benefits of organic agriculture

The impact of organic agriculture on natural resources favours an interactions within the agro-ecosystem that is vital for both agricultural production and nature conservation. The ecological services derived include the soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrient cycling, predation, pollination and habitats (Anonymous, 1998, Kler *et al.*, 2002).

The environmental costs *of* conventional agriculture are substantial, and the evidence for significant environmental amelioration via conversion to organic agriculture is overwhelming (Kler *et al.*, 2002 Kumar *et al.*, 2001). A review *of* over 300 published reports (Stolze *et al.*, 2000). showed that out of 18 environmental impact indicators (floral diversity, faunal diversity, habitat diversity, landscape, soil organic matter, soil biological activity, soil structure, soil erosion, nitrate leaching, pesticide residues, CO_2, N_2O, CH_4, NH_3, nutrient use, water use and energy use), the organic farming systems performed significantly better in 12 and performed worse in none. There are also high pre-consumer human health costs to conventional agriculture, particularly in the use of pesticides (Conway and Pretty, 1991). It is estimated that 25 million agricultural workers in developing countries are poisoned each year by pesticides (Jeyaratnam, 1990).

Safety and quality of organically produced food

There is a growing demand for organic foods driven primarily by the consumer's perceptions of the quality and safety of these foods and to the positive environmental impact of organic agriculture practices. The 'organic' label is not a health claim, it is a process claim. It has been demonstrated that organically produced foods have lower levels of pesticide and veterinary drug residues and in many cases lower nitrate contents. No clear trends have, however, been established ill terms of organoleptic quality differences between organically and conventionally grown foods.

There have been many claims that eating organic foods increases exposure to microbiological contaminants (Avery, 1998). But studies investigating these claims have no evidence to support them (Pell, 1997, Burros, 1999; Jones, 1999; Rutenberg, 2000). Organic foods must meet the same quality and safety standards applied to conventional foods. These include the CODEX General Principles of Food Hygiene and Food Safety Programmes based on the Hazard Analysis and Critical Control Point (Anonymous, 1999). Analysis of pesticide residues in produce in the US and Europe has shown that the organic products have significantly lower pesticide residues than conventional products (Anonymous, 2000; Woese *et al.*, 1997; Benbrook and Baker, 2001). Nitrates are significant contaminants of foods, generally associated with intensive use of nitrogen fertilizers. The studies that compared nitrate contents of organic and conventional products found significantly higher nitrates in conventional products (Anonymous, 2000; Woese *et al.*, 1997; Muramoto, 2000).

There are also claims that food produced by organic methods tastes better and contains a better balance of vitamins and minerals than conventionally grown food. However, there is no clear scientific evidence, with some studies showing an increase in vitamin C, minerals and proteins (Lampkin, 1990), more sweeter and less tart apples (Reganold *et al.*, 2001) 53 and others not (Woese *et al.*, 1997). A crude analysis of the literature, however, favours organic products in this area (Worthington, 1999). A tasting panel convened by the Consumer Association in the United Kingdom did not consistently favour the taste of organic fruits and vegetables (Anon, 1992). Quality after storage has been reported to be better in organic products relative to conventional products after comparative tests (Reganold *et al.*, 2001, Benge *et al.*, 2000). Reviews of organic vs conventional product sensory analysis studies have reported results that do not clearly substantiate claims of superior organic product tastiness (Woese *et al.*, 1997).

It is a known fact that the quality of crops is controlled by a complex interaction of factors, including soil type and the ratio of minerals in added compost, manure and fertilizer. So it is difficult to separate the influence of the environment and farming system (Warman and Harvard, 1998). There is a scope to generate the information on the quality of produce generated on organic farms in future studies.

Pest and disease management in organic farming

Pest control in organic farming begins by making sensible choices, such as growing crops that are naturally resistant to diseases and pests, or choosing sowing times that prevent pest and disease outbreaks. The careful management in both time and space of planting not only prevents pests, but also increases population of natural predators that can contribute to the control, of insects, diseases and weeds (Anonymous, 2003). Other methods generally employed for the management of pests and diseases are: improving soil health to resist soil pathogens and promote plant growth; rotating crops; encouraging natural biological agents for control of diseases, insects and weeds; using physical barriers for protection from insects, birds and animals; modifying habitat to encourage pollinators, and natural enemies of pests; and using semi-chemicals such as pheromone attractants and trap pests.

Organic farmers have long maintained that synthetic fertilizers and pesticides increase crop susceptibility to pests (Yepsen, 1976). Research substantiates some of these claims. Organic crops have been shown to be more tolerant as well as resistant to insect attack (Lotter *et al.*, 1999). Organic rice is reported to have thicker cell walls and lower levels of free amino acid than conventional rice (Kajimura *et al.*, 1995). Plant susceptibility to insect herbivory has been shown in numerous studies to be associated with high plant N levels related to high inputs of soluble N fertilizers (Phelan, 1999). Free amino acids, associated with high N applications, have been reported to increase pest attack (Hedin *et al.*, 1993).

Soil-borne root diseases are generally less severe on organic farms than conventional farms, while there were no consistent differences in foliar diseases between the systems. The successful control of root diseases in organic systems is likely to be related to the use of long and diverse crop rotations, crop mixtures and regular application of organic amendments (Wan Bruggen, 1995). Increased levels of soil microbial activity leading to increased competition and antagonism in the rhizosphere, the presence of beneficial root-colonizing bacterial and increased levels of vesicular-arbuscular mycorrhizal colonization of roots have all been identified as contributing factors in the control of root diseases (Azcon Aguilar and Barea, 1996).

Organic agriculture: Its relevance to Indian farming

Only 30 % of India's total cultivable area is covered with fertilizers where irrigation facilities are available and in the remaining 70 % of arable land, which is mainly rainfed, negligible amount of fertilizers is being used. Farmers in these areas often use organic manure as a source of nutrients that are readily available either in their own farm or in their locality. The northeastern region of India provides considerable opportunity for organic farming due to the least utilization of chemical inputs. It is estimated that 18 million hectares of such land is available in the NE, which can be exploited for organic production. With the sizable acreage under naturally organic/default organic cultivation, India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world's organic market (Anonymous, 2002) .

The report of the Task Force on Organic Farming (Anonymous, 2001) appointed by the Government of India also observed that in vast areas of the country, where limited amount of chemicals is used and have low productivity, could be exploited as potential areas for organic agriculture. Arresting the decline of soil organic matter is the most potent weapon in fighting against unabated soil degradation and imperilled sustainability of agriculture in tropical regions of India, particularly those under the influence of arid, semiarid and sub-humid climate. The application of organic manure is the only option to improve the soil organic carbon for sustenance of soil quality and future agricultural productivity (Katyal, 2000).

It is estimated that around 700 mt of agricultural waste is available in the country every year, but most of it is not properly used. This implies a theoretical availability of 5 tonnes of organic manure/hectare arable land/year, which is equivalent to about 100 kg NPK/ha/yr (Tondon, 1997). However, in reality, only a fraction of this is available for actual field application. The various projections (Tondon, 1997, 1993) place the tapable potential at around 30% of the total availability. There are several alternatives for supply of soil nutrients from organic sources like vermin-compost, bio-fertilizers, etc. The technologies have been developed to produce large quantities of nutrient-rich manure/compost. There are specific bio-fertilizers for cereals, millets, pulses and oil seeds that offer a great scope to further reduce the gap between nutrient demand and supply. There is no doubt that organic agriculture is in many ways a preferable pattern for developing agriculture, especially in countries like India.

Conclusions

The following conclusions can be drawn on important issues regarding organic farming:

1. Large-scale conversion to organic agriculture would result in food shortage with the present state of knowledge and technology as the yield reductions of organic patterns relative to conventional agriculture average 1015 %, especially in intensive farming systems. However, in traditional rainfed agriculture, organic farming has the potential to increase the yield, since 70% of total cultivable land falls in this category. Mere 5-10% increase in farm production would definitely help achieve the targeted growth rate of 4-5% in agricultural production.

2. Organic manure is an alternative renewable source of nutrient supply. A large gap exists between the available potential and utilization of organic wastes. However, it is not possible to meet the nutrient requirements of crops entirely from organic sources, if 100% cultivable land is converted to organic farming.
3. Organic farming systems can deliver agronomic and environmental benefits both through structural changes and tactical management of farming systems. The benefits of organic farming are relevant both to develop nations (environmental protection, biodiversity enhancement, reduced energy use and CO_2 emission) and to developing countries like India (sustainable resource use, increased crop yields without over-reliance on costly external inputs, environment and biodiversity protection, etc.).
4. Organic foods are proved superior in terms of health and safety, but there is no scientific evidence to prove their superiority in terms of taste and nutrition, as most of the studies are often inconclusive.
5. The combination of lower input costs and favourable price premiums can offset reduced yields and make organic farms equally and often more profitable than conventional farms. However, the studies that did not include organic price premiums have given mixed results Oil profitability. Thus it is the premium price on the organic food which decides the economic feasibility of organic farming, at least at the current rate of development in organic agriculture.
6. In organic farming systems, pest and disease management strategies are largely preventive rather than reactive. In general, pest and disease incidence is less severe in organic farms compared to conventional farms.

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Session-V
Experiences in organic farming

Organic agriculture : A revolution in reckoning

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Introduction

Organic agriculture has grown out of the conscious efforts by the inspired people to create the best possible relationship between the earth and men. Since its beginning the sphere surrounding the organic agriculture has become considerably 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 the commodities. During the last two decades, there has also been a significant sensitization of the global community towards the environmental preservation and assuring of food quality. The 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 the 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.

In India the organic farming has started simultaneously from two streams. While the commercial growers of spices, basmati rice and cotton adopted organic for premium prices in export market, resource-poor farmers in rainfed marginal lands adopted it, as all alternative livelihood approach, which not only promises clean environment and healthy food but also ensure soil fertility, long term sustainability and freedom form debt and market forces. What is unique with this growing concept of organic farming in India is that, it holds the last hope to the farmers in so-called farmer suicide zones.

The world of organic agriculture

As per the latest survey conducted by IFOAM and SOËL Association (Willer and Yussefi 2007), almost 31 million hectares (m ha) are currently managed organically by more than 600000 farms worldwide. This constitutes 0.7 percent of the agricultural land of the countries covered by the 2007 survey. The continent with most organic land is Australia/Oceania with almost 11.9 m ha, followed by Europe with almost 7 m ha, Latin America (5.8 m ha), Asia (almost 2.9 m ha), North America (2.2 m ha) and Africa (almost 0.9 m ha).

Currently the countries with the greatest organic lands are Australia (11.8 m ha), Argentina (3.1 m ha), China (2.3 m ha) and US (1.6 m ha). The number of farms and the proportion of organically compared to conventionally managed land, however, is the highest in Europe. There has been major growth of organic land in North America and in Europe. Both have added over half a million ha each during 2005-2006. In North America it constitutes an increase of almost 30%, as an exceptional growth. In most of the other countries organic farming is on the rise; there have, however, also been decreases of organic land (extensive pastoral land) in China, Chile and Australia.

As per 2007 survey, land use information was available for 27 million hectares, 90 percent of organic land and more than half of the organic agricultural land (64%) is used for permanent pastures/grassland, one quarter is used for arable cropping

(14%), almost ten percent for permanent crops (5%), followed by the other crops (5%) and other land use (1%). There is no information about 10% of land.

On a global level, permanent pastures/grassland (19.8 million hectares) account for almost two third of the world's organic land. More than half of this grassland is in Australia. Furthermore, large areas of permanent pastures are in Latin America and Europe.

The main crop categories for arable land are cereals followed by field fodder growing, other arable crops, set-aside/green manuring, protein crops, vegetables, oilseeds, industrial crops, medicinal & aromatic plants, root crops, seed production etc.

Besides the above, there is about 62 million ha of organic wild collection area with 979 organic wild collection projects, world over. The largest collection areas are in Europe and Africa (almost 27 million ha each). In terms of quantities the important wild collected products are: bamboo shoot (36%), fruits and berries (21%) and nuts (19%).

The global sales of organic food and drink have increased by 43% from 23 billion US$ in 2002 with sales reaching 33 billion US$ in 2005. The organic monitor expects sales to have approached to 40 billion US$ in 2006. Although the organic agriculture is now present in most part of the globe, demands remain concentrated in Europe and North America. The two regions are experiencing the undersupply because the production is not meeting the demand. Thus large volumes of import are coming in from other regions. Production in developing world is rising at much faster rate than that in the industrial countries. For example the amount of organic farm land increased in triple digits in Asia, Africa and Latin America since 2000, whereas the double digit growth has been observed in the other regions.

Demand for organic products mainly comes from affluent countries. Six of the G-7 countries comprise 84% of global revenues. This disparity between production and consumption of organic foods puts the industry in a fragile condition. A dip in demand from Europe and/ or North America would have a major impact on global production of organic food. The industry could lose confidence as export markets close, causing oversupply and organic food prices to drop. The organic food producers in Asia, Africa and Latin America have been advised to become less reliant on exports and develop internal markets for their products. By developing internal markets, the business risks can be reduced to minimum. Consumers can also benefit by having the access to regionally-produced organic foods.

Standards and Regulation – Global View

Currently more than 60 countries have a regulation. Worldwide 395 organizations offer organic certification services. Most certification bodies are in Europe (160) followed by Asia (93) and North America (80). The countries with the most certification bodies are US, Japan, China and Germany. 40% of the certification bodies are approved by the European Union, 32% have ISO 65 accreditation and 28% are accredited under the US National Organic Program. Under India's National Programme on Organic Production (NPOP) 11 certification bodies have been authorized to oversee and certify the organic certification process.

Organic Agriculture in India

Since January 1994 "Sevagram Declaration" for promotion of organic agriculture in India, the organic farming has grown many folds and number of initiatives at Government and Non-Government level has given it a firm direction. While National Programme on Organic Production (NPOP) defined its regulatory framework, the National Project on Organic Farming (NPOF) has defined the promotion strategy and provided necessary support for area expansion under certified organic farming. Nine states have formulated organic promotion programmes and are trying to formulate the organic policies. Three years ago states like Uttarakhand moved to make organic farming a thrust area for agricultural development. States of Mizoram and Sikkim declared intention of the states to go totally organic. Recently in March 2007, the state Government of Nagaland has also declared the intention of state Government to work for total organic and defined organic pathway and policies. Under NPOFs service provider scheme, more than 300 farmer groups have been developed throughout the country to spread organic farming. Various other schemes of NPOF being operated through the state Governments and many non-government agencies have also contributed significantly to the growth of organic agriculture.

Growing certified area

Before the implementation of NPOP during 2001 and introduction of accreditation process for certification agencies, there was no institutional arrangement for assessment of organically certified area. Initial estimates during 2003-04 suggested that approximately 42,000 ha of cultivated land were certified organic. By 2005 India had brought more than 2.5 million ha of land under certification. Out of this while cultivable land was approximately 76,000 ha remaining area was forest land for wild collection. Growing awareness, increasing market demand, increasing inclination of farmers to go organic and growing institutional support has resulted into more than 200% growth in total certified area during the last two years. The state wise area brought under certification process during 2005-06 and 2006-07 are given in Table 1.

Table 1. Total Area under organic certification process (certified and under conversion) during the year 2006-07

S.No.	State	Area in Hectare		
		Certified Area	Under Conversion	Total
1	Andhra Pradesh	5561.17	4925.9	10487.07
2	Arunchal Pradesh	65.87	632.77	698.64
3	Asam	2526.61	540.24	3066.85
4	Bihar	0	0	0
5	Chattisgarh	279.16	28.72	307.88
6	Delhi	3632.63	1830.35	5462.98
7	Goa	4100.5	2849.8	6950.3
8	Gujrat	7102.31	658.51	7760.82
9	Haryana	3382.54	15.78	3398.32
10	Himachal Pradesh	69.03	9507.7	9576.73
11	J & K	32541.79	0	32541.79
12	Jharkhand	10.5	2253.35	2263.85
13	Karnataka	8735.06	2976.78	11711.84
14	Kerala	11631.93	3112.73	14744.66
15	Manipur	913.68	5105.87	6019.55
16	Maharashtra	41390.48	72238.44	113628.92
17	Madhya Pradesh	87536.03	59875.81	147411.84
18	Mizoram	0	16802.5	16802.5

S.No.	State	Area in Hectare		
		Certified Area	Under Conversion	Total
19	Meghalaya	0	304.4	304.4
20	Nagaland	0	878.89	878.89
21	Orissa	66625.42	7959.69	74585.11
22	Punjab	347.6	698.36	1045.96
23	Rajasthan	15034.26	9697.53	24731.79
24	Sikkim	274.82	1531.91	1806.73
25	Tripura	0	0	0
26	Tamilnadu	3414.09	1652.39	5066.48
27	Uttar Pradesh	5589.56	1700.57	7290.13
28	Uttaranchal	3178.63	5250.88	8429.51
29	West Bengal	7332.75	3147.18	10479.93
30	Other	510.52	966.32	1476.84
	Total	**311786.94**	**217143.4**	**528930.31**

Decreasing cost of certification

Prohibitively high cost of certification had always been a matter of concern for small and marginal farmers. But with the increasing competition, increasing number of producers and introduction of Grower Group Certification (GGC) system, per farmer costs have reduced drastically. The costs which were ranging from 1.5 to 2.0 lakh per individual project and Rs. 500 to 2500 per farmer in groups have come down to Rs. 45,000 to 75,000/- in case of individual projects and Rs. 100-150/- per farmer in groups. Recently, the initiatives taken up by Government of India to promote State Government bodies as certification agencies has further reduced the prices. The Uttaranchal State Organic Certification agency is offering certification at a price of Rs. 10,000 to 15,000/- per project.

Role of National Project on Organic Farming in Promotion of Organic Farming

Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India has launched a Central Sector Scheme "National Project on Organic Farming during X five year plan w.e.f. 1st October, 2004. Main objectives of this scheme are as follows:-

1. Capacity building through service provider
2. Financial support to different production units engaged in production of biofertilisers, compost and vermicompost etc.
3. Human resource development through organizing training on Certification and Inspection, Production and Quality Control of Organic Inputs, Training of Extension Officers / Field Functionaries, Farmers Training on Organic Farming etc.
4. Field demonstration on organic inputs and enriched biogas slurry
5. Setting up of Model Organic Farms
6. Market Development for organic produce
7. Development of Domestic Standards
8. Support to new initiatives on technology related to organic farming
9. Awareness programmes etc.

10. Quality Control of various Biofertilisers and Organic Fertilisers as per Fertiliser Control Order

Details of total achievements in respect of different components during the two and half year period of 10th plan are given in Table 2. Details of funds released to different states during the same period are given in Table 3.

Table 2. Physical Targets and Achievements under the National Project on Organic Farming during 10th Five Year Plan

Sr. No.	Components	Total Achievements (no.)
A.	**Capacity Building through Service Providers**	**308**
B.	**Organic Inputs Production Units**	
	i) Fruit / Vegetable compost units	**15**
	ii) Biofertiliser Production Units	**24**
	iii) Vermiculture hatcheries	**521**
C	*Trainings Programmes*	
1.	Training on Certification and Inspection Agencies	**52**
2.	Training on Production & Quality control of Organic inputs	**169**
3.	Training of Extension Staff	**302**
4.	Training of farmers on Organic Farming	**1325**
D.	**Field demonstrations**	
1.	Field demonstrations on organic inputs	**3344**
2.	Setting up of Model organic farm	**232**
3.	Field demonstrations on enriched biogas slurry	**782**

Table 3. Details of funds sanctioned and released during the period from 2004-05 to 2006-07 under National Project on Organic Farming

(Rs. in lakh)

Sr. No.	Name of the States	2004-05	2005-06	2006-07	Total
	North Eastern States				
1.	Assam	1.0725	66.71	3.68	71.47
2.	Arunachal Pradseh	4.4875	30.16	41.28	75.93
3.	Manipur	6.69	5.74	101.58	114.02
4.	Meghalaya	2.34	38.07	0.78	41.19
5.	Mizoram	45.3125	22.50	166.59	234.4
6.	Nagaland	0	86.69	88.31	175
7.	Sikkim	10.34	49.11	32.58	92.03
8.	Tripura	8.975	25.84	30.00	64.81
	Other States		0	0	0
1.	Andhra Pradesh	0	**34.6625**	**39.60**	**74.265**
2.	Bihar	0	1.13	69.36	70.49
3.	Chattisgarh	14.975	0	119.24	134.21
4.	Delhi	0	6.51	1.82	8.335
5.	Goa	0	4.39	4.13	8.52
6.	Gujarat	2.0	59.74	0	61.75
7.	Haryana	0	4.40	48.23	52.63
8.	Himachal Pradesh	2.0	12.78	50.56	65.335
9.	Jharkhand	0	6.96	93.00	99.96
10.	Karnataka	1.78	25.43	57.10	84.31
11.	Kerala	1.71	69.56	50.20	121.74
12.	Lakshdweep	0	2.30	0	2.30
13.	Madhya Pradesh	6.885	31.81	149.45	188.14
14.	Maharashtra	5.385	**102.22**	**169.93**	**277.535**
15.	Orissa	0	7.20	197.11	204.31
16	Punjab	0.24	0.08	16.16	16.48
17.	Rajasthan	0	13.74	17.56	31.30
18.	Tamilnadu	1.00	87.01	72.96	160.97
19.	Uttar Pradesh	9.35	44.34	51.88	105.57
20.	Uttranchal	48.20	0.88	332.72	381.80
21.	West Bengal	0	24.39	99.13	123.52
22.	NABARD	150.00	732.5	0	882.50
23.	NCDC, New Delhi	0	100.0	0	100.00
	Total	**322.43**	**1698.34**	**2106.89**	**4126.167**

Growing organic food market

During the last seven years there have been many estimates on the size of the organic food market in India: some say "organic foods are the super rich man's food and have negligible or no market, while some have speculated to be a market of about 2-3 million consumers with estimated potential of Rs. 96 billion based on a modest spending of Rs. 4,000/- per month. Recently International Competence Centre for

Organic Agriculture (ICCOA) conducted a survey in top 8 metro cities of India (which comprise about 5.3 % of the households) to assess the organic food market potential and consumer's inclination and behavior towards the organic food. The market study estimates the accessible market potential for organic foods in 2006 in top 8 metros of the country at Rs 562 crores taking into account the current purchase patterns of consumer in modern retail format. The overall market potential is estimated to be around Rs.1452 crores, the availability will however be a function of distribution-retail penetration and making the product available to the customer.

Another finding of the survey was consumer's preference for different categories of organic food. Across all cities and regions, the most preferred category is the fresh vegetables followed by fruits as organic. The next is milk and diary products. The Table 2 arranges the 20 different food categories in the order of preference, with the market potential for these categories.

Table 4. Market Potential For Organic Foods by Study Products in Top 8 Metros In India

(At Retail Level 2005/6 Prices - Considering Organic Premium 10-20%)

STUDY PRODUCTS	Accessible Potential		Market Potential	
	Rs Million	%	Rs Million	%
Vegetables	1030	18	3220	22
Fruits	710	13	2460	17
Milk	520	9	1660	11
Dairy product	500	9	1110	8
Bakery Products	480	9	1860	13
Oils	320	6	590	4
Rice	270	5	460	3
Ready to eat	260	5	360	2
Wheat -Atta	250	5	4700	3
Snacks	220	4	560	4
Frozen foods	220	4	300	2
Dals	180	3	320	2
Health Drinks	170	3	340	2
Canned foods	170	3	230	2
Tea	120	2	230	2
Coffee	100	2	170	1
Condiments	50	1	120	1
Spices	40	1	80	1
Sugar	2.8	0	4.8	0
Baby Food	0.1	0	0.30	0
TOTAL	5620	100	14520	100

(Source – Rao et al 2006, The Market for Organic Foods in India, ICCOA Publication)

Future prospects

Although India has traditionally been a country of organic agriculture, but the growth of modern scientific, input intensive agriculture has pushed it to wall. But with the increasing awareness about the safety and quality of foods, long term sustainability of the system and only hope for rainfed-resource poor farmers, the organic farming has emerged as an alternative system of farming which not only addresses the quality and sustainability concerns, but also ensures a debt free, profitable livelihood option. With in a short span of five years organic agriculture has grown from a controversial niche subject to a mainstream agriculture. It has grown at a rate of nearly 200% in the last two years and is likely to grow by more than 100% in the next five years to come. Institutional mechanisms and Governmental support has ensured its sustained growth during the 11^{th} plan period. But to keep the hopes of these farmers, efforts are necessary to link them to market. For this efforts need to be done on the same scale, as has been initiated for increasing the area.

Session-VI
Organic farming for Horticulture crops

In situ organic farming for horticultural and medicinal crops

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In India like elsewhere, chemical fertilizers and pesticides have been aggressively promoted and heavily subsidized to keep the fertilizer companies afloat, without realizing the resulting devastation these chemical applications have wrought on the sustainability of agriculture.

The most recent introduction of GM seeds and crops (genetically modified, also called GE, genetically engineered), which need to be purchased every year at a high cost, and need to be heavily sprayed with the killer pesticides that the same companies produce, evokes a strong response from health and environment conscious people all over the world.

Many of India's farmers have lost much of their ancestral farming knowledge and ancient seed varieties since the introduction of chemical based commercial agriculture and hybrid seeds. In many areas of India and all over the world, a valuable medicinal plants are becoming endangered because of the indiscriminate commercial over-harvesting and other adverse collection practices that damage essential natural habitats. The proper organic agricultural practices require training and supervision for sustainable procurement methods that preserve rare and endangered wild plant species and the earth's natural bio-diversity.

The conventional farming had helped India not only to produce enough food for its own consumption but also generated surpluses for exports. The modern system of farming, which is increasingly felt, is becoming unsustainable as evident by declining crop productivities, damage to environment, chemical contaminations, etc. The necessity of having an alternative agriculture method which can function in a friendly eco-system while sustaining and increasing the crop productivity is realized now. The organic farming is recognized as the best known alternative to the conventional agriculture.

The organic farming in horticulture is now gaining its importance worldwide. Organic production involves a system that uses a combination of management techniques to maintain the soil quality and fertility and control weeds, pests and diseases. Crop rotation plays a big role in achieving these goals. Conventional chemical fertilizers, herbicides and pesticides are eliminated, although "organic" products are generally allowed, subject to compliance with the organic standard. There are several organic certification organizations. The standards of these organizations may vary, in part, due to the different interpretations of "restricted use" products.

Some of the major organically produced agricultural crops in India include crops like plantation, spices, pulses, fruits, vegetables and oil seeds etc.

Major products produced in India by organic farming (2003)

Type of Product	Products
Commodity	Tea, Coffee, Rice, Wheat
Spices	Cardamom, Black pepper, white pepper, Ginger, Turmeric, Vanilla, Tamarind, Clove, Cinnamon, Nutmeg, Mace, Chili
Pulses	Red gram, Black gram
Fruits	Mango, Banana, Pineapple, Passion fruit, Sugarcane, Orange, Cashew nut, Walnut
Vegetables	Okra, Brinjal, Garlic, Onion, Tomato, Potato
Oil seeds	Mustard, Sesame, Castor, Sunflower
Others	Cotton, Herbal extracts

The organic crops grown in Orissa are Cotton, Turmeric, Ginger, Niger and some pulses. (*Source: Regional Bio-fertilizer Centre (GOI), Bhubaneswar*)

Organic Herb Production:

Culinary Herbs

A wide range of herbs can be grown outdoors or in greenhouses. The organic garlic is in demand in some areas, but production may not be practical on a large scale because garlic must be kept weed free and can be affected by some of the same pests as onions. The growers may find the garlic seed market to be more lucrative than the culinary market. Most culinary herb production needs to take place near urban centres where farmers' markets or restaurants can be supplied, unless the grower plans to dry and package the herbs for later use. The other value-added products are also possible, including herbal tea mixtures, flavoured vinegars and oils, as well as packaged seeds.

Medicinal Herbs

The vast majority of medicinal herbs grown in Canada are produced organically. Aside from spearmint, which has had only regional production in Saskatchewan, and those herbs which are also regarded as spice or oil crops (such as borage and dill), only Echinacea has been the major herb crop to date. However, markets for medicinal herbs are very volatile and growers need to use caution before planting any medicinal herbs on a large scale. As with vegetables, medicinal herbs are mostly grown as row crops. Pest and disease problems are known for some and the incidence could increase if acreages become significant. Organic cultivation of medicinal herbs is mandatory. Therefore all sorts of precaution should be taken while growing the medicinal herbs by taking organic inputs as a whole.

India is best known as an exporter of organic tea and also has great export potential for many other products. Other organic products for which India has a niche market are spices and fruits. There is small response for cashew, oil seed, wheat and pulses. Among the fruit crops Bananas, Mangos and oranges are the most preferred organic products.

Export Market

The current production of organic crops is around 14,000 tons. Out of this production, tea and rice contributes around 24% each, fruits and vegetables combine makes 17% of this total production. From India around 11,925 tons of organic product is exported, that makes around 85% of total organic crop production. The major export market for Indian producers are Australia, Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Singapore, South Africa, Saudi Arabia, UAE, UK, and USA. Estimated quantity of various products that are exported from India in 2002 is shown in the Table below. This shows that around 3000 tons of tea was exported and in quantity term it was the highest, next major exports are rice (2500 tons), fruits & vegetables (1800 tons), cotton (1200 tons) and wheat (1150 tons).

Major organic products exported from India (2002)

Product	**Sales (Tonnes)**
Tea	3000
Coffee	550
Spices	700
Rice	2500
Wheat	1150
Pulses	300
Oil Seeds	100
Fruits & Vegetables	1800
Cashew Nut	375
Cotton	1200
Herbal Products	250
Total	**11,925**

The basic rules of organic production are that the natural inputs are to be applied and the synthetic inputs are prohibited. An organic production system would be designed to:

- Enhance biological diversity within the system;
- Increase soil biological activity;
- Maintain long-term soil fertility;
- Recycle plant and animal waste;
- Rely on renewable resources in locally organized system;
- Promote healthy use of soil, water and air and minimize all forms of pollution;

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

In view of the growing demand for the organically produced food items worldwide the natural advantages in this regard needs to be fully exploited. For adopting organic farming for perennial and non perennial fruit crops, aromatic plants, vegetables, spices etc. additional assistance will be given over and above the area expansion programme @ Rs. 10,000 per hectare subject to a limit of 4 ha per beneficiary. The NHM also provides financial assistance up to a maximum of Rs 5.00 lakhs for a group of farmers covering an area of 50 ha, duly recommended by State Govt., on a case for certification of organic process / produce.

Organic horticulture depends mostly on promotion of Integrated Nutrient Management and Integrated Pest and Disease Management. The emphasis is given on the following points for organic farming of horticultural crops.

i. Sanitary and Phyto-sanitary
ii. Promotion of IPM
iii. Disease forecasting units
iv. Bio-control labs
v. Plant health clinics
vi. Leaf / Tissue analysis labs.

Soil Fertility

Organic horticulture relies heavily on the natural breakdown of organic matter, using techniques like green manure and composting, to replace nutrients taken from the soil by previous crops. This biological process, driven by microorganisms, allows the natural production of nutrients in the soil throughout the growing season, and it is often referred to as "feeding the soil to feed the plant."

Pest control

In conventional horticulture, a specific insecticide may be applied to quickly kill off a particular insect pest. Chemical controls can dramatically reduce pest populations for the short term, yet by unavoidably killing (or starving) natural predator insects and animals, cause an ultimate increase in the pest population. Organic pest control involves the cumulative effect of many techniques, including:

- Allowing for an acceptable level of pest damage
- Encouraging predatory beneficial insects to flourish and eat pests
- Encouraging beneficial microorganisms
- Careful plant selection, choosing disease-resistant varieties
- Planting companion crops that discourage or divert pests
- Using row covers to protect crop plants during pest migration periods
- Rotating crops to different locations from year to year to interrupt pest reproduction cycles
- Using insect traps to monitor and control insect populations

Each of these techniques also provides other benefits soil protection and improvement, fertilization, pollination, water conservation, season extension, etc. and these benefits are both complementary and cumulative in overall effect on site health.

Problems and Constraints

1. Lack of awareness

It is a fact that many farmers in the country have only vague ideas about organic farming and its advantages as against the conventional farming methods.

2. **Output marketing problems**

It is found that before the beginning of the cultivation of organic crops, their marketability and that too at a premium over the conventional produce has to be assured.

3. **Shortage of biomass**

Many experts and well-informed farmers are not sure whether all the nutrients with the required quantities can be made available by the organic materials.

4. **Inadequate supporting infrastructure**

In spite of the adoption of the NPOP during 2000, the state governments are yet to formulate the policies and a credible mechanism to implement them. There are only four agencies for accreditation and their expertise is limited to fruits and vegetables, tea, coffee and spices.

5. **High input costs**

The groundnut cake, neem seed and cake, vermi-compost, silt, cow dung, other manures, etc. applied as organic manure are increasingly becoming costly making them unaffordable to the small cultivators.

6. **Marketing problems of organic inputs**

Bio-fertilizers and bio-pesticides are yet to become popular in the country. There is a lack of marketing and distribution network for them because the retailers are not interested to deal in these products, as the demand is very low.

7. **Lack of financial support**

The cost of certification, a major component of which is the periodical inspections carried out by the certifying agencies, which have freedom to fix the timings, type and number of such inspections appears to be burdensome for the small and marginal farmers.

8. **Low yields**

Small and marginal farmers cannot take the risk of low yields for the initial 2-3 years on the conversion to organic farming. There are no schemes to compensate them during the gestation period.

9. **Inability to meet the export demand**

The demand for organic products is high in the advanced countries of the west like USA, European Union and Japan. It is reported that the US consumers are ready to pay a premium price of 60 to 100 per cent for the organic products. The upper classes in India are also following this trend as elsewhere.

10. **Lack of quality standards for bio-manures**

The need for fixing standards and quality parameters for bio-fertilizers and bio-manures has arisen with the increasing popularity of organic farming in the country. The process of composting which is a major activity to be carefully done is achieved usually by one of the two methods, vermi-composting or microbe composting. Bio-fertilizers do nothing to enhance soil quality while the loss of soil quality has been the major problem faced by the farmers these days.

Prospects:

Indian agriculture should be able not only to maintain but also must strive to increase the production of food grains. The potential areas and crops, which fulfill the above constraints, could be explored and brought under the organic agriculture. The rainfed, tribal, northeast and hilly regions of India where the traditional farming is more or less practiced could be considered

Limiting factors organic produce market:

- Lack of market information in general and organic market information in particular is biggest drawback for Indian agriculture. As a result, the farmers are in a predicament as they are unable to attune their production practices as per the market changes.
- Quality of Indian food industry is always a constraint for growth, low consistency of quality and contamination in food products is a hindrance in capturing the available market especially the international market.
- As the certification process for organic farming is very lengthy and complex, the cost of certification is also unaffordable for small farmers (Rs.22000 to Rs.29200 per certification).
- Government has shown limited interest for organic agriculture, though the activities from government side are increasing but till date there is no direct support from Government side in terms of subsidy or market support towards the organic agriculture.
- Lack of proper infrastructure in terms of roads from remote villages, cold storage facilities and slow transportation infrastructure affects the cost, quality and is out of reach of producers.
- Indian organic agriculture is very fragmented and there are no organizations for managing the entire value chain of organic products.

Future Initiatives

1. A taskforce on organic farming technologies is to be formed who could formulate the future guidelines on organic farming and offer crop specific and area specific package of practices.
2. Organic farming areas should be identified for different crops and commodities and for future establishment of organic market on the basis of present and future potential.
3. Quality assessment of available bioorganic resources having potential for use in organic farming should be done.
4. Organic / bio-dynamic farming vis-à-vis farming with integrated plant nutrient and pest management in term of yield, quality of the produce, soil health and economic advantage should be evaluated.
5. Quality standards for organic inputs and products need to be formulated to meet the requirement of importing countries.
6. Government should provide the requisite financial, institutional support in developing a strong R&D backup, regulatory mechanism and market infrastructure in this emerging new industry.
7. Referral laboratories for soil, water and plant analysis should be strengthened with state of the art facilities for analysis and certification of organic farms and products.
8. Awareness about organic farming is created among farmers by organizing training programmes, field demonstrations using organic inputs etc. to encourage the adoption of organic concept of farming.

The agriculture experts believe that the yield from organic farming is much higher than other types of farming. In India some states especially in the Northern part of the country are now exploring this vast opportunity and are looking at setting up of Special Purpose Councils to concentrate on this sector.

The Ministry of Agriculture in states such as Punjab, strongly believes that this move will help them from diversifying from the wheat-paddy cycle.

Senior officials at State level, from the Ministry of Food and Agriculture, have further affirmed that the state was getting together with large industrial houses to make the crop diversification scheme accomplish best results. This is in line with the expectation that in the next decade. It is expected that about 9-14% of the cultivated land in states such as Punjab would have organic farming and viticulture.

While already companies like Tropicana and Pepsi have worked for citrus growth, Bharti Group for horticulture, Nasik-based Sona Somant Group for viticulture and search was on for organic sector; more groups would be wooed to make Punjab their destination. The Reliance Group has also announced that they would set up a platform in the state to procure fruits and vegetables to sell them through its retailers.

In its market research report named "Food Processing Market in India (2005)" RNCOS informs that in the next decade the Punjab state Government plans to cover 33% of the 105 lakh acres of agricultural land under crop diversification schemes which will yield remunerative incomes for the farmers.

The market research report reviews that both processed food exports and value-added agricultural produce would grow faster in the following years. This would help the food processing industry in India to make greater profits over the coming years.

Practicability of organic farming in fruit crops

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From the limited research effort exerted, there is a definite future promise for organic farming in fruit crops which can be a long term solution to the existing ecological crisis. The shift from organic to inorganic farming is much easier, while the reverse is much more difficult which leads to some short term problems *viz.* reduction in yield, increased disease and insect pest incidence, shortage of substitutes for inorganic fertilizers and pesticides etc. In horticulture, it is easier to manage fruit crops organically than vegetable and flower crops due to perennial growth habit. The dryland fruit crops which are considered high valued health food and being easily grown organically for years together, are the best suited for organic cultivation e.g. custard apple, jamun, tamarind, anola and ber. Among the different irrigated fruit crops, banana, mango, sapota and guava can be very well tuned with organic cultivation which is rather challenging in crops like grapes, pomegranate and citrus due to vulnerability to certain pest and diseases. Therefore, in future much more efforts should be exerted to standardize the organic techniques in these fruit crops which can minimize a long span to replace the existing chemical-intensive farming system.

In addition to the common cultural practices, the organic production of fruit entails, proper nutrient management, intercropping, control of weeds, pests and diseases, soil and water conservation, etc following ecologically sound and sustainable approaches.

The most important aspect in organic fruit production is supply of nutrients through the organic source. The concentrated organics like different cakes, bone/fish meal will be useful in supplying major nutrients. Biofertilizers like *Azotobacter, Azospirillum* and PSB are of immense use in supplying unavailable nutrients and has immense importance in organic fruit production. The green manuring not only helps to improve the soil health but is also useful in reduction of weed intensity.

The recent study conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri showed an increase in yield to the extent of 8.87 t/ha in acid lime and 7.7 t/ha in sweet orange with application of biofertilizers (VAM @ 500 g + PSB 100 g + *Azosprillium* 100g + *T harjanium* 100 g per plant). Furthermore, the application of organic manures *viz.* FYM, vermicompost and neem cake resulted in to the highest juice content (49%) with the highest TSS (15.50 ^{0}Brix) in pomegranate. Similar results were also obtained in aonla. Such quality improvement arising through organic cultivation is of utmost important in processing industry. In banana, application of 25 kg compost + 1 kg vermicompost + 1 kg neem cake + 2.50 kg poultry manure per plant at 3rd, 5th and 7th month after planting resulted in higher yields (5.5 kg bunch weight, 55.89 fingers per bunch and 6.8 hands per bunch).

Plant growth regulators have immense importance in quality improvement of fruit crops. However, the use of these chemicals is not permitted in organic cultivation. Therefore, the specific horticultural techniques should invariably be applied for fruit quality improvement e.g. in grapes horticultural techniques like berry thinning, stem girdling, cane girdling, paper wrapping, spreading shed-net etc. Similarly, horticultural techniques need to be standardized in other fruit crops.

In pomegranate, sugarcane trash as a mulch, resulted in the highest marketable yield (17.65 kg /tree; total yield 19.35 t/ha.). A few chemicals like vinegar, corn gluten, citric acid etc. recently emerged as weedicides in organic farming and can be evaluated particularly for dryland fruit crops.

Biological control of pests and disease has now been widely adopted in several fruit crops. In this context, research outcome and orchard management showed the high promise e.g. *Verticillium lecanii* (Phule Bugicide) for control of mealybug, thrips, white fly and scales in pomegranate, grape, guava and custard apple (4-6g /lit.). Furthermore, NSE 5% spray also proved as an effective alternative. *Beauveria bassiana* 0.2% also found effective against thrips. The nematodes and soil borne pathogens can be effectively controlled by means of *Trichoderma viridae* +*Paecilomyces* (Trichoderma$^+$), neem cake and black polyethylene mulch.

Control of diseases is the most limiting factor in organic fruit production and hence, selecting the resistant varieties or rootstocks is of a prime importance e.g. pomegranate decline by using the acidic rootstock. The growers should practice sanitation by cleaning up debris, avoiding the incorporation of plant material of the same crop carrying the loads of diseases into the soil, pruning of diseased plants and removing disease vectors. In organic farming a good defence against plant disease is to maintain the crop in excellent health and vigour but not with excessive nutrients and moisture.

Weaknesses

Before starting the organic cultivation of fruits, one shall consider following weaknesses of organic farming in fruit crops.

- Scanty research data.
- Availability of organic manure.
- Initial yield gap.
- Heavy load of pest and diseases.
- No concrete organic means to control disease once appeared.
- Only prevention is the way of controlling disease.
- No breakthrough for control of diseases.
- Climate plays havoc.

Strengthening required

Organic cultivation in fruit crops is a difficult task. While implementation the organic cultivation, it is essential to study the crops in various aspects. For this purpose, the consideration of following points is of prime importance.

- Development of resistant varieties.
- Suitable rootstocks.
- Standardization of organic mulch.
- Organic weedicides.
- Effective combination of organic manures.
- Standardization of horticultural practices (e.g. girdling, berry thinning, wrapping with papers in grapes)
- Disease forecasting unit.

Research Achievements

Pomegranate

The experiment on effect of bio-agent *Verticillium lecannii* (Phule Bugicide) against mealy bugs on pomegranate (2006-07) revealed that, *Verticillium lecanii* @ 6.0 g/litre gave 83.97 per cent reduction of mealy bugs (nymphs) on 10 DAS as against the control. The initial population of mealy bugs was 40 nymphs/fruit.

Banana

The experiment on organic cultivation of banana cv. Rasthali conducted at NRC, Banana, Trichi, revealed that the organic treatment comprising of compost 2.5 kg +1 kg vermicompost + 1 kg neem cake + 2.5 kg poultry manure per plant at 3rd, 5th and 7th month after planting recorded 5.52 kg bunch weight, which was at par with the RDF treatment. Thus, with organic treatment the yield levels were maintained.

Similar results were observed in another experiment conducted at NRC, Banana, Trichi on cv. Karpuravalli.

The experiment on organic cultivation of banana conducted by Swamy *et al.* (2005) revealed that, the inoculation of suckers with VAM cultures (*Glomus fasciculatum*) @ 50 g/plant in pit before planting + 1 kg vermicompost /plant was found effective for increasing the yield and recorded 25.44 t/ha yield of banana.

The experiment on effect of panchgavya on bunch quality conducted at BRS, Marathwada Agril. University, Parbhani revealed that the organoleptic score was increased by the application of panchgavya.

The experiment on control of red rust thrips on banana, conducted at BRS, Jalgaon, MPKV, Rahuri (2007), revealed that the bio-pesticides *viz.*, NSKE 5% and *V. lecanii* was found effective. Per cent infestation on fruits/bunch in case of NSKE 5% was 22.90 and *V. lecanii* 21.11 per cent as against 80.11 per cent in untreated control.

Sweet orange

The experiment on organic farming in sweet orange conducted at AICRP on Citrus revealed that, with addition of vermicompost (20 kg/tree) + neem cake (8 kg/tree) with organic plant protection gave the additional yield of 8.22 t/ha.

The experiment on use of biofertilizers in sweet orange and acid lime at Citrus Project, MPKV, Rahuri showed that, in sweet orange, application of GRDF (15 kg neem cake + 20 kg FYM + 500:300:600 g NPK/tree along with biofertilizer VAM (500 g) + PSB (100 g) + Azotobacter (100 g) + *T. harzianum* (100 g) gave additional yield of 7.79 t/ha and with the same treatment, in acid lime, 8.87 t/ha additional yield was recorded.

Grape

In grape, organic management for thrips was found effective. In two years trial, *Verticillium lecanii* 0.05 % was found effective in reducing thrips population upto 53%, while NSKE @ 5% revealed 54% reduction of thrip population and thereby increasing the yields.

In another experiment, for diseases management i.e. downy mildew and powdery mildew, initial spray of 1% bordeaux mixture with *Azadiractin* 0.03% + *T. viride* and *T. harzianum* 0.5% each were effective in controlling the diseases.

It has also been observed that, the following practices were found effective for control of important pests and diseases of the grape.

Cleaning and burning pruned material. Removal of loose bark from stem and valanda. Swabbing of stem and arms of vines with Geru 300 g in 10 of water. Spraying of 5 % NSE, two times starting from new flush stage .Spraying of *Verticillium lecanii* (Phule bugicide) 5 g +5 ml whole milk/lit at an interval of 10-12 days for three times. Two releases of predatory beetles (*Cryptolaemus montrouzieri*) 1500/ha two times at an interval of 21 days

Thus, arid zone fruit crops like custard apple, aonla, tamarind, jamun, ber can be grown easily by following the organic preferences. However, the crops like banana, grape, pomegranate, require special horticultural practices along with organic cultivation practices for better yields.

Organic vegetable production

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Introduction

Vegetables are rich and cheap source of vitamins and minerals which act as a protective food in our daily diet. They are also consumed raw as a salad and are major source of fibre in digestion. However, vegetable crops are vulnerable to diseases and pests, therefore they need chemical sprays to protect from them. Similarly, for getting optimal yield they need chemical fertilizers. Thus, in commercial vegetable production with the increase in chemical inputs, the risk of degradation of agroecosystem has also been increased. Therefore, todays need is to grow vegetables organically.

Components for organic cultivation

Fertilizers

Farm Yard Manure

This is the only easily available input to the farmers. It is well known that FYM improves the soil physical properties by improving soil aggregation, aeration and water holding capacity. From the research conducted during past years, it is recommended that it is essential to add 20 t. of F Y M /ha. before planting for good crop growth and maintaining the soil health. To avoid bulky application of FYM, its cultivation with organic concentrates (e.g. neem cake, cotton cake etc) are found promising.

Vermicompost

Vermicompost is a potential organic manure, rich in NPK nutrients as compared to FYM or other organic manures. It also contains micronutrients, hormones and enzymes. The beneficial microorganisms also grow fast in vermicompost. It influences the physico chemical and biological properties of soil.

Biofertilizers

Biofertilizers are ecofriendly, low cost inputs playing a significant role in improving quality of agricultural produce and sustaining the productivity over a longer period of time. Among the biofertilizers for increasing nitrogen supply for vegetable crops, Azotobacter and Azospirillum are utilized @ 2.5 kg/ha while for increasing the availability of phosphorus, Phosphorus Solubilising Bacteria (PSB) @ 2.5 kg/ha are utilized. Vesicular Arbuscular Micorrhiza (VAM) also dissolves the fixed phosphate available as insoluble phosphate in the rhizosphare zone. Ten kg VAM is sufficient for one hectare.

Green Manures

Fast growing leguminous crops viz.Dhaincha, Sannhemp and Glericidia are used as a green manure crops which are used mainly to improve the soil fertility and soil physical properties. It is one of the most effective and environmentally sound methods of organic farming which minimises the use of chemical fertilizers.

Neem Cake

It is utilized as a manure which supplies N:P:K in a considerable amount to the crop. It also acts as a medium for the growth of beneficial microorganism viz. Trichoderma. It acts as a nematicide for the control of phytophagous nematodes.

Other organic sources

Groundnut cake, castor cake and fish meal which could be utilized for organic cultivation of crops.

Poultry Manure

It is also one of the important sources of nutrients to the plants.

Pesticides and Bioagents

Neem Seed Kernel Extract

It is the only botanical pesticide widely used in organic cultivation. Neem is made up of about 40 different active compound called Tetranortriterpenoids or liminoids. The main active principle of neem is azadirachtin and tetranortriterpenoids. It exhibits antifeedants, insect repellent and insect sterilization properties. The research work on the efficacy of neem seed kernel extract against pests of vegetables was conducted at All India Coordinated Vegetable Improvement Project and NSKE 4% is recommended for the control of sucking pests and fruit borer of vegetable crops and the same has been reviewed.

Trichoderma viride

This microorganism was most thoroughly and widely studied for their antagonistic activities towards soil borne harmful soil pathogens. Different species of *Trichoderma* under field conditions were reported to control a large number of wilt pathogens. This is recommended as soil application with organic matters viz. FYM, vermicompost or neem cake @ 6.25 kg/ha.or drenching @ 5g./l.of water. This is also recommended as seed treatment @ 5g./kg, seed and also mixed with jeevamrut or beejamrut.

Paecilomyces liliacae

This microorganism is being utilized along with *Trichoderma* sp. as a mixed formulation for the control of phytophagous nematodes.

Verticillium lecanii

This bioagent is recommended for the control of sucking pests viz. aphids, whitefly, thrips, leafhoppers and mites of vegetable crops. The recommended dose is 4g/l.

Beauveria bassiana

Many of the lepidopterous insect pests viz. brinjal shoot and fruit borer, okra shoot and fruit borer, tomato fruit borer are controlled by using this microorganism. The recommended dose is 4 g/l.

Nuclear Polyhedrosis Virus

This virus has been identified to infect *Helicoverpa armigera* which is polyphagous pest. The virus has been isolated from infected *Helicoverpa* larvae collected from field and being cultured in the laboratory. It is available in liquid formulation and recommended @ 1 ml/l. for the control of *Helicoverpa armigera* on tomato, pea, okra and cabbage.

Bacillus thuringiensis

The most widely used microbial pesticides are subspecies and strains of *Bacillus thuringiensis*. (B.t.). B.t. proteins are completely legitimate pesticides for use on organic farming. The powder and liquid formulations are available commercially. This biopesticide is recommended @ 1g./l. or 1 ml/l. for the control of various lepidopterous pests of vegetables. Now B.t. genes have been incorporated in brinjal, tomato and cabbage to get rid off the most devastating pests.

Predators and Parasitoids

Trichogramma chilonis an egg parasitoid of *Helicoverpa armigera* of tomato and okra, *Leucinodes orbonalis* of brinjal is recommended. *Chrysoperla carnae* is a predator used against sucking pests viz. aphids and whitefly. Other parasitoids and predators available naturally could be nourished, protected and made available by planting refugia crops viz. maize and cow pea around the main crops.

Trap crops/ Barrier crops/ Refugia crops

These crops viz. Maize, Marigold , Cowpea and Mustard are grown at the border of main crops. Maize acts as a refugia crop or barrier crop in brinjal and okra. Marigold is a trap crop for *Helicoverpa armigera* in tomato while mustard is a trap crop for *Plutella xylostella* in cabbage. Cow pea also harbor some beneficial insects like lady bird beetle which is the predator for aphids.

Pheromone traps

The concept of using pheromone traps is to monitor the pests for their appearance and the incidence e.g. tomato fruit borer (*Helicoverpa armigera*), diamondback moth (*Plutella xylostella*), okra fruit borer (*Earias vittella*) and cucurbit fruit fly (*Bactrocera cucurbitae*). However, for brinjal shoot and fruit borer (*Leucinodes orbonalis*) it is being utilized for mass trapping.

Research findings on organic vegetable production

The research work conducted on effect of each component of organic farming on production and protection of vegetables in Mahatma Phule Krishi Vidyapeeth, Rahuri is reviewed.

Tomato :

1. The experiment on organic cultivation in tomato was conducted on cv. Dhanashree during 2003. The data revealed that the application of organic fertilizers containing F.Y.M. (20 t/ha.) + Neem cake (250 kg/ha.) + Soil treatment with *Trichoderma* (6.25 kg/ha.) + *Azospirillum* 2.5 kg/ha.) + PSB (2.5 kg/ha with trap crop marigold and the plant protection with NSKE4%, HaNPV 1ml/l. and B.t. 1 g./l. has produced comparable yields to that of recommended dose. In case of incidence of fruit borer, the lowest incidence was observed in the treatment with trap crop. As far as diseases are concerned, no much difference was observed in the treatments with trap and without trap crop. The B:C ratio was better in organic than inorganic treatment. (Table 1).

Table 1. Organic cultivation in tomato (cv. Dhanashree) season – rabi (Nov.-April)

Sr. No.	Treatments	Total yield (q/ha)	B:C ratio	Pest and disease incidence			
				Fruit borer (%)	Early blight (%)	Late blight (%)	TSWV (%)
	With trap crop						
1	Control RDF (200:100:100) + FYM 20 t/ha + Trap crop (marigold)	465.39	1.20	4.43	15.82	22.76	7.22
2	FYM (20 t/ha.) + Neem cake 250 kg/ha.) + Package	452.57	1.31	4.40	12.74	20.56	7.25
	Without trap crop						
3	Control RDF (200:100:100) + FYM 20 t/ha + without trap crop	457.76	1.18	6.50	14.88	19.34	8.10
4	FYM (20 t/ha.) + Neem cake 250 kg/ha.) + Package	439.95	1.27	6.48	11.23	17.25	6.77

Package

Trichoderma 6.25 kg/ha. + *Azospirillum* 2.5 kg/ha + PSB 2.5 kg/ha. Plant protection : NSKE 4%, HaNPV 1 ml/l., B.t. 1 g./l.

2. The experiment on organic cultivation in tomato conducted during 2005, on cv. Phule Raja revealed that application of organic fertilizers containing F.Y.M. (50% N i.e. 30 t/ha.) + Cotton seed cake 50% N i.e.2.34 t/ha.) + Vermiphos (P) 0.5t/ha. + Sulphate of potash (K) 0.1 t/ha.+ Neem cake 200 kg/ha + *Trichoderma* 4g./kg + *Azospirillum* 200 g/10 l.+ PSB 200g/kg and the plant protection with NSKE4%, HaNPV 1ml/l. and B.t. 1 g./l. recorded the yields as comparable with the recommended dose of fertilizers without FYM. In case of pest and disease incidence, no much difference was observed in both the treatments.(Table 2)

Table 2. Organic cultivation in tomato (F 1 cv. Phule Raja) season – *Rabi* (Nov.-April)

Sr. No.	Treatments	Yield (q/ha.)		B:C ratio	Pest and disease incidence		
		Total	Marketable		Fruit borer (%)	Late blight (%)	TSWV (%)
1.	FYM (50% N) + Cotton seed cake (50% N) + Package	748.37	718.37	2.00	3.20	7.50	3.40
2.	RDF (300:150:150) without FYM	743.60	718.66	3.63	4.01	8.11	3.36

Treatment 1: FYM (50% N) (30 t/ha) + Cotton seed cake (50% N)(2.34 t/ha) + Vermiphos (P) (0.5 t/ha)+ SOP (K) (0.1 t/ha)

Package : Neem cake 200 kg/ha + *Trichoderma* 6.25 kg/ha. + *Azospirillum* 2.5 kg/ha + PSB 2.5 kg/ha.+ NSKE 4%, HaNPV 1 ml/l., B.t. 1 g./l.sprays

3. In another experiment on tomato conducted during 2006-2007, revealed that the treatment with RDF (200 :100:100 NPK kg/ha) + FYM (20 t/ha), recorded the maximum yield as compared to the organic treatments FYM (60 t/ha) + Biofertilizers; vermicompost (20 t/ha) + BF and Neem cake (6 t/ha) + BF (Table 3).

Table 3. Organic farming in tomato for processing (cv. Dhnashree)

Sr. No.	Treatment	Kharif 06		Rabbi 06-07	
		Fruit yield (t/ha)	Marketable yield (%)	Fruit yield (t/ha)	Marketable yield (%)
1	FYM (60 t/ha) + BF	25.03	84.50	36.55	94.80
2	Vermicompost (20 t/ha) + BF	23.10	82.60	42.06	96.17
3	Neem cake (6 t/ha) + BF	20.26	79.52	23.93	94.32
4	RDF + FYM (20 t/ha)	26.62	89.07	53.81	96.82
5	RDF alone	23.10	89.00	39.59	95.23

RDF : Recommended dose of fertilizer (200:100:100)

BF : Biofertilizers i.e. *Azospirillum* +PSB +*Azotobactor*

For organic plant protection NSKE 4% , HaNPV, B.t., *Verticillium*, *Trichoderma* were used

Cucumber

The experiment on organic cultivation of cucumber conducted during 2004 for two seasons revealed that the maximum yield was produced with organic manure treatment consisting of cotton seed cake (25% N i.e 0.64 t/ha) + Poultry manure (75% N i.e. 2.5 t/ha) + Vermiphos (0.500 t/ha.) + Sulphate of potash (0.105 t/ha) + neem cake @ 200 kg/ ha + *Trichoderma viride* @ 4 g /kg + *Azotobactor* @ 200g/ 10 kg +

Azospirillium @ 200 g/ 10 kg + PSB @ 200g/10kg + NSKE 4%spray which was 23.4% higher during summer season and 30.01% higher than control (Table 4).

Table 4. Organic cultivation of cucumber (var. Himangi) season kharif and summer 2004

Sr. No.	Treatment	Yield (q/ha)		B:C ratio	
		Summer	Kharif	Summer	Kharif
1.	FYM (25% N) + Poultry manure (75 % N) + Vermiphos + SOP + Package	186.13 (+20.20%) *	166.93 (+24.58%) *	1.49	1.22
2.	Cotton seed cake (25% N) + Poultry manure (75 % N) + Vermiphos + SOP + Package	191.00 (+23.44%) *	173.53 (+30.01%) *	1.56	1.32
3.	Control (RDF + FYM 20 t/ha)	154.73	134.40	1.54	1.19

* per cent increase over control

Note : Green manuring with dhaincha for all the treatments.

Treatment 1: FYM (25% N) (5 t/ha) + Poultry manure (75% N)(2.6 t/ha) + Cotton seed cake (50% N)(2.34 t/ha) + Vermiphos (P) (0.5 t/ha)+ SOP (K) (0.1 t/ha)

Treatment 2: Cotton seed cake (25% N)(0.64t/ha) + Poultry manure (75% N)(2.6 t/ha) + Vermiphos (P) (0.5 t/ha)+ SOP (K) (0.1 t/ha)

Treatment 3 : Control RDF (100 : 50 :50) + FYM (20 t/ha.)

Package : Neem cake 200 kg/ha + *Trichoderma* 4g/kg. + *Azospirillum* 200g/10 kg +*Azotobactor* 200g/10 kg + PSB 200g/10 kg.

Plant protection : NSKE 4%

Bitter gourd

The experiment on organic cultivation of bitter gourd during 2005, revealed that the maximum yield was produced with organic manure treatment consisting of Neem cake (25% N i.e 0.7 t/ha) + Poultry manure (75% N i.e. 2.47 t/ha) + Vermiphos (0.5 t/ha.) + Sulphate of potash (0.1 t/ha.) + Neem cake @ 200 kg/ ha + *Trichoderma viride* @ 4 g /kg + *Azotobactor* @ 200g/ 10 kg + *Azospirillium* @ 200 g/ 10 kg + PSB @ 200g/10kg + FYM 20 t/ha. + NSKE 4% spray which was 13.40% higher than control (Table 5).

Table 5. Organic cultivation of bitter gourd (var. Phule Green Gold) Season : (August – Feb 2005)

Sr. No.	Treatment	Yield (q/ha)	B:C ratio
1	FYM (25% N) + Poultry manure (75% N) + Vermiphos (P) + SOP (K) + package	250.20 (+7.75%)*	1.83
2	Neem cake (25% N) + Poultry manure (75% N) + Vermiphos (P) + SOP (K) + package	263.33 (+13.40%) *	1.98
3	Control (RDF + FYM 20 t/ha)	232.20	1.99

* per cent increase over control

Note : Green manuring with Dhaincha for all the treatments

Treatment 1: FYM (25% N) (5 t/ha) + Poultry manure (75% N)(2.47 t/ha) + Vermiphos (P) (0.5 t/ha)+ SOP (K) (0.1 t/ha)
Treatment 2: Neem cake (25% N)(0.7 t/ha) + Poultry manure (75% N))(2.47 t/ha) + Vermiphos (P) (0.5 t/ha)+ SOP (K) (0.1 t/ha)
Treatment 3 : Control RDF (100 : 50 :50) + FYM (20 t/ha.)
Package : Neem cake 200 kg/ha + *Trichoderma* 4g/kg. + *Azospirillum* 200g/10 kg +*Azotobactor* 200g/10 kg + PSB 200g/10 kg.
Plant protection : NSKE 4%

Cabbage

The experiment on organic cultivation of cabbage during 2003, revealed that the maximum yield was produced with inorganic fertilizer dose as recommended by STCR but it was at par with that produced by organic package consisting of FYM @ 20 t/ha + Neem cake @ 250 kg/ha + soil treatment with *Trichoderma* @ 6.25 kg/ha + *Azospirillium* @ 250 g/ 10 L water + PSB @ 250 g/ 10 L water , NSKE 4% spraying + HaNPV @ 10 ml / 10 L water + Bt. @ 10 ml / 10 L water + *Trichoderma* @ 50 g/ 10 L water + trap crop of mustard in two rows in between every 25 rows of cabbage + fenugreek in between plants of cabbage. The incidence of diamondback moth was less in this package (Table 6)

Table 6. Organic cultivation of cabbage (var. Golden acre) Season : *rabi*

Sr. No.	Treatment	Yield (q/ha)	No.of DBM larvae/ plant
1	Inorganic (without FYM) (160:80:80 NPK kg/ha)with trap crop mustard	329.82	4.00
2	Organic package	297.68 (-9.74%)*	2.60
3	Recommended as STCR with trap crop	346.42 (+5.03%)*	4.13

* per cent increase or decrease over inorganic
Organic Package : FYM @ 20 t/ha + Neem cake 250 kg/ha + *Trichoderma* 6.20 kg/ha. + *Azospirillum* 250g/10 kg + PSB 250g/10 kg.+ NSKE 4% + HaNPV @ 10 ml/10 l + B.t. 10 g/10l.+ *Trichoderma* @ 50 g/10l..

Onion

1. The study on organic cultivation of onion during rabi 2005 revealed that the higher yield was obtained in FYM 30 t./ha + Neem cake 1 t./ha + cotton seed cake 0.8 t/ha + NSKE 4% sprays + Trichoderma sprays 0.5%. However, the pests and disease incidence was the lowest in chemical sprays.(Table 7).

Table 7. Organic cultivation of onion (var. N-2-4-1) season *rabi* 2005

Sr. No.	Treatment	Yield (t/ha)	No. of thrips/ plant	Per cent disease intensity
1.	GRDF (100:50:50 kg NPK + 20 t FYM/ha) + chemical spray	30.25	6.14	22.09
2.	FYM 20 t/ha + Neem cake 1 t/ha + cotton seed cake 0.8 t/ha (201:162:211) + NSKE 4% + Trichoderma 0.5%	29.82	29.92	35.15
3.	FYM 30 t/ha + Neem cake 1 t/ha +	31.88	30.04	36.29

	cotton seed cake 0.8 t/ha (251:227:299) + NSKE 4% + Trichoderma 0.5%			

2. The study on organic cultivation of onion during rabi 2006 revealed that the treatment FYM 20 t/ha + 100% RDF + biofertilizers + chemical spray recorded maximum yield. Among the organic treatments FYM 20 t/ha + 75 % N (Vermicompost) + 25 % N (Cotton seed cake) + Neem cake + biofertilizers gave good results. The treatment with FYM 20 t/ha + Beejamrut + Amrutpani and FYM 20 t/ha + Beejamrut + Jeevamrut also recorded the good yield as compared with the recommended dose of fertilizer and other organic treatments (Table 8).

Table 8. Organic cultivation of Onion (var. N-2-4-1) Season : *rabi* 2006

Sr. No.	Treatment	Yield (t/ha)	No. of thrips/pla nt	Per cent disease intensity
1.	FYM 20 t/ha + 100% RDF + Biofertilizers + Chemical spray	35.96	17.05	11.48
2.	FYM 20 t/ha + 100% N through organic cakes + Biofertilizers + NSKE 4%	28.00	60.32	57.53
3.	FYM 20 t/ha + 75% N through Vermicompost + 25% N through Cotton Seed Cake + Neem cake + Biofertilizers + NSKE 4%	29.00	57.57	52.99
4.	FYM 20 t/ha + Beejamrut +Amrutpani + NSKE 4%	28.02	77.57	57.62
5.	FYM 20 t/ha + Beejamrut + Jeevamrut + NSKE 4%	26.25	77.57	59.14

2. The studies conducted on effect of mulches on onion during kharif 2005 revealed that the maximum yield was obtained in the mulch of sugarcane trash with 40.70 % increase over the control and maximum C:B ratio (Table 8).

Table 8. Effect of mulches on onion (Phule Samarth) Season : *Kharif* 2005

Sr. No	Treatment	Yield of marketable bulbs (q/ha)	C:B ratio
1.	Black polyethylene mulch	28.48 (+ 39.67)*	1.57
2.	White polyethylene mulch	23.96 (+ 17.51)*	1.66
3.	Wheat straw mulch	26.65 (+ 15.98)*	5.09
4.	Sugarcane trash mulch	28.69 (+ 40.70)*	6.63
5.	Control	20.39	4.21

* per cent increase over control

Conclusion

1. Conversion of recommended dose of fertilizers (RDF) in organic form noticed beneficial to maintain yield levels in vegetable crops.
2. Use of mulch, biofertilizers and biopesticides found effective in organic vegetable cultivation.
3. The seasonal effect was observed promising to lower down disease and pest incidence.
4. Use of biocontrol agents would be beneficial in organic vegetable cultivation.

Organic floriculture

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Organic floriculture is the science and art of growing flowers, or ornamental plants by following the essential principles of **organic agriculture** in soil building and conservation, pest management, and heritage-species preservation.

The organic floriculture favours renewable resources and recycling, returning to the soil nutrients found in waste products. The organic floriculture respects the environment's own systems for controlling pests and disease in raising crops and livestock and avoids the use of synthetic pesticides, herbicides, chemical fertilizers, growth hormones, antibiotics or gene manipulation. Instead, the organic farmers use a range of techniques that help to sustain ecosystems and reduce the pollution.

Environmental impacts of organic farming are:

- The improvement of soil biological activity.
- The improvement of physical characteristics of soil.
- Reducing nitrate leaching.
- Increasing and improving wild life habitant.

Need for organic floriculture

1. Whenever you touch or inhale the scent of your non-organic flowers, you are likely touching or inhaling poisonous chemicals. When you buy organic flowers, you will not have to worry about chemicals on your flower bouquets being toxic to your children, other members of your family, or yourself.
2. The main goal of organic agriculture is to farm in ways that do not harm the environment, while there is no such motive for most non-organic farms.
3. Buying organic flowers supports the local organic farming communities and the organizations.
4. Organic flowers have greater vase life.
5. On a spiritual, holistic level, organic flowers have been farmed in such ways that they retain the essence of flowers.
6. Organic flowers are a natural part of a healthy, natural lifestyle.
7. Pesticides and other toxic chemicals used on flowers affect the health of farm workers and florists. Florists who handle non-organic flowers have been known to develop dermatitis on their hands.
8. The toxic residue of chemicals used on flower farms poison groundwater and the soil. These chemicals also become part of the food chain, as animals such as birds will eat the sprayed plants. In the course of their seasonal migrations, these birds will spread these chemicals globally.
9. Through evaporation of toxic pesticides and fertilizers that are sprayed on flower farms end up in the atmosphere. They then travel to other global areas to fall as rain or snow.
10. Every flower counts: Increasing the sales of certified organic flowers give the market notice that more organic flowers need to be grown which makes more flower farms convert to using the organic agricultural methods.

Soil fertility

Organic horticulture relies heavily on the natural breakdown of organic matter, using techniques like green manure and composting to replace nutrients taken from the soil by previous crops. This biological process, driven by microorganisms, allows the natural production of nutrients in the soil throughout the growing season and is often described as "feeding the soil to feed the plant".

Organic approach is to minimize the adverse impacts on the environments, by avoiding the use of materials from non-renewable resources, recycling where possible, use minimum amount of pesticides, avoiding the use of resources which cause pollution, relying on crop rotation, using crop residue recycling, animal manure, legumes and green manure, ground-rock mineral, minimum tilt, vermicompost, vermiwash, poultry manure, bone meal, fish meal, blood meal, biodynamic compost, various cakes and bio agents to be used to maintain soil productivity to minimize the energy costs of production and transportation materials to keep the soil more fertile. The organic methods improve soil health, increase population of healthy worms, fungi and other soil organisms. The organic agriculture saves the land from losses due to erosion and soil degradation, improves the soil fertility and enhances the moisture conservation.

Pest control

Different approaches to pest control are equally notable. In chemical horticulture, a specific insecticide may be applied to kill off a particular insect pest quickly. Chemical controls can dramatically reduce the pest populations for the short term, yet by unavoidably killing (or starving) natural predator insects and animals, cause an ultimate increase in the pest population. A repeated use of insecticides and herbicides and other pesticides also encourage rapid natural selection of resistant insects, plants and other organisms necessitating increased use or requiring new or more powerful controls.

In contrast, organic horticulture tends to tolerate some pest populations while looking to the long haul. Organic pest control involves the cumulative effect of many techniques, including:

- Allowing for an acceptable level (ETL) of pest damage
- Encouraging predatory beneficial insects to flourish and eat pests
- Encouraging beneficial microorganisms
- The careful plant selection, choosing disease-resistant varieties
- Planting companion crops that discourage or divert pests
- Using row covers to protect crop plants during pest migration periods
- Rotating crops to different locations from year to year to interrupt pest reproduction cycles
- Using insect traps to monitor and control insect populations

Each of these techniques also provides other benefits like soil protection and improvement, fertilization, pollination, water conservation, season extension etc. and these benefits are both complementary and cumulative in overall effect on site health. Effective organic pest control requires a thorough understanding of pest life cycles and interactions.

The organic farmers using garlic, green chilli, pyrethrum and *neem* to control pest and diseases also use predators to control various insect pests.

Constraints

1. Organic agriculture requires time and well trained extension workers. Since organic farming is a new practice it needs competent and reliable management.
2. Major problem is a lack of public awareness of organic food.
3. Development of viable producer and consumer linkages.

4. Poverty alleviation, sustainable development, food security, agrarian reforms and appropriate technologies better farm management is needed.
5. Due to lack of marketing structure, organic products are sold at the market rate of conventional produce. Artificial price structure bring disadvantage to the consumer as well as the producer.
6. Organic farmer suffers due to high labour cost and labour scarcity.

Future

1. In future we have to check the economic market and policies in which organic products produce and marketed and check in the financial results which fluctuate by the resources, farm business, better management and the labour availability.
2 In future, Government design better Trade regulation which are socially fair, ecologically sound and better standards for green and fair trade.
3. In future we have to establish promotion and training programmes to foster the export opportunities for organic products.
4. Future attention should be given to meet the guarantee system that will ensure organic quality and allow consumer to develop their preferences for organic products with feeling of trust.
5. In future we have to develop a practical and sophisticated monitoring procedure that is applicable to different farming structures to maintain international standards.
6. Needs proper organic standards, rules and regulations.

Applications of organic floriculture

I. Nursery management (More / Singh, Mangala)

Seed treatment: 1. Seed dressings with Trichoderma + PSB @ 4 g / kg of seed
2. Dipping of root system of plants 1.0 % Trichoderma + PSB solution at the time of repotting

Soil preparation for organic media: Ingredients *viz*; field soil + Goat excreta (*Lendi*) + crushed seed of custard apple + leaves of *Neem*, marigold + fresh dung. All these ingredients are thoroughly mixed, moistened, heaped and kept for partial decomposition. After partial decomposing bio agents *viz*; *Azotobacter*, *Rhizobium*, PSB + *Trichoderma* are mixed, moistened, heaped, covered with polyfilm and kept for about 8 – 10 days.

Organic media: Above specially prepared soil $3/4^{th}$ part + $1/4^{th}$ part vermi compost + *Neem* cake. This media is used for filling of nursery bags / pots

Slurry / Jeevamrut is applied to soil at monthly intervals with irrigation water.

Bio pesticides: 1. Spraying with animal urine approximately 0.5 %
2. Extract of Garlic + Chilli + *neem* leaves + crushed seed of custard apple

II. Rose (open field)

Commercial rose cultivation of cv Gladiator is raised by applying EM solution + *slurry* once in two month from September onwards on 0.2 ha. area. Small quantity of chemical fertilizer is applied once in a year. They found better frame work of plants due to the better shoot length with dark green foliage, more number of flowers (60 – 65 flowers / plant) with better quality, less incidence of soil borne pests and diseases and more survival of plants during the heavy rains of 2005 and 2006 monsoons (Nimhan, Pundlik).

III. Tuberose

1. Soil application of 2.0 kg FYM, 200 g *Neem* cake and 20 g. *Trichroderma*/m^2 + Biofertilizers (VAM + *Azosprillum* + Phosphate solublising bacteria) - @ 2 g each per plant at an interval of 2 months + fortnightly sprays of 4.0 % Panchagavya + 2.0 % Manchurian tea was found superior and recorded more number of flower stalk per plant (8.00), more number of florets per spike (48.6) and weight of spike (147 g) with better vase life in case of tuberose cv. Phule Rajani (Patil, *et. al.* 2006)
2. The stem rot of tuberose caused by *Sclerotium rolfsii* is one of the serious disease which causes losses both in terms of quality and quantity. The control measures become limited success because the pathogen has extensive host range, the profile growth and ability to produce large number of sclerotia that may persist for several years in soil. At present the disease become a major limiting factor in tuberose production. In this case bulb dip (10.0 g/lit) + soil application of (100g/sq.m) of bio agent *Trichoderma viride* (36.66% PDI) was found superior in respect of control of stem rot and gave more number of flower stalk per plot and more number of bulb per plant (Kakade, *et. al.* 2006)

IV. Gladiolus

Soil application of 2.0 kg FYM, 200 g *Neem* cake, 20 g . *Trichroderma* and 500g vermicompost/m^2 + Bio fertilizers (VAM + *Azosprillum* + Phosphate solublising bacteria) - @ 2 g each per plant at an interval of 2 months + 3.0 % Panchagavya sprays at fortnightly intervals were significantly recorded maximum spike length , more spike weight and more number of spikes per plot. While, size of floret, number of florets per spike and vase life were non significant in case of gladiolus cv Phule Ganesh (Singh, *et. al.* 2006)

V. Mogara

Mogara bud borer is controlled by periodical spraying from flower bud formation with 1.0 % solution of molasses/sugar/dried fish powder (Save).

VI. Aster

Dipping of root system of seedlings in EM 2 solution for 10 – 15 minutes before transplanting. Thereafter periodical either drenching or spraying of EM 2 solutions. Flowering started from 45 – 50 days and continued for 60 – 75 days and harvested about 180000 bunches (5 flowers in each bunch) of aster flowers from a area of one acre Obtained better flower yield and observed porous / loose soil at the time of uprooting of plants (Gawade).

VII. African Marigold

Dipping of root system of seedlings in EM 2 solution for 10 – 15 minutes before transplanting. There after periodical either drenching / spraying of EM 2 solutions. Flowering started from 45 – 50 days and continued for 60 – 70 days and harvested about 12000 kg flowers from a area of one hectare (Gawade, P. P.).

VIII. Rose (Protected cultivation)

Soil application of 2.0 kg FYM, 200 g *Neem* cakes, 20 g . *Trichroderma* and 500g vermicompost/m^2 + Bio fertilizers (VAM + *Azosprillum* + Phosphate solublising bacteria) - @ 2 g each per plant at an interval of 2 months + 3.0 % Panchagavya sprays at fortnightly intervals produced significantly maximum number of flowers per plant per year (33.80), more number of flowers with 60 cm stem length (20.00) and also better vase life of 6.50 days(Anonymous, 2007).

IX. Gerbera (Protected cultivation)

Soil application of 2.0 kg FYM, 200 g *Neem* cakes, 20 g. *Trichroderma* and 500 g vermicompost/m^2 + Bio fertilizers (VAM + *Azosprillum* + Phosphate solublising bacteria) - @ 2 g each per plant at an interval of 2 months + 3.0 % Panchagavya sprays at fortnightly intervals was significantly superior in respect of flowers per plant (33.8), flower stalk length (49.6 cm), flower stalk diameter (0.80 cm) and vase life of 5.6 days (Anonymous, 2007).

X. Carnation (Protected cultivation)

Significantly more vase life of carnation flowers (7.0 days), plant height (81.4 cm), number of flowers per plant (7.60) and flower diameter (7.00 cm) was recorded in treatment soil application of 2.0 kg FYM, 200 g *Neem* cakes and 20 g. *Trichroderma*/m ^{2} + Bio fertilizers (VAM + *Azosprillum* + Phosphate solublising bacteria) - @ 2 g each per plant at an interval of 2 months + fortnightly sprays of 4.0 % Panchagavya + 4.0 % Manchurian tea (Anonymous, 2007).

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Session-VII
Organic dairy farming

Organic dairy farming

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The technologies involving the greater use of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient-responsive, high-yielding varieties of crops have boosted the production output per hectare in most of the cases. The use of pesticides, fungicides and herbicides could cause adverse changes in biological balance as well as lead to an increase in the incidence of cancer and other diseases, through the toxic residues which are present in the food. In the rapid pace of development, we have inflicted serious damage to the natural resources and consequently we are now faced with questions as where is the clean milk and milk products? This question has given rise to a process of serious thinking to safeguard the quality of dairy products for sustainability of dairy farming. Since, over 50 million women and 15 million men are involved in Dairy Enterprises in India, more and more emphasis is being given towards returning to nature and adoption of organic dairy farming.

Need for organic milk market

Even though India has achieved white revolution and is top in milk production in the world, we can hardly take the same pride when comes to the quality milk product. The unhealthy practices like abuse of oxytocin for milk let down, use of growth hormones in dairy industries and rampant use of antibiotics that has led to large scale prevalence of resistant pathogens in human beings through the milk is a concern for prevalent dairy farming in India and there is a need to think of an alternative i.e. organic dairy farming.

Scenario of organic milk market

The best-selling organic food in Denmark has been organic milk. Organic milk now has a 15 per cent share of the domestic market in Denmark and shows an increasing trend. The demand for organic milk products has expanded rapidly over the past 4-5 years in Denmark, where more than 23 per cent of the liquid milk currently sold is organic. The annual production of organic milk in Germany is approximately 250 million kg, 60 per cent of which is marketed directly by dairy farms or used in the production of conventional milk products. 100 million liters of organic milk/year is processed by 39 dairy factories into organic milk products. The sales of organic milk in mainstream supermarkets of the USA over the last eight years is going up, as more organic milk processors are entering in market and more mainstream supermarkets sell organic products. The International Federation of Organic Agriculture Movements notes that the world organic sales hit 27.8 billion US dolor in 2004 and most is sold in Europe and north America with new markets, emerging in Brazil and Middle East. The growing awareness on quality products among Indian consumers and their willingness to pay extra for the quality can adequately motivate the farmers to go for organic production methods. The liberalized Indian economy under WTO regime may also force the farmers to produce the milk as per the standards stipulated by FAO/WHO on food safety for export to other countries.

Organic dairy farming in India

Organic dairy farming is not new to Indian farming community. The organic production systems are based on specific standards precisely formulated for food production and aim at achieving an agro ecosystems, which are socially and ecologically sustainable. Livestock keeping at farms is an age old practice. Livestock play major role in organic agriculture as the intermediary between the utilization of crop residues or fodder produced at the farm and the return of nutrients as manure. Dairying in particular has helped number of small and marginal farmers to improve their income. Animal dung is one of the potential sources of nutrients of organic farming. While animal dung has competitive use as fuel, it is extensively used in the form of farmyard manure. The development of several compost production technologies like vermicomposting, microbe mediated, phosphor composts, N-enriched phosphor composting, etc. improves the quality of composts through enrichment with nutrient-bearing minerals and other additives. These manures have the capacity to fulfill the nutrient demand of crops adequately and promote the activity of beneficial and macro and micro-flora in the soil. This not only improves the nutrients availability from organic sources but also prevents potential hazard of ground water pollution.

The organic dairy farming and food production systems are quite distinct from conventional farming in terms of nutrient management strategies. Organic systems adopt management options with the primary aim to develop whole farms, like a living organism with balanced growth, in both crops and livestock holding. Thus, nutrient cycle is closed as far as possible. Only nutrients in the form of food are exported out of the farm.

Approaches for organic dairy farming

The organic dairy farming involves adhering to general management principles, giving an adequate conversion period, planning and executing proper breeding programme, organic feeding and traditional system of animal health care.

The general management practices of livestock should be governed by the physiological and ethological needs of farm animals. This includes providing natural habitat for their basic behavioral habits, good health and welfare of animals.

Establishment of organic dairy farming requires an interim period which is called conversion period. Organic livestock products can be sold/offered at agro-eco-tourism centers only after the 1st year of rearing the animals as per the standards of organic animal husbandry. With regard to milk this period shall not be less than 30 days. As a general principle all organic animals should be born and reared on the organic holding.

Breeds should be selected as per their adaptability to local conditions. Breeding methods should be in accordance with the animal's natural behaviour and directed towards good health. Breeding shall not include methods that make the farming system dependent on high technological and capital intensive methods. The use of genetically engineered species or breeds, hormonal treatment and induced birth unless applied to individual animals for medical reasons are not allowed. Though artificial insemination is allowed only upon veterinary necessity but in general it is not allowed under organic production that may hinder the massive grading up programme promoted by the government. However, the rich livestock diversity, high disease resistance in local cattle and their tolerance to stresses of various kinds offer more opportunities for converting to organic production systems in India. Indian farmer possess a wealth of indigenous practices to treat their animals locally.

The feeding programme shall draw no standards for feed and feed ingredients. The livestock should be fed only with organically grown feed and fodder. All feed shall come from the farm itself or be produced within the region and by products from the organic food processing industry shall be used. The products like synthetic growth promoters or stimulants, synthetic appetizers, urea, fed subjected to solvent (e.g. hexane) extraction (soya and rape seed meal) or the addition of other chemical agents etc.

Management practices should be directed to the well being animals, achieving maximum resistance against disease. Sick and injured animals shall be given prompt and adequate treatment. In all possible cases, homeopathy, ayurvedic medicine and acupuncture to be used for treating the cases though there is inadequate availability of ayurvedic, homeopathic and other herbal products that may hamper the organic production. During the disease outbreaks the aim should be to find the cause prevent future outbreaks by changing manage mental practices.

Conclusion

The demand for organic milk has increased rapidly during the last decade. India as a developing country can't afford lagging behind; especially when export demand is rising for such products. There is an excellent scope for converting to organic production systems as India has livestock diversity and has in born low cost technologies. Further organic dairy farming is not only the need of the hour but it is the necessity as Francis Bacon had said 'Nature to be commanded is to be obeyed' and one has to have belief that the nature can provide for all our needs if not greed and calls for understanding the delicate and fragile aspects of biosphere.

Organic dairy farming for future

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Introduction

Due to the media and communication explosion and the upshot of globalization, lifestyles all over the world are going through a phase of transmutation. The food habits of consumers all over the world are also undergoing massive changes with this. They are expecting new things from the food industry for various reasons, like satisfying their palate, health consciousness, convenience, social aspects, nutrition, freshness, etc. The consumption of organic milk and milk products is a part of a wider trend towards the consumption of natural and healthy food. Because of greater health consciousness and awareness of possible types of food contamination, there has been a growing demand for bio (organic) products in recent years. The organic farms, therefore, are now recognized segments of agriculture in several Western countries. There is currently a growing interest in local organic milk, prompted by concerns about health, care of the environment and excessive transportation and packaging of produce.

Scope in India

Being a developing country, there is a big scope of organic dairy farming in India due to the following reasons (Kaur *et al.*, 2006).

i. Rich in livestock diversity.
ii. Wealth of indigenous non-chemical alternative to production.
iii. The high disease resistance in Indigenous breeds of cattle and their tolerance to stresses of various kind e.g. Gir, Sahiwal,Red Sindhi etc.
iv. The liberalized Indian economy under WTO regime may also force the farmers to produce the milk as per the standard stipulated by FAO/WHO on food safety for export to other countries.
v. The absence of local markets for organic products in many of the Asian countries also brightens India's chances for exporting organic milk.
vi. Cheap and easy availability of wide geographical and agro climatic conditions enable the farmers to more towards the labour intense organic production.
vii. The growing awareness towards quality products among Indian consumers.
viii. APEDA, ICAR, SAUs, NGO working towards the promotion of organic production in India.

Organic milk and your health

Organic milk is rich in conjugated linoleic acids (CLAs) and excellent source of calcium, it is produced without antibiotics, synthetic hormones and harmful pesticides. The organic milk contains 71% higher Omega-3, Vitamin A, E, antioxidants like Lutein and Zeaxanthine and than non-organic milk.

Senario of organic milk market

Organic milk production is popular in European Union and North America. This concepts is now a days going to be popular in Asia also.

Present status of organic milk production

Milk million kg	Country	Year	OMP in million kg
3303	Sweden	2001	110
27864	Germany	2005	370
11074	Holland	2001	100
24235	France	2001	100
4454	Denmark	2005	390

(Sen, 2003, Nissen, 2000 and Kaur, 2006)

From the above table it is evident that the production of organic milk is steadily increasing.

Production of organic milk and products in different European countries

Country	Company	Products
France	Triballat Noyal	Fruit Yoghurts
	Laiterie Le Gall	Yoghurts & butter
	Laiterie d'Armor	Yoghurt,butter,cheese,desserts,cultured milk
Denmark	MD food	Yoghurt & butter
	Naturmaelk	Cheese & butter
Italy	Gelati Betrona	Ice cream
	Salzburg	Cheese
Switzerland	Tony Holding SA	Butter Cheese,Dried milk
	Rocombe farm	Ice cream,yoghurt
	Torbay & Devon	Organic cheese
Swenden	Skane Dairies,PEOS	Cultured milk,Yoghurt,Cheese
USA	Stonyfield	Cheese,butter
	Horizone organic dairy	Chilled dairy produces

(Gurujeet Kaur, 2006)

Marketing growth rates of organic dairy products in develod countries

Country	Annual Growth Rate (%)
Denmark	30
UK	30
Austria	30
Spain	25
France	15
Germany	15
Sweden	15

(Sen, 2003 and Gurujeet Kaur, 2006)

National Standards (Ministry of Commerce, 2000)

The Government of India has taken some concrete steps to give a boost to organic production by formulating National Organic Standards and Certification Scheme based on European Union standards. The launching of National Programme for organic production (NPOP) in April 2000 has encouraged the organic farming as one of the core areas for promotion and development of the country.

At present, six accreditation agencies have been approved by the Ministry of Commerce for organic produce in India. These are Agricultural & Processed Food Exports Development Authority (APEDA), Coffee Board, Spice Board, Tea Board, Coconut Board and Cocoa and Cashew nut Board. Besides, there are private certification agencies for organic farms (Kumar et al, 2003)

Basic principle

The livestock should be fed 100 per cent organically grown feed of good quality. All feed should come from the farm itself or be produced within the region. The diet should be offered to the animals in a form allowing them to execute their natural feeding behavior and digestive needs.

National standards for organic livestock production in India

I. Landscape

The plant products produced annually can be certified as organic when the national standards requirements have been met for minimum of 12 months before the start of the production cycle.

II. Animal Husbandry Management

1. The certification programme shall ensure that the management of the animal environment takes into account the behavioral needs of the animals and provides for

- Sufficient free movement
- Sufficient fresh air and natural day light 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 animals. For all animals requiring bedding, natural materials shall be provided.
- Ample access to fresh water and feed according to the needs of the animals. .

III. Length of conversion period

- Animal products may be sold as organic agriculture only after the farm or relevant part of it has been under conversion for at least twelve months and providing the organic animal production standards have been met for the appropriate time.
- Animals present on the farm at the time of conversion may be sold for organic meat when the organic standards have been met for 12 months.

V. Breeds and breeding

- The accredited certification programme shall ensure that breeding systems are based on breeds that can copulate and give birth naturally.
- Artificial insemination is allowed only upon veterinary necessity.
- The embryo transfer techniques are not allowed.
- The hormonal heat treatment and induced birth are not allowed unless applied to individual animals for medical reasons and under veterinary advice.
- The use of genetically engineered species or breeds is not allowed.

VI. Animal Nutrition

- The accredited certification programme shall draw up standards for the feed and feed ingredients.
- The prevailing part (at least more than 50 %) of the feed should come from the farm unit itself or should be produced in cooperation with other organic farms in the region. The accredited certification programme should allow exception with regard to the local conditions under a set time limit for implementation.
- Use of Colouring agents, synthetic growth promoters or stimulator, synthetic appetizers, preservatives (except used as processing aid),pure amino acids and Genetically engineered products is prohibited.

Future development

The large tracks of land in India are already cultivated with very low use of agrochemicals and traditional production systems adopted by farmers for many perennial crops have been, by and large, without any use of fertilizers and pesticides. Although yields in these areas are low and production is principally for subsistence, there exists great scope for organic feeds and fodder. Work carried out in different universities and institutions suggests that the productivity in these areas could be improved further by adoption of organic techniques, for example, organic manure and biopesticides, compost, biogas slurry and farmyard manure. There is growing appreciation for organically grown feed, especially as it provides additional value to production. However, there are a number of challenges that India and its organic community need to face:

- The awareness needs to be raised amongst producers, processors and consumers regarding the organic feeds and fodder and the potential of domestic and export markets for organic products.
- The domestic markets need to be developed and supported and the role of NGOs must be encouraged.
- A holistic approach for organic feeds and fodder needs to be encouraged with farmers but also at research institutes and universities.
- The local certification should be developed and a database on organic livestock farming and marketing of produce should be initiated and maintained.

Challenges

The rich livestock diversity \, high disease resistance in indigenous cattle breedsand their tolerance to stresses of various kinds offer more opportunities for converting to organic production system in India. The low external input based Indian dairy sector has better opportunity to convert organic production since majority of Indian farmers are organic farmers not by choice but by default (Chander 2001).In India 70 per cent milk comes from small marginal/landless farmers. In Asia the demand of milk and milk products is also expected to increase from 195 MT in 1998 to 567 MT in 2025, this will also increase the demand for organic milk & milk products.

Future need

Over 85 countries involved in organic milk production (Yussefi and Wiler, 2006). The worldwide 1.2 billon people are overweight and about 250 million are obese and 5.2 per cent diabetics patient. Therefore the demand/need for low fat, low calorie organic milk products will be increased in future. The value added products gaining popularity in the market. Therefore, there is a great scope for value addition in organic dairy products. Though the milk produced in rural area is devoid of chemicals through fertilizer, insecticide, however the farmers producing milk are scattered and productivity 1 to 3 lit /animal therefore, farmers may not able to bear the expense on certification of their milk. As organic produce under these circumstances cooperative sector should come forward in bringing these small farmers under one umbrella for procurement and processing of milk through community milking. The cooperative also should bear expenses on certification of the said organic milk.

The organic dairy farming cannot exist in isolation on large scale therefore there should be linkage of organic farming and of cereals, pulses and the organic dairy farming. The crop residue produced under the organic farming can be very well utilized for feeding the dairy animals or organic dairy farming. It can reduce the expenses on production of organic fodder thereby enhancing the economic viability of organic dairy farming. The FYM produced on dairy farm can be very well utilized for enhancing fertility of soil thereby enhancing productivity of crops under the organic farming.

Conclusions

The rate of urbanization in India is increasing with high income consumers with an environmental concern & health consciousness. This population could be target for profitable marketing strategy for organic milk where quality will be more important than price. There is a scope for converting to organic production system as our country has rich livestock diversity. The cooperatives should take initiatives in organizing small dairy farmers in rural area for certification, procurement & processing of organic milk & milk products.

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Production of organic milk and milk products

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Organic milk production is a vital output of organic dairy farming system. In the organic milk production, disease free, healthy milch animals are fed with pesticide free feed produced by the natural fertility of the soils. The green fodder accounts a major share in the organic feed ration. The green fodder to be fed to the animals produced without the use of synthetic fertilizers or pesticides. The animals are fed with organic feed have access to the pasture and/or outside and restrict the use of antibiotics and hormones. Some feed additives such as vitamins, minerals, probiotics are permitted on approved by the certifying authorities. In organic dairy farming, treating the sick animals, priority is given to the homeopathy and ayurvedic medicines.

Thus the organic milk is the output of animals, which are totally maintained under natural (i.e. organic production) system.

Production requirements of organic milk

The organic milk production is not a new phenomenon in rural India. It is still in existence in remote places, where intensive production system remained untouched. However, according to present concept of organic milk production, the animals which are considered for are tought to be managed by natural system without artificial involvement. The system includes

- Feeding by pasturing in pasture having sufficient area for grazing, with green fodder supplementation if required.
- Concentrate shall be free from GMOs, BSE, solvent extract and urea.
- Sufficient quantity of clean drinking water.
- Confinement of animals for longer duration be avoided.
- Rearing of pure local breeds for organic milk.
- Prohibition of Artificial Insemination (AI).
- When animal does get sick and needs treatment include homeopathy, herbal/plant based product and immune system such as vitamins, kelp, selenium, colostrum whey be considered.
- To control flies-use of plant and herbal oil based fly spray is advocated. However, mechanical fly traps, good sanitation, use of parasitic wasps are avenues for the fly control.

Significant qualities of organic milk

The significant qualities of organic milk reported are in additional to the conventionally produced milk. A limited number of studies have compared nutritional composition of organically produced milk. The results summarized are as follows -

- The organic cow had significant lower daily milk yield. This differs in early lactation. No differences in gross chemical composition were found (Table 1).
- Less protein but of a better quality, with exceptions of significantly higher non protein nitrogen noted.
- The higher content of nutritionally significant minerals (i.e. Fe, Mg, P, Ca) with lower amount of heavy metals.

- Milk fat in organic milk had a higher content of unsaturated fatty acids which are easily digestible.
- Organic milk content lower concentration of nitrates and higher content of dry matter. Higher nitrate level in milk are converted to carcinogenic nitrosamines. Nitrate have been impared the ability of blood to carry oxygen and may pose a risk of methemogobinemia.
- Less content of urea and somatic cells.
- Higher level of vitamin E (50 %), vitamin C, Omega-3 essential fatty acids, antioxidant (lutein and zeaxanthine) and beta karotene (75 %).

Omega-3 essential polyunsaturated fatty acids, which are believed to provide the protection from coronary heart disease has cancer fighting properties. Omega-3 in our diet help to maintain healthy heart, flexible joints, lower blood pressure and linked with fewer mood disorders. Antioxidants protect the body from free radicals-bad chemicals in the blood. Free radical alter cholesterol in a process known as oxidation. Which is thought to speed up the hardening of the arteries. Beta carotene is converted into vitamin A in the body.

- Conjugated linoleic acid (CLA) level are thought to be higher in organic milk, which is believed to boost immune functions and reduce the growth of tumours, control diabetes.
- The organic milk is free from pesticides – children are particularly susceptible to pesticide residues. They have higher intake of food than adults, have immature organic system and may have limited ability to detoxify these chemicals, to whom organic milk is beneficial.
- The organic milk is free from antibiotics, GMOs, solvents and BSE, thereby protects from the ill effects on human health. Chemical residues lead to nervous and endocrine problem.
- Higher level of salicylic acid (six time more)-salicylic acid is a protective compound against stress and diseases. Salicylic acid act as an anti-inflammatory and help combat hardning of arteries.
- The organic milk and milk product tastes better.

Characteristics of organic milk and milk products

- They are antibiotic free.
- Growth hormones are not administered to the animals.
- Harmful insecticides/pesticides are not present.
- All organic milk products are certified by the authorities established for -
- The packaging material is constructed out of an earth friendly, recyclable, opaque paper board to avoid environmental pollutions.
- Food safe water based inks are used during packaging.
- High profit margin due to the willingness of consumers to pay higher price for the environment friendly healthy food.

Organic milk products

Documented evidences indicated that the organic milk processing started in Denmark in 1986. A number of companies are now involved in processing of organic milk and manufacture of milk product thereof (Table 2). Unfortunately, India is not appearing in the list. However, rural house holds at remote places are utilizing the milk produced eco-friendly production system. Such milk and milk products are not less than the organic milk.

In the manufacture of organic milk product, special care is taken to exclude artificial or chemical ingredients including the flavours, colour, sweeteners and stabilizers etc. The artificial additives causes health problems such as heart disease, oesteoporosis, hyperactivity and migraines- which are not used in organic milk product system hence prevent the health problems. The products which are being manufactured organically are same as the conventional products i.e. liquid milk, dahi, yoghurt, butter, cheese, ghee, ice cream etc.

The list of some of the leading companies engaged in the processing of organic milk are listed in Table 2.

Organically flavoured milk such as chocolate or strawberry are popular options for kids too. The organic milk products are not irraditated – Irradiation destroy vital nutrients, the process changes physical structure of frugile proteins in milk and distorts them into proteins that can actually be harmful to our body. Additionally, the process virtually eliminate any good bacteria normally present in milk.

Hurdles in production of organic milk products

- The geographical areas is the hurdle in manufacture and marketing of organic milk and milk products, which are not on the routine pick up routes.
- Rennet coagulation is slower in organically produced milk especially during winter season.
- The insufficient supply of raw organic milk in product manufacture.
- The limited technical know how for the manufacture of organic milk and milk products – which will be rectified by conducting the systematic research in this area.

Conclusions

Organic milk and milk products, emphasizing human health, lot of interest have been generated among producers, processers, consumers, researchers and policy makers. It is certainly more biofriendly and sustainable. So far this segment has remained confined to developed countries. A systematic steps can help India to enter into the movement of organic dairy farming and organic milk too. More research is needed in India context. The resources at remote places, where intensive production system remained untouched shall be trapped and converted into organic dairy farming and production of organic milk and milk product to cope-up with the movement.

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Table 1. Milk yield and composition of organically produced milk

Compo nent	Whole lactation		1-10 week		11-34 week		35-44 week	
	Organic	Conve-ntional	Organic	Conve-ntional	Organic	Conve-ntional	Organic	Conve-ntional
Milk/ day (kg)	23.8	25.9	28.5	30.7	24.5	24.9	17.7	17.9
ECM (kg)	25.6	27.5	29.9	31.9	26.2	26.7	20.2	20.5
Fat (%)	4.5	4.5	4.3	4.3	4.5	4.5	4.9	4.9
Protein (%)	3.5	3.5	3.4	3.3	3.5	3.5	3.8	3.8
Lactose (%)	4.7	4.7	4.8	4.8	4.7	4.7	4.7	4.7

Table 2. List of companies processing of organic milk

Country	Company	Organic products
Denmark	MD foods	Fluid milk, butter, yoghurt
	Naturemaelkamba (South Jutland)	Processing milk
USA	Horizon organic dairy (Longmont, Colorado)	Refrigerated milk products
	Robinson Dairy (Denver, Colorado)	Processing milk
	Coulee Region organic produce pool (Wisconsin)	Processing milk
	Stonyfield farm (Hampshire)	Yoghurt, Ice-cream
Germany	Bioland	Processing milk
France	Triballat Noyal	Fruit yoghurt
	Laiterie Le Gall	Yoghurt, butter
	Laiterie d Armor	Yoghurt, butter, cheese, dessert, cultured milk
	Besnier	Yoghurt, butter, pasteurized milk
	Domaine de La crox morin	Milk, yoghurt, cheese, butter lactic acid product
Italy	Gelati Betrona (Salzburg)	Ice-cream, cheese
Sweden	Skane Dairies (PEOS Jarna)	Cultured milk, yoghurt, cheese, Ice-cream, whipping cream
Switzerland	Schwyzer Milchuns dairy	Cheese
	Tony Holding SA	Butter, cheese, dried milk
	Rocombe Farm (Torbay and Devon)	Ice-cream, Frozen yoghurt

Session-VIII
Processing technology for organic foods

Processing technology for future organic foods

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Organic refers to the way agricultural products—food and fiber—are grown and processed. The organic food production is based on a system of farming that maintains and replenishes soil fertility without the use of toxic and persistent pesticides and fertilizers. The organic foods are minimally processed without artificial ingredients, preservatives, or irradiation to maintain the integrity of the food.

"Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on the minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony."

"Certified Organic" means the item has been grown according to strict uniform standards that are verified by independent state or private organizations. Certification includes inspections of farm fields and processing facilities, detailed record keeping, and periodic testing of soil and water to ensure that growers, handlers and processors are meeting the standards which have been set.

Any agricultural product that meets third-party or state certification requirements may be considered organic. The organic foods are becoming available in an impressive variety, including pasta, prepared sauces, frozen juices, frozen meals, milk, ice cream and frozen novelties, cereals, meat, poultry, breads, soups, chocolate, cookies, beer, wine, vodka and more. These foods, in order to be certified organic, have all been grown and processed according to organic standards and must maintain a high level of quality.

There are many reasons to eat organic food. It protects future generations' health, protects water quality, preserves topsoil, eliminates health risks, preserves biodiversity, keeps rural communities health, provides a safer and healthier habitat, supports a 'true' economy and makes food nutritious taste great.

There are number of hazards eg.. Synthetic agrochemicals, Environmental pollutants, Nitrates, Animal feed contaminants and veterinary drugs, Natural plant toxins, Pathogenic microbes and microbial toxins in and around food which are deteriorating health of food and eventually the health of the consumers. The food processing helps to get freedom from these hazards to maximum extent.

Food processing

The food processing industry would contribute to rapid economic growth and high employment generation. The Favourable policies were evolved to encourage agriculture based industries especially under the public sector as well as in the small scale private sector. The adoption of WTO agreements on international trade increased the pace of food export. Significant growth of organized retailing has helped in increasing the access to the market for the industry. If the present market trend continues lot of changes can be anticipated that may help the Indian food industry to achieve significantly faster growth levels in future. The processing and packaging, marketing and buyers attitude is changing dramatically through out the world. The consumers attitude towards quality and safety, variety is helping the diversified processing. The agriculture, livestock and poultry, sea food provide the raw materials to the food processing industry.

Present scenario of food processing industry

It is widely recognized that India is worlds second largest food producer In spite of this its contribution to national GDP is negligible. Achieving genuine value addition through technological and management interventions and higher value addition to agriculture and other allied produce, more significant will be contribution to the country's GDP. Our country food industry could manage only less than 16% value addition to agricultural raw material as compared to 180% achieved by USA. Looking towards this we have to strive very hard for longer time to catch up with industrialized nations. In our country white sugar, cereal products (wheat), dairy products, edible oil, tea and coffee and marine products dominate the food industry.

Now there are perceptible signs of charges in the market, a trend considered to be helpful to the food industry to achieve higher growth rate in coming years. The market for organic food is increasing world wide by 20-30% so we should think of capturing this by diverting our efforts in this direction.

Food processing opportunities: India's food processing mainly involves primary processing (80-90%) and the rest of it involves development of value added products.

Fruits and vegetables	:	Primary processing, processed products from fruits and vegetables like dried and dehydrated products, jam, jelly and marmalade, pickles, chutney, fruit bars, toffees, fruit juices, RTS, squash, cordials. leather, powder, concentrate, ketchup, Crush, canned products, wafers, etc.
Cereals and legumes	:	Grains primary processing, rice milling, flour mills, bakery products, biscuits, extruded food products. Texturized vegetable proteins, flakes, pops, roasted products etc.
Oil seeds	:	Refined oil, vanaspati, deoiled cake, etc.
Milk & milk products	:	Market milk, indigenous western dairy products, fermented, milk products, etc.
Meat, fish and poultry	:	Canned products, dehydrated products, pickles, smoked products, etc.
Fermented foods	:	Cereal and legume based, wine, pickles, sauerkraut, distilleries, milk based.
Spices	:	Dehydrated products, powders, oleoresins, essential oils, flavourings, herbal drinks.

Challenges ahead

Now the world scenario is changing, India is a signatory to GATT and a founder member of WTO. Accordingly the international efforts are to pull down all technical barriers to trade (TBT) and universal application of Sanitary and Phytosanitary Measures (SPS) for smooth global trade. The WHO/FAO laid down Codex Alimentarius Commission and ISO Standards, for food products. The consumer should be assured for quality and safety of the processed food products.

Food processing technology for organic

At simplest, the processing may involve only picking, sorting, and washing fruits and vegetables before they are sent to market. Some processing methods convert raw materials into a different form or change the nature of the product, as in the manufacture of sugar from sugar beets, oil from corn or olives, or cheese from milk. Processing may also involve an extremely complex set of techniques and ingredients to create ready-to-eat convenience foods. The food preservation refers specifically to the processing techniques that are used to keep food away from spoiling.

There are number of modern technologies developed for food processing which as such can not be used for processing of organics as many of them uses harmful additives and reduces the nutritional value.If the equipment has to be shared with conventional processing, complete cleaning up shall be operated afterwards, without any residues of cleaning detergents; or, a small quantity of organic raw materials shall be processed to clean up the remaining substances from conventional processing either after the organic conversion and conventional processing or before the beginning of organic processing; in other words, purge process. The products from purge process shall not be sold as organic products. The records of purge processing shall be kept.

The organic product processing shall not damage the main nutritional elements; such techniques as mechanical, refrigerating, heating, micro-waving and smoking may be used, as well as fermentation. Extraction, concentration, sedimentation and filtration may also be used.Ionizing radiation is prohibited in the process of food processing and storage. Asbestos filtrating materials or filtrating materials that could be penetrated by hazardous matters shall be prohibited in food processing. Low input processing is adopted for processing of organics.

Primary processing

Harvesting at proper stage and with suitable method. While harvesting, the factors like delicacy of crop, maturity criteria, time, method of harvesting, mode of packaging and transportation affects the quality. The quality of harvested products can't be improved further but it can be retained till their consumption by adopting appropriate post harvest handling operations. The special care for perishables like fruits and vegetables is taken by pre-cooling using cold air, cold water (hydro-cooling), contact icing, evaporative cooling, vacuum cooling and combination of vacuum and hydro cooling (hydrovac cooling) grading, washing, cleaning and trimming.

Curing of vegetables like onion, garlic, sweet potato etc. to reduce the water loss during storage. The curing of the root and tuber crops develops periderms over cut, broken for wound restoration. It helps in the healing of harvest injuries and prevent the infection by decay pathogens.

Drying and Dehydration

In modern times, the dried foods industry greatly expanded after World War II (1939-1945) but remained restricted to certain foods, including milk, soup, eggs, fruits, yeast, some meats, and instant coffee, that are particularly suited to the process. Three basic methods of drying are used today: sun drying, a traditional method in which foods dry naturally in the sun; hot air drying, in which foods are exposed to a blast of hot air; and freeze-drying, in which frozen food is placed in a vacuum chamber to draw out the water.

Freeze-drying

In freeze-drying frozen food is placed in a special vacuum cabinet. There, the water escapes from the food by sublimation, a process in which ice changes from a solid directly to a vapor without first becoming a liquid. Freeze-dried foods retain their original flavor, texture, and nutrients upon re-hydration but must be packaged in moisture-proof, hermetically sealed containers. The freeze-drying is an expensive process used for such products as instant coffee, dried soup mixes, strawberries, mushrooms, and shrimp.

Flash drying

Capable of processing even heat sensitive and volatile materials. This system incorporates a broad range of operating temperatures and pressures to allow customization to specific drying application. It can be used in production of dry, discrete, deagglomerated product from raw feeds containing 95% moisture.

Foam mat drying

The foamed juice is spread on a tray and dried. The material dries rapidly due to porous nature without impairing flavour and colour.

Thermal processing

The main function of heat in food processing is to inactivate pathogenic and spoilage organisms, as well as enzyme inactivation to preserve foods and extend the shelf life. Other advantages of heat processing include the destruction of anti-nutritional components of foods (e.g., trypsin inhibitors in legumes), improving the digestibility of proteins and gelatinization of starches, and the release of niacin. Higher temperatures for shorter periods achieved the same shelf life extension as food treated at lower temperatures and longer periods, and allowed retention of sensory and nutritional properties.

Aseptic packaging

Aseptic packaging is now commonly used for packaging the milk and juice. Like canning, aseptic packaging involves heat sterilization of food, but unlike canning, the package and food are sterilized separately. The food can be sterilized more rapidly and at lower temperatures in aseptic packaging than in canning, allowing the food to retain more nutrients and better flavor. The containers are sterilized with hydrogen peroxide rather than with heat, permitting the use of plastic bags and foil-lined cartons, which would be destroyed by heat sterilization. These containers cost less than the metal and glass containers used in canning and also weigh less, reducing the transport costs. Aseptically packaged foods will keep without refrigeration for long periods of time, perhaps even years. They are growing in popularity because of their low cost, good taste, nutrition and convenience. If it is to be used in future organic processing then packaging material manufacturing should be as per the norms laid down in CAC standards and sterilization with some natural agents.

In USA Horizon Organic and Tetra Packs have launched an organic flavored milk in aseptic tetra pack and aseptic packaging for soy-based beverages respectively.

High pressure processing (pascalization)

High hydrostatic pressures around 650 MPa (650-0 atm), for 10-15 min. reduced the microbial load in food such as milk, meats and fruits. The microbial inactivation by high pressure is enhanced by low pH and temperature above and below ambient. The microbial cell membrane lipid bi-layers have been shown to compress under pressure and this alters their permeability. The bacterial endospores are more resistant to hydrostatic pressure but can be killed by increasing temperature during pascalization.

The pressure acts instantly and uniformly throughout a food so that the processing time is not related to container size. The nutritional inability, flavour, appearance and texture resemble the fresh material very closely. To the consumer, it is a natural process with none of the negative association of processes such as irradiation or chemical preservatives. The equipments capable of processing food on a commercial scale are developed and used in Japan.

Extrusion cooking

India has been traditionally producing snack foods by extrusion process since several centuries. Extension is simply a forming and shaping process. In early forties the extrusion cooking process was first developed wherein most of the unit operations were conducted in a single machine. It is energy efficient process. Modern extruder is a bioreactor which can work at high temperature short time under pressure and at the exist pressure drop causes puffing to occur. Macaroni and pasta type ready to eat puffed snacks, chips, flakes, textured vegetable proteins etc. are prepared.

As it is a continuous thermal-plus-mechanical process (high shear press and high shear process) applied to food ingredients of low moisture contents (10-30%) extrusion cooking differs from most other thermal and cooking processes. It is to note that stable and nutritionally balanced foods such as biscuits, pre-cooked flours for gruels, porridges and weaning foods can be prepared in developing countries by extrusion of indigenous raw materials at lower cost. The extrusion cooking inactivates some endogenous enzymes (carrying deteriorative reactions) inactivates antinutrional and toxins and microorganisms, which increases the safety of extruded foods. However, slight losses of nutritional value of proteins and vitamins.

Low-temperature storage (Refrigeration and Freezing)

Low-temperature storage as a preservation method probably began when prehistoric humans stored meat and other foods in ice caves. However, mechanical refrigeration and large-scale freezing are relatively recent innovations. In 1920s, the procedures, equipment, and packaging was developed for quick-freezing.

Storage at low temperature slows many of the enzymatic reactions involved in spoilage and reduces the growth rate of microorganisms (though it does not kill them). To minimize microbial growth, refrigerators should be kept at 0° to 4° C 32° to 40° F) and freezers at or below 0° C (32° F). Refrigeration is advantageous because it does not cause chemical or physical changes to food. Freezing allows foods to be stored for longer periods than refrigeration because it inhibits enzyme activity and microbial growth to a greater degree.

Foods that should be refrigerated include meats, fish, eggs, milk, some fruits, and some vegetables. Many of these foods can also be frozen. Frozen produce is often high in quality and can rival the flavor of fresh. In many cases, produce frozen and stored under proper conditions contains more nutrients than produce picked unripened and allowed to mature during transportation Quick/Fast freezing is used commercially for preservation of valuable food commodities.

Flash freezing is a process of super cooling foods to temperatures of -195°C (-320°F) through the use of liquid nitrogen. The process reduces cellular deterioration and increases retained moisture so that the foods are tastier when they are unfrozen.

Hurdle Technology

It is the term often applied when foods are preserved by a combination of processes. The hurdle includes temperature, water activity, redox potential, modified atmosphere, preservatives, etc. The concept is that for a given food the bacteria should not be able to "jump over" all of the hurdles present, and so should be inhibited. If several hurdles are used simultaneously, a gentle preservation could be applied, to get safe foods of high sensory and nutritional properties. This is because different hurdles in a food often have a synergistic (enhancing) or additive effect. For instance, modified foods may be designed to require no refrigeration and thus save the energy. On the other hand, preservatives (e.g., nitrite in meats) could be partially replaced by certain hurdles (such as water activity) in a food. Moreover, a hurdle could be used without affecting the integrity of food pieces (e.g., fruits) or in the application of high pressure for the preservation of other foods (e.g., juices). Hurdle technology is applicable to both large and small food industries. In general, hurdle technology is now widely used for food design in making new products according to the needs of processors and consumers. For instance, if energy preservation is the goal, then energy consumption hurdles such as refrigeration can be replaced by hurdles (a_w, pH, or E_h) that do not require energy and still ensure a stable and safe product. This hurdle effect is of fundamental importance for the preservation of food, since the hurdles in a stable product control microbial spoilage and food poisoning as well as undesirable fermentation.

Minimal and careful processing

In several standards, guidelines and publications, organic food processing is strongly associated with "minimal processing" and "careful processing". The term minimal processing is nowadays often used in the general food processing industry and described in literature. The term careful processing is used more specifically within the organic food processing but is not yet clearly defined.

Minimal Processing

Increasing consumer demand for fresh quality products is turning processors to the so-called minimally processed products (MP), an attempt to combine freshness with convenience to the point that even the traditional whole, fresh fruit or vegetable is being packaged and marketed in ways formerly reserved for processed products. The technology for shelf-stable high moisture fruit products (HMFP) is based on a combination of inhibiting factors to combat the deleterious effects of microorganisms in fruits, including the additional factors to reduce major quality losses from reactions. These products, apart from special handling, preparation, and size reduction operations, might also require special distribution and utilization operations such as controlled atmosphere /modified atmosphere/air flow rate/vacuum storage (O_2, CO_2, N_2, CO, C_2H_2, H_2O controls), computer controlled warehousing, retailing and food service, communications network, etc. The methods used are mild heat treatment with quick cooling, use of acidulants, antioxidants, chlorine and anti-microbials etc.The concept of minimal processing in food production covers a wide range of technologies that seek to achieve two things:

a. To use processing procedures that changes the inherent fresh-like quality parameters as little as possible or techniques which have a limited impact on the nutritional and sensory properties of the food.
b. To endow the product with a shelf life sufficient for its transport from the processing plant to the consumer. The specific technologies cover a wide range, e.g. Clean room technologies, High pressure treatment, Gamma irradiation. There has been very little attention given to environmental and ethical issues.

Careful processing concept in organic food standards/guidelines

The basis of processing organic products is that its vital qualities are maintained throughout each step of the process. Developing standards which emphasize careful processing methods, limited refining, energy saving technologies, minimal use of additives and processing aids etc. It is interesting that the guidelines for organically produced food in the Codex Alimentarius Commission also refer to "careful processing methods ". The integrity of the organic product must be maintained throughout the processing phase. This is achieved by the use of techniques that are appropriate to the specificities of the ingredients with careful processing methods limiting refining and the use of additives and processing aids. Ionizing radiation should not be used on organic products for the purpose of pest control, food preservation, and elimination of pathogens or sanitation. A much broader definition of careful food processing is related to

- **Carefulness to the product**
  Processing methods/ assessment, nutrition, taste, shelf life, ethics, trace ability, food safety.
- **Carefulness to the pepople**
  Working environment, assessment of working conditions, organization of work, education, competencies,
- **Carefulness to the environment**
  Cleaner technologies, energy, water, waste

Application of surface coating

The coating of waxes, fatty acid/esters of sucrose, chitosan and composite coatings made up of different combinations of proteins, carbohydrates and lipids are used for extension of shelf life of fresh fruits and vegetables, eggs etc. It restricts moisture loss and due to contact application of fungicide and antibacterial compounds restricts the growth of microorganisms.

Natural Food preservation system

The present day customers demand products with no chemical preservatives free from additives, natural with assured safety and better shelf life. Keeping in mind the consumers demand exploitation of natural substances from plants, animals and micro-organisms as natural preservatives is on top priority. Many of these have superb stability under processing conditions that make them ideal bio-preservatives for use in foods. Fermentation by-products are formed during fermentation of fruits and vegetables, as in sauerkraut processing, pickling, and wine making. One by-product, lactic acid, is formed during fermentation of cabbage or cucumbers. This acid decreases the pH of fruits and vegetables, producing the characteristic flavour of sauerkraut, and acts as a controller of pathogens that may develop in the final fermented product.

The spices and herbs beside contributing flavour many of these have antimicrobial activity. The antimicrobial compounds of some popular spices are Allicin (Garlic onion). Thymol (Savory), Cinnamic aldehydes (Cinnamon), Euganol (Clove), Vanillin (Vanilla) etc. Beside this the natural enzymes also have anti microbial activities such as : 1) Oxidases, lactases, Catalases etc. enzymes may deprive micro-organisms of the nutrients for their active growth and development. These are used for preservation of fruit juices and beer. 2) There are several enzymes that produce toxic substances lethal to microbes eg. Lipase, Lactoperoxidase, Myeloperoxidase and Xylitol phosphorylase. These are used in preservation of raw milk. 3) The enzymes having effective antibacterial activity by attacking their cell membrane and altering their cell membrane permeability eg. Lysozyme, Chitinase and Mannase etc. 4)The enzymes capable of inhibiting other enzymes that have potential role in microbial metabolism eg. Protease and Sulphahydryl oxidase.

The organic acids, whether naturally present in foods due to fermentation or intentionally added during processing, have been used for many years in food preservation. Some organic acids behave primarily as fungicides or fungi-static, while others tend to be more effective at inhibiting bacterial growth. The most commonly used organic acids in food preservation include: citric, succinic, malic, tartaric, benzoic, lactic, and propionic acids.

Market

U. S. sales of organic food totaled $5.4 billion in 1998, about $6.5 billion in 1999, and reached nearly $7.8 billion in 2000. The market has grown 20%–24% annually during the 1990s. The adoption of national standards for certification is expected to open up new markets for U. S. organic producers. The world wide markets for organic foods are expanding with annual growth rates of 15 to 30% in Europe, United States and Japan for the past 5 years. Projected market size in 2010 will be at least $ 46 billion in the European Union, $ 45 billion in the U.S. and $ 11 billion in Japan. Presently in these countries 20 to 30% consumers purchase organic foods regularly.

In the context of organic processing we are fortunate to have very strong base of traditional small scale processing (35%) with appreciable support from Government to this sector. Such small scale technologies are presently used in developed countries for manufacturing organic, beauty and nutraceutical foods. So future is bright in this sector and to capture this besides hurdle and care full processing we have to divert our research priorities towards he improvement, modifications, tailoring of different methods to get rid off the dangers of the toxic compounds formed during processing particularly high temperature processing and to have stable certified organic foods.

Organic farming influencing food quality and safety

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I. Introduction

The word "organic" refers to the way farmers grow and process agricultural products such as fruits, vegetables, grains, dairy products and meat. Organic foods are produced according to certain production standards. For crops, organic food mean they are grown without the use of conventional pesticides, artificial fertilizers, human waste, or sewage sludge, and that they are processed without ionizing radiation or food additives. For animals, it means they are reared without the routine use of antibiotics and without the use of growth hormones. In most countries, organic produce must not be genetically modified.

Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony. Organic is a labeling term that denotes products produced under the authority of the Organic Foods Production Act. Organic agriculture practices cannot ensure that products are completely free of residues, however, methods are used to minimize pollution from air, soil and water. The organic food handlers, processors and retailers adhere to standards that maintain the integrity of organic agriculture products. The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and the people.

The organic food typically describes food that has been cultivated and/or processed without the use of chemicals of any sort including fertilizers, insecticides, artificial coloring or flavoring and additives. Organic label is therefore a process claim rather a product claim.

II. What is food quality?

An intrinsic property of food by which it satisfies the predefined requirements is referred to as the quality. The food quality can be grouped into several properties *viz.*, nutritional (carbohydrates, proteins, oils, minerals, fibres etc.), hygienic (incidence of pests and diseases, residues of pesticides, contamination of microbes and molds), organoleptic (taste, colour, flavour, and consumer acceptability), functional (processing qualities, storability), and environmental compatibility (safe food and environmentally friendly production). Food quality, therefore, is the value that is subjectively or objectively attached to the food quality properties (Sayed Ismail, 2005).

III. Current trends for organic foods

According to many reports, the organic food is a growing business with long-term prospects. Despite the heightened attention that organic agriculture has attracted during the last decade, it still only accounts for a small proportion of overall agricultural land: an average of about 2% of the countries of the European Union, 0.1% of the USA and 1.34% for Canada. The organic agriculture is also gaining importance in a number of developing countries including China, Egypt, India, Philippines, Sri Lanka and Uganda.

As the area of production increases significantly, from farming only a few acres, into farming hundreds of acres, problems of soil fertility or pest outbreaks become more difficult to manage with organic techniques. Thus, considerable research support will be necessary in future to develop production techniques that will allow for the successful production of organic crops on a wider scale than is possible today. The educated consumers may also be willing to pay a premium price for organic products, knowing that a large organic industry translates in the long term into a healthier environment with cleaner lakes and rivers and potable aquifers.

IV. Organic food quality and processing

Food quality and safety are of a great concern to every individual. Conventional food does contain pesticide residues, often multiple residues. The consumers expect these foods to be enjoyable, nutritious and safe. At the level of processing of organic food, the use of food ingredients of non-agricultural origin are restricted. There are no differences between the processing of conventional and organic foods. Food safety concerns that have been investigated in relation to the contamination of processed foods with chemical compounds contained in certain packaging materials or processing contact surfaces are equally relevant to organic and conventionally produced food. A major function of processing operations is to render a food microbiologically stable for a defined period. With minimally processed foods, unacceptable levels of microbiological contamination will occur if an adequate care is not exercised in their processing and handling. The quality of agricultural production improves with organics because of the supply of all the growth principles such as enzymes, hormones, growth regulators etc. besides the essential plant nutrients but it does not mean that they can substitute the inorganic fertilizers as a lot of data are available to prove quality enhancement in integrated nutrient management (INM) than organic farming.

The processed organic food usually contains only organic ingredients, or where there are numbers of ingredients, atleast a minimum percentage of the plant and animal ingredients must be organic (95% in Australia). Any non-organically produced ingredients must still meet the requirements. It must be free of artificial food additives, and is often processed with fewer artificial methods, materials or conditions (no chemical ripening, no food irradiation and no genetically modified ingredients, etc). They may also be required to be produced using the energy saving technologies and packaged using recyclable or biodegradable materials when possible.

V. Risks and benefits of organic foods

The organic products are sold at premium prices as these products are grown without pesticides and thus may be more expensive to produce because of the added labour; they are grown in a way that minimizes harm to the environment; no genetically modified organisms are used in the production process; they are better testing and the produce may have been grown locally and the consumer wishes to support small family farmers. The increase in shelf life and quality of citrus with organics has been observed as compared to inorganic applications by Huchche *et al.*, (1998). A 2001 study by researchers at Washington State University concluded, under judgement by a panel of tasters, that the organic apples were sweeter. Along with taste and sweetness, the texture as well as firmness of the apples were also rated higher than those grown conventionally. The study team suggested these differences might be a result of greater soil quality resulting from organic farming techniques compared to those of conventional farming. A small study looking at processed organic foods, found participants could not differentiate organic and conventional varieties of a rice cakes and vitabrits. There is no detectable difference in the taste (or quality, nutrient value or safety) between organic and conventional produce. Sharma (1995) found significantly higher pod yields of okra and its protein content with 10 tons compost + fermented cow dung as compared to recommended NPK levels in vertisols. An increase in seed cotton yield with the application of green manure to supply 40 kg N/ha was recorded in cotton (Chitdeshwari and Pravikesavan, 1998).

The health benefits derived from organic foods include that chromium found in organic food is essential for normal utilization of glucose which will reduce the prevailing incidence of *Diabetics mellitus* in India. Selenium as an antioxidant nutrient is also found higher in organic foods that protects against cancer and heart disease. In addition, calcium, boron, lithium, iron and vitamin C are all found in higher concentrations in organic foods compared to ordinary foods (Jha, 2003).

It is to be emphasized that the philosophy of sustainable agriculture will jeopardize, if fertilizer use is reduced or excluded in the name of quality improvement of agriculture produce or environment protection. The intensive agriculture on a commercial scale cannot sustain for long through the total organic farming (Kumarswamy, 2002). Even Chhonkar (2002) predicted that organic farming will not be able to sustain food production at levels to meet the food and fibre needs of the ever increasing population. It is also necessary to consider the opinion of Dr. Norman E Borlaug in this context who advocated "We can use all the organic that is available but we are not going to feed six billion people with organic fertilizer" (Borlaug, 2002). Improper handling of organic produce after harvest may result in product contamination and in food borne illnesses. Some of the organic farms may not be managed correctly resulting in environmental problems such as excess erosion. Some of the natural botanical pesticides need to be evaluated for their risk to humans, wild life and the environment.

VI. Conclusions

Thus, it is important that the consumer becomes educated about the benefits and possible risks of purchasing either conventional or organic products, so that proper decisions can be taken about what to buy, and whether it pays to invest in products with a premium price. The data on quality of organically grown food is very meagre except on pesticide residues and vitamin C content. Hence, in depth studies by human nutritionists are further needed. There is a need for researching healthy food and body care products made from organic produce for the present day market. Promoting the organic agriculture in our country will provide employment to our burgeoning population. The organic food must meet specified production standards, which specify growing and processing conditions different from normal agricultural and food safety requirements. Most studies found no proof that organic food offers greater nutritional values, more consumer safety or any distinguishable difference in taste.

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Microbial technology in relation to organic farming

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Role of microbes for efficient organic farming

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India is predominantly an agriculture-based country and seventy percent of the population depends on agriculture for their livelihood. India with geographical area of 329 M ha presently supports 17% of the world's population on merely 2.5% world's land area and 4% world's fresh water resources (Sarkar, 2005). India has made a marvelous achievement in attaining self sufficiency in food grain production after the advent of Green Revolution which eventually resulted in maintaining all time high buffer stock in warehouses of our country. As a result, the food grain production increased from 50.8 Mt in 1951 to 217 Mt in 2004 which closely coincides with increase in consumption of plant nutrients from 0.07 Mt to 18 Mt. Despite this impressive gain in crop yield, India is still in a very low position at the global level in terms of unit crop yield. According to Katyal (2001), fertilizer use is projected to increase to 31.76 Mt (22.93 Mt N + 6.77 Mt P + 2.06 Mt K) up to the year 2020. Against this projected use, crop uptake related to removal would sum up to 37.46 Mt of NPK (11.87 N + 5.27 P + 20.32 K Mt) in 2020. Thus a negative balance of about 8 Mt of NPK is foreseen in 2020 even if we continue to use chemical fertilizers maintaining present growth rates of production and consumption. The grain production per kg NPK nutrients decreased from about 17 kg in 1950-59 to 12 kg in 1960-69 and 9 kg in 1990-99. If this trend continues, the nutrient response will go down further by 2025 and 2050. Moreover, the one billion plus population is expected to reach 1.4 billion by 2025 requiring 315 Mt of food grains (compared to 210 Mt at present) with a projected decrease in per capita land availability to 0.08 ha (0.15 ha at present) This raises a pertinent question whether these targets can be achieved and soil resources base can be maintained in a sustainable and environment friendly way in view of large scale land degradation. Here comes the concept of organic farming.

What is organic farming ?

There are many explanations and definitions for the organic farming but all coverage to state that it is a system that relies on ecosystem management rather than external agricultural inputs. As per the definition of FAO/WHO codex Alimentarius Commission, 1999 "Organic farming is a holistic production management system which promotes and enhances agro-ecosystem health including biodiversity, biological cycles and soil biological activities". It emphasizes the use of management practices in preference to the use of off-farm inputs taking into account that regional condition require local adopted systems. This is accompanied by using where possible agronomic, biological and mechanical method, as opposed to using synthetic materials to fulfill any specific function within the system.

Why organic farming is required?

With the introduction of High Yielding Varieties, increasing use of chemical fertilizers, irrigation and pesticides to increase the production of food and fibre are causing concern for the following reasons:

- Soils which receive plant nutrients only through chemical fertilizers are showing declining productivity despite being supplied with sufficient nutrients.
- The decline in productivity can be attributed to the appearance of deficiency in secondary and micronutrients.

- The deteriorating physical condition of the soil which is a consequence of the long term use of chemical fertilizers especially the nitrogenous ones, aggravate the problem of poor fertilizer nitrogen use efficiency. The excess nitrogen use leads to ground water and environmental pollution apart from destroying the ozone layer through N_2O production.
- The continuous use of chemical fertilizers more particularly nitrogenous fertilizer causes acidity in soil
- The recent energy crisis, high fertilizer cost and low purchasing power of the farming community have made it necessary to rethink alternatives.
- The indiscriminate use of pesticides by the farmers leads to the adulteration of food by the residue.
- Unlike chemical fertilizers, organic manure and biofertilizers are available at cheaper rates indigenously. They enhance crop yields per unit of applied nutrients by providing a better physical, chemical and biological environment conducive to higher productivity.

Benefits of organic farming

Organic farming offers the possibility of sustaining crop yields and maintenance of soil health. It avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives and solely depends on the use of crop residues, animal manures, biological inoculants, off-farm organic wastes, crop rotation incorporating legumes and biological pest control to maintain soil productivity (Palaniappan and Annadurai, 1999). Organic farming improves the bulk density of soil and thereby reduces the resistance to penetration by plant roots. It also supplements nitrogen up to 50 % of the nitrogen requirement of the crop besides increasing P and K use efficiency. The system is quite effective in minimizing the adverse effect of Al^{+3} and/or Fe^{+3} in acidic soils through the chelation of these ions by organic molecules liberated from FYM in the course of mineralization. At present, the estimates show that about 25-30% nutrient requirements of Indian agriculture can be met by utilizing various organic sources (Chhonkar, 2003). The major emphasis should, therefore, be not merely on optimizing crop yields but also on sustenance of the agricultural resource base and improvement of the environmental quality by using organic sources of nutrients and biofertilizers/ microbial inoculants for different cropping systems. Products of biological origin can be advantageously blended to replace a part of the energy intensive inputs to achieve the ultimate goal of increasing productivity in an economically viable way.

Microbes in organic farming:

Beneficial soil microbes play very important role in agricultural productivity. While some microbes help in soil fertility (Biofertilizer, earthworm), others help in controlling plant diseases, insects pest and nematodes (Biocontrol).

Biofertilizers

The term biofertilizer refers to preparation containing primarily active strains of specific microorganisms, which helps in enhancing the soil fertility either by fixing atmospheric nitrogen, solubilisation/ mineralization of phosphorus and potassium or decomposing organic wastes or by augmenting plant growth by producing growth promoting substances with their biological activities. The role of biofertilizers in agriculture production assumes special significance, particularly, in the present context of increased cost of chemical fertilizers and their hazardous effects on soil health. These microorganisms play vital role in mobilization of different nutrients from organic and unavailable forms to available forms and *vice versa*.

Biofertilizers are important for their contribution as agricultural input due to the following advantages:

- Biofertilizers are supplement of chemical fertilizers as they contribute plant nutrients through biological N fixation and solubilization of fixed phosphates.
- Replaces 25-30% equivalent fertilizer cost and increase the grain yields by 10-40%.
- Helps in decomposition of plant residues, thereby minimizing C:N ratio of soil and improving soil texture, structure and water holding capacity.
- Does not have harmful effect on plant growth and soil fertility.
- Helps in stimulating the plant growth and expanded root system as they secrete various growth promoting hormones, providing better nutrient uptake and increased tolerance towards drought and moisture stress.
- They secrete some fungistatic and antibiotic like substances, which reduce the incidence of certain diseases and increase disease resistance.
- Helps in mineralization of plant nutrients.
- They are eco-friendly and non-pollutants.

Type of biofertilizers

Broadly, the biofertilizers are classified into two types *viz.* i) Biological nitrogen fixing biofertilizers ii) Phosphate solubilizing or mobilizing biofertilizers. Nitrogen fixing biofertilizers consist of microorganisms that fix atmospheric nitrogen either symbiotically or non-symbiotically into the plants. Phosphate mobilizing biofertilizers are further classified into phosphate solubilizers (*Bacillus*, *Pseudomonas*, fungus) and phosphate absorbers (Mycorrhiza).

Biological nitrogen fixing biofertilizers

Rhizobium

Rhizobium, a soil bacterium, has the ability to fix atmospheric nitrogen in symbiotic association with host legumes. It was estimated that a total of 175 million metric tonnes of N is fixed per year globally through biological nitrogen fixation in legumes (Burns and Hardy, 1975). The quantum of N fixed by various *Rhizobium* species is shown in Table 1 (Bhattacharya and Mishra, 1995).

Pulses and oilseed legumes occupy about 30 M ha in India and it requires 15,000 t of *Rhizobium* to cover the whole area considering its application @ 500 g/ha. Present production level is 1000-1200 t including *Rhizobium*, *Azotobacter* and *Azospirillum* and the current annual total production capacity is 2685 t (Verma and Bhatacharya, 1992).

Table 1. Contribution of *Rhizobium* in biological N fixation

Crop	*Rhizobium* species	Quantum of N fixed (kg N/ha/yr)
Soybean	*Rhizobium japonicum*	60-80
Alfalfa	*R. meliloti*	100-200
Clover	*R. trifolii*	100-200
Groundnut	*R. sp.*	50-60
Pea	*R. leguminosarum*	52-77
Cowpea	*R. sp.*	80-85
Green/Blackgram	*R. leguminosarum*	50-55
Bengalgram	*Bradyrhizobium sp.*	85-110

Source: Bhattacharya and Mishra (1995)

Azotobacter

Azotobacter is a chemoheterotroph organism of aerobic character and fixes atmospheric nitrogen as non-symbiont. *Azotobacter* fixes on an average 20-40 kg N/ha/year. Response study showed that Maize responded magnificently to seed inoculation with *Azotobacter* which exhibited 36.5-71.7 % increase in yield over control, while the other cereals showed a range of 1-38.1% increase in grain yield. Vegetables also responded better to *Azotobacter* when applied by root dipping method and showed per cent increase in yield up to 50 per cent (Subba Rao,1993) (Table 2).

Table 2. Crop response to *Azotobacter* in various crops

Crop	Method of inoculation	Per cent increase in yield over control
1. Maize	Seed inoculation	36.5-71.7
2. Sorghum	--do--	9.3-38.1
3. Rice	--do--	1.0-20.0
4. Wheat	--do--	10.0-30.0
5. Cotton	--do--	6.7-26.6
6. Brinjal	Root dipping	1.0-42.0
7. Tomato	--do--	2.0-29.0
8. Cabbage	--do--	25.0-50.0
9. Onion	--do--	18.0-22.0

Source: Subba Rao (1993)

Application of single microbial inoculation in combination with 60 kg N/ha as urea and 60 kg P_2O_5/ha as rock phosphate in straw amended soil produced significant effect on yield of wheat (Dahama, 2003). The combined inoculation of organisms had a significant effect on growth and yield of wheat.

The results of a study on the usage of *Azotobacter* in an Ultisol of Mizoram showed 44 and 24 per cent increase in grain and stover yield of maize, while increase in N uptake by grains and stover accounted to 59 and 81 percent , respectively (Laxminarayana, 2001).

Azospirillum

Azospirillum, an associative symbiotic nitrogen fixing bacterium has a higher N fixing potential. It also produces growth-promoting substances, which favours better growth of plants. It helps in increasing the grain yield of paddy, barley, pearlmillet, ragi, sorghum, sugarcane, vegetable crops, tea, coffee, fodder crops, fruits and flower plants. It helps to save 20-30 kg N/ha. Azospirillum inoculations increased the grain productivity of cereals by 5-20%, millets by 30% and of fodder crops by over 50% (Dahama, 2003). Singh and Dixit (1998) reported that inoculation of *Azospirillum* in combination with 50% of the recommended doses of NPK showed an increase of 5-11 percent grain yield of paddy over to 100% NPK (Table 3).

Table 3. Effect of *Azospirillum* on the productivity of rice in *kharif* and *rabi* seasons

Treatment	Grain yield (kg/ha)	
	Kharif	*Rabi*
1. 100% NPK (125:50:100) Chengalpattu (14 trials)	3973	4054
1a. Azospirillum + 50% NPK	4285	4466
2. 100% NPK (125:50:100) Pudukottai (17 trials)	4611	4482
2a. Azospirillum + 50% NPK	5110	4503
3. 100% NPK (150:75:75) Vellor (24 trials)	4854	5535
3a. Azospirillum + 75% NPK	4662	5317

Azospirillum inoculation showed 30 percent higher kernel yield of maize with an increase of 41 and 79 percent increase of N uptake over control in an Ultisol under upland terraced conditions of Mizoram (Laxminarayana, 2001).

Blue green algae

Blue green algae are photosynthetic cyanobacteria and promote the growth of lowland paddy by supplying fixed nitrogen through exudation and microbial degradation of dead algal cells. In Indian soils, predominant genera are *Anabaena, Nostoc, Aulosira, Tolypothrix*. Various studies conducted in India showed that BGA application @ 10 kg/ha after one week of transplantation contribute 25 to 30 kg N/ha/season with a yield of 10-15 percent. A judicious use of BGA could provide to the country's entire rice acreage as much nitrogen as obtained from 15-17 lakh tonnes of urea. It has been observed that the species of blue green algal flora occurred in rice fields were *Anabaena, Anabaenopsis, Aulosira, Cylindrospermum, Nostoc, Calothrix, Scytonema, Tolypothrix, Fischerella, Hapalosiphon, Mastigocladus, Stigonema, Campylonema, and Microchaete* as dominant nitrogen fixers. Besides fixing nitrogen, these algae excrete Vit.B_{12}, auxins and ascorbic acid, which may also contribute to the growth of rice plants (Subba Rao, 1993).

The usage of BGA in lowland paddy on a Typic Hapludult of Mizoram for 3 seasons (2000-2002) showed that BGA application significantly increased the grain yields for all the seasons and its combination with fertilizer N aggravated the crop yields. Inoculation of BGA not only enhanced the crop yields but also improved the fertility status of the soil (Table 4).

Table 4. Effect of BGA on grain yield of paddy

Treatment	Grain yield (q/ha)			Org. C (%)	Available nutrient (kg/ha)		
	2000	**2001**	**2002**		**N**	**P**	**K**
Control	34.27	39.64	45.61	0.48	246	7.86	130
40 kg N/ha	46.50	42.58	50.73	0.66	280	8.31	140
80 kg N/ha	50.67	45.84	53.80	0.72	290	8.38	152
120kg N/ha	53.10	47.84	55.30	0.71	296	8.40	158
BGA	43.70	40.17	48.60	0.65	278	8.28	141
BGA + 40 kg N/ha	51.57	48.04	52.70	0.68	284	8.36	149
BGA + 80 kg N/ha	54.70	51.06	55.80	0.74	294	8.62	166
BGA + 120 kg N/ha	-	51.42	56.70	0.76	302	8.76	169
Initial	-	-	-	0.62	272	8.26	134

Azolla

Azolla is an aquatic fern and it has utility as a nitrogen fixer and green manure in rice cultivation. The leaf of *Azolla* contains blue green algae symbiont i.e. *Anabaena Azolla* which is responsible for nitrogen fixation. *Azolla* has very fast growing character, it doubles its biomass in 3-5 days and fixes 40-60 kg N/ha. The fern is found abundant in all the states of northeastern region. A local isolate i.e. *Azolla pinnata* is found in roadside ditches swampy lands and village tanks. Every 100 g of *Azolla* contribute 0.5g N, 0.5g P_2O_5, 0.4g Ca, 0.5g Mg, and 0.45g Fe (Singh, 1981). Nutrient content of *Azolla pinnata* is 2.33-3.83, 0.196 and 0.153% N, P and K, respectively (Majid ,1983).

The experimental results on *Azolla* indicated that 50% of NPK along with *Azolla* dual cropping recorded the highest yields (29.5 q/ha) with an increase of 54.5% over control (Table 5), while *Azolla* dual cropping registered 41% higher yields (22.3 q/ha). However, application of 50% NPK in combination with *Azolla* compost @ 10t/ha recorded 44.6% higher crop yields over control (Hazarika *et al.* 1999).

Table 5. Performance of rice as influenced by *Azolla* dual cropping and *Azolla* compost

Treatment	Grain yield (q/ha)	% increase over control
Control	13.8	-----
50% NPK + *Azolla* compost @10t/ha	23.5	44.6
50% NPK + *Azolla* dual cropping	29.5	54.5
50% NPK + *Azolla* @ 10 t/ha enriched with P	26.6	51.4
Azolla dual cropping	22.3	41.4
100% NPK	25.2	49.1

Around 50% N can be supplemented through Azolla and incorporation of 10t/ha green biomass of Azolla ensure 25 kg N/ha after its decomposition in the soil. Experiments carried out at Department of Soil Science, Assam Agricultural University showed that *Azolla pinnata* from CRRI, India proved to be better under the agro climatic condition of Assam, but during December to January, the fern did not survive at low winter temperature. It has been worked out that *Azolla caroliniana* (from USA), was found to be excellent among all the strains studied and could overcome the drawback possessed by local species *Azolla pinnata*. Results showed that *Azolla caroliniana* could be mass multiplied round the year, enhanced rice yield by 30-40 per cent and produced effective compost besides organic feed substitute for fish, cattle, etc. It can also be used for successful alternate propagation through spore inoculums. The dual application of azolla @ 300 kg/ha/crop could increase soil nitrogen by 50-60 kg/ha and thereby reduced 30-35 kg fertilizer Nitrogen required by rice.

Phosphate solubilizing microorganisms

Several soil bacteria, particularly the genera *Pseudomonas* and *Bacillus*, and fungi belonging to *Penicillium* and *Aspergillus* possess the ability to bring insoluble phosphates into soluble forms (Subba Rao, 1993).

The effect of P solubilizing microorganisms (PSM) on crop yield was critically reviewed by Chhonkar (1994) and reported a significant increase of 5-10% yields over control plots. The integrated use of rock phosphate and phosphate solubilizing cultures are known to add 30-35 kg P_2O_5/ha. In wheat, significant increase in the yield and P uptake by grain and straw was observed as a result of inoculation with *Bacillus polymyxa*. Inoculation of PSMs alone or in combination with phosphate fertilizer has increased the root CEC, available P in soil and total P uptake in rice (Mohod *et al.*, 1989). The effect of PSMs on yield and P uptake by different crops are summarized in table 6.

Table 6. Effect of PSM on yield (kg/ha) and P_2O_5 uptake (kg/ha) by wheat, rice and chickpea

Treatment	Wheat		Rice		Chickpea	
	Grain yield	P_2O_5 uptake	Grain yield	P_2O_5 uptake	Grain yield	P_2O_5 uptake
Control	3440	24.6	2490	6.7	2370	5.7
P. striata	3730	29.6	2540	6.8	2460	6.1
B. polymyxa	3660	27.8	2580	7.1	2920	7.9
A. awamori	3620	27.2	2560	6.9	2780	7.2
Rock phosphate	3730	27.2	2720	7.4	2560	7.2
RP+ *P. striata*	4350	34.9	2740	7.5	2920	8.8
RP+ *B. polymyxa*	4170	32.8	2820	7.8	3140	10.7
RP+ *A. awamori*	4170	32.2	2740	7.5	3070	10.1
Super phosphate	4440	35.3	2870	8.3	2850	9.1
C.D (P=0.05)	142	-	140	-	45	-

Rock phosphate and super phosphate were applied @ 60 kg/ha for wheat, rice & chickpea
Source: Gaur and Sunita (1999)

In a study with inoculation of *P. striata* in lowland paddy in an Ultisol of Mizoram for 3 seasons (2000-2002) indicated that PSB inoculation has increased around 11 per cent grain yield over control and 44 per cent increase in combination with 60 kg P_2O_5 /ha and PSB (Table 7).

Table 7. Effect of PSM on grain yield (q/ha) of lowland paddy

Treatment	2000	2001	2002
Control	36.90	40.16	42.05
30 kg P_2O_5 /ha	44.60	45.45	49.60
60 kg P_2O_5 /ha	49.90	49.98	54.30
90 kg P_2O_5 /ha	53.30	49.86	59.80
Pseudomonas striata	43.10	40.62	48.15
PSB + 30 kg P_2O_5 /ha	48.70	49.17	58.20
PSB + 60 kg P_2O_5 /ha	55.30	53.93	62.80
VAM fungi	40.10	40.94	46.70
VAM + 30 kg P_2O_5 /ha	47.50	48.66	52.90
VAM + 60 kg P_2O_5 /ha	50.50	52.02	56.16
C.D (P=0.05)	1.75	1.52	1.06

Mycorrhizal fungi

Mycorrhiza is the symbiotic association between plant roots and fungal mycelia. There are two types of Mycorrhizal fungal association viz., 1.Ectomycorrhiza and 2. Endomycorrhiza.

Mycorrhizal plants increase the surface area of the root system for better absorption of nutrients from soil especially phosphorus. The fungal hyphae enter the cells of the root and are often disintegrated and thus contribute to the nutritional requirements of the host. Another class of Endomycorrhizae is known as Vesicular-arbuscular mycorrhiza (VAM), which possesses special structures known as vesicles and arbuscules, the latter helping in the transfer of nutrients from soil into the root system. These fungi are classified into five genera: *Glomus, Gigaspora, Acaulospora, Sclerocystis and Endogone.*

Field experiments carried out on different crops showed that VAM inoculation is beneficial on cereal, pulses, vegetable and horticultural crops (Table 8). It also enhances the P uptake by crops (Subba Rao, 1993). VAM can improve uptake of certain relatively immobile elements, e.g., P, Zn and Cu. Mycorrhizal plants recover from water stress more quickly than non-mycorrhizal plants.

Table 8. Effect of mycorrhizal (VAM) inoculation on crop yields

Crop	Supplement of P_2O_5 through inoculation (kg/ha)	% Yield increase over control
Fingermillet	19	18
Soybean	25-50	19
Chillies	37.5	55
Chickpea	40.0	25
Groundnut	-	10-20

Source: Dahama (2003)

Cellulolytic microorganisms

Inoculation with *Azotobacter* and *Aspergillus awamori* (P solubiliser) along with rock Phosphate proved beneficial in improving the quality of compost in terms of N (1.82 %), C/N ratio (12.0), humus (15.2%) and available P_2O_5 (0.36%) after 12 weeks of decomposition (Mathur, 1998). Bhardwaj and Gaur (1985) have listed several species of fungi isolates that were reported to be good inoculants for composting of various plants residues such as *Aspergillus, Penicillium, Trichoderma, Chaetomium, Trichurus, Paecilomyces, Alternaria and Cladosporium* etc.

Ramat (1982) found that *Trichoderma* species shortened the composting time for rice straw by 20 days. Some commercial activators are also available for composting such as Fabreath-110, marketed by Fab International and Bactin, marketed by Indian Organic Chemicals Limited. Bharadwaj and Gaur (1985) reported that incorporation of 10 kg fresh animal dung in 90 kg of dry compositing material was as effective as fungal cultures (Table 9).

Table 9. Comparison of cellulolytic fungi and animal dung in composting of plant residues

Inoculum used	Org. C (%)	Total N (%)	C/N ratio	% weight loss of material
1. Control (No inoculum)	32.9	1.38	24	45
2. *Aspergillus niger*	30.8	1.50	21	60
3. *Paecilomyces fusisporus*	30.9	1.50	21	58
4. *Trichurus spiralis*	30.8	1.52	20	56
5. Animal dung (10% of dry weight)	30.3	1.53	20	60

Compost

Recycling of organic wastes as manure for sustaining soil health and crop productivity is important in the present context. Composting is a process by which organic wastes are converted into organic fertilizers by means of biological activity under the controlled condition. It is an easy and important technique for recycling agricultural waste and for improving the quality and quantity of organic fertilizers.

Vermicompost

Degradation of organic waste by earthworms is one of the recent developments in biological sciences. They are responsible for the breakdown of complex organic residues into simpler water-soluble substances. The organic matter when subjected to decomposition with the help of earthworms, the resultant product is vermicompost and the process is known as vermicasting. The product is the result of organic waste consumed by earthworm, digested and excreted in the form of granules. The vermicompost, chiefly the faecal matter of earthworm is rich in plant nutrients, plant growth promoters and beneficial microflora. They grow plants extremely well and they can also be used as structural additives for poorer soils to provide nutrients and minimize erosion.

Vermicompost is the compost with added benefits. Pathogenic bacteria such as *E. coli* and *Salmonella* are destroyed due to competition from the active microflora and intestinal secretions. Most of the human pathogens are anaerobic and cannot survive in the highly aerobic microenvironment created by the earthworms, which produce castings with balanced plant nutrients. It also immobilizes micro flora, which continue their function in the soil. It is rich in vitamins, enzymes, antibiotics and growth hormones. Although chemical fertilizers have many nutrients listed and higher laboratory analysis percentages, the ability of plants to optimally use these nutrients is limited. Since the nutrients are not broken down in a manner that plants can readily use. Moreover, the chemical fertilizers do not have sufficient organic matter that is essential for plant growth. Chemical fertilizers are most often detrimental to soil microbiology and often destroying much of the beneficial microbial and bacterial activity. It is also known to be harmful to earthworms. Vermicompost improves soil aeration because they do not pack together when mixed in soil and in turn promotes the rapid plant growth. Earthworm castings improve the soil's drainage, reducing waterlogged soil and root rot. The soil's water retention capacity also improves because vermicompost contains absorbent organic matter that holds only the necessary amounts of water needed by the roots. The solid wastes lying unattended in street corners have become an inseparable part of every human being. It has been found that India, as a whole, generates as much as 285 million tonnes (mt) of rural compost, 273 mt of crop residue and 14 mt of city refuse of diverse composition per year. But per capita waste production in India is low when compared to the per capita production of wastes in the industrialized countries. Even so, the problem of waste disposal in India has of late attaining serious proportions posing immense health hazards and an environmental crisis of the first magnitude including degradation of soils. A common feature of all sorts of soil degradation is the significant decrease of organic reserves and a severe depletion of soil invertebrate communities especially earthworms.

Earthworm species and preferred wastes

Earthworms degrade all types of organic wastes such as agricultural waste, animal droppings, weeds, forest litter and agro-industrial wastes. Agricultural wastes like paddy straw, sugarcane trash, maize stubbles, vegetable wastes, haulms of potato and groundnut, soybean harvest waste favour faster development of worms and eventual compost production. Agro-industrial wastes such as bagasse, press mud, sericulture waste etc., were also degraded using earthworms. The earthworms are invertebrates assigned to Phylum *Annelida*, class *Chaetopoda* and order *Oligochaeta. Oligochaeta* includes the major earthworms belonging to *Megascolecidae* and *Lumbricidae* families are valuable to agriculture. More than half the earthworm species of the world belong to *Megascolecidae*. The genus *Pheretinia* alone has a large number of species. The commonly used species are *Eisenia foetida (fedida), Perionyx excavatus, Lumbricus rubellus, L. terrestris, Eudrillus* spp., *Lampito mauritii, Octochaetona serrata, Drawida willsi, O. Surensis* and *O. thurstoni.*

The nutrient content of vermicompost differs greatly depending on the parent material. However, when their nutrient content is compared with that of a commercial plant growth medium to which inorganic nutrients have been added, they usually contain more of most of the necessary mineral elements for plants, although there is often a deficiency of magnesium (Table 10).

Table 10. Major plant nutrient elements in earthworm-processed animal wastes

Waste material	Element content (% dry wt.)					
	N	**P**	**K**	**Ca**	**Mg**	**Mn**
Separated cattle solids	2.20	0.40	0.90	1.20	0.25	0.02
Separated pig solids	2.60	1.70	1.40	3.40	0.55	0.03
Cattle solids on straw	2.50	0.50	2.50	1.55	0.30	0.05
Pig solids on straw	3.00	1.60	2.40	4.00	0.60	0.05
Duck solids on straw	2.60	2.90	1.70	9.50	1.00	0.10
Chicken solids on shavings	1.80	2.70	2.10	4.80	0.70	0.08
Commercial plant growth medium	1.80	0.21	0.48	0.94	2.20	0.92

It has been found that most of the tried crops have given good results on application of vermicompost at level of 15-20 tonnes per ha; sugarcane at 8 tonnes per ha; and dry land crops at 5 tonnes per ha. The economics of the production of vermicompost and its use has shown that it is more economical when the compost is prepared by the farmers themselves to use in the farm. The cost of production in the farmer's field ranges between Rs.350 to 600 per tonne depending upon the location and the available farm waste. For commercial units located in cities, the production cost is found to be Rs. 1000 to 2000 per tonne. By encouraging the vermicompost production it is possible to check the demand for chemical fertilizer and changing the farming system to Organic Farming.

Enriched compost

When the substrate i.e. the organic residues meant for composting is fortified with certain naturally occurring mineral ores/amendments and beneficial microoraganisms (N_2 fixers & P solubilizers) at different stages of decomposition, the end product is termed as the "Enriched compost". Specific minimal dose of certain low cost nutrient sources like Mussoorie rock phosphate; Iron Pyrite, limestone etc. are generally used as mineral amendments to enrich the compost.

Why enriched compost?

A number of points can be cited in support of the use of enriched compost.

1. The ordinary compost prepared by the farmers is found to be low in some essential nutrients. Fortification of the substrate with the above mentioned amendments has been found to give a boost to the nutritional status of the ordinary compost.
2. Some amendments like Mussoorie Rock Phosphate etc. plays a vital role in speeding up the decomposition process, thereby compressing the time required for preparation of the compost.
3. Moreover, inoculation of beneficial organisms like Cellulose decomposing bacteria, Silicate solubilizers, thermo-actinomycetes hastens the rate of decomposition
4. The enriched compost has been found to have a far greater impact on growth and yield of the crop as compared to that obtained from application of ordinary compost and mineral fertilizer.

The results of the experiments carried out in the Department of Soil Science, AAU, Jorhat showed that the enriched compost prepared by incorporating rock phosphate, CDM, nitrogen fixers and P-solubilizers contains N: 0.5 – 1.5 %, P_2O_5 : 0.1-0.3 % and K_2O : 0.1-0.2% .Application of enriched compost to *kharif* rice @1.0 t/ ha has brought about 30 per cent higher yield than the yield obtained from application of ordinary compost and 22 per cent higher yield than that attributed to application of 40: 20: 20 kg N, P_2O_5 and K_2O/ ha.

Microorganisms for biocontrol in organic farming

Role of Biocontrol Agents in Disease Management:

Biological fungicides, or bio-fungicides, are commercial products that are composed of beneficial organisms, such as fungi, bacteria, or actinomycetes that suppress plant diseases. These biological control organisms are formulated as powders for seed treatments, in granular form for soil incorporation, and as suspensions for root drenches and foliar sprays. Biofungicides suppress disease by using different mechanisms, such as competition, enhanced nutrient uptake, antibiosis, antagonism or by inducing host resistance. The products that utilize several mechanisms may have increased activity and/or may inhibit a wider range of target pathogens.

Among the fungal antagonists, *Trichoderma* species are found most effective in controlling plant diseases. *Trichoderma* species are saprophytic, cosmopolitan, soil inhabitant fungi in nature. Several isolates of *Tricholderma harzianum, T. hamatum, T. koningii, T. pseudokoningii, T. polysporum* and *T. viride* are the potential antagonists of soil borne plant pathogens. Now-a-days, several *Trichoderma* based bio-formulations such as BINAB- T, F-stop, MTR-35, Trichodermin etc. are available in the market of European countries (Torre *et al.*, 2002). In India, seed treatment formulation of *T. viride* such as Bioguard, Ecoderma and Funginil are marketed with certain private organisations for the control of seedling diseases, root rots of vegetable and other plants.

Penicillium citrinum, a white sterile fungus is widely used against several plant diseases. Sindhan *et al.*, (1997) evaluated *Penicillium citrinum, Bacillus subtilis, Aspergillus niger*, and the antibiotic streptocycline against the disease caused by X. *axonopodis* pv. *cyamopsidis* on cluster beans (*Cyamopsis tetragonoloba*). The treatments effectively reduced the disease and foliar sprays were found more effective than the seed treatments.

Among the biocontrol agents, bacterial antagonist is considered the ideal candidates because of their rapid growth, ease of handling and aggressive colonizing character. The bacterial antagonists, *Pseudomonas*, and *Bacillus* in particular, are good candidates for biological control. The *Pseudomonas* are germ-negative rods and have simple nutritional requirements; they are excellent colonizers and widely prevalent in rice rhizosphere. *Bacilli* are germ-positive endospore-producing bacteria that are tolerant to the heat and desiccation; a very good feature required for field application.

The fluorescent and nonfluorescent strains of a number of antagonistic bacteria associated with upland and lowland rice rhizosphere soils have been found effective in vitro, greenhouse and the field against sheath blight (Chen *et al.*, 2002).The major rice diseases and their biological control are shown in Table 11.

Table 11. Major rice diseases and their biocontrol agents

Disease	**Causal organism**	**Biocontrol agent**
Blast	*Pyricularia grisea* (Cooke) Sacc.	*Pseudomonas fluorescens*
Brown spot	*Bipolaris oryzae* (Breda de Haan) Shoemaker	*P. aeruginosa, B. subtilis*
Bacterial blight	*Xanthomonas oryzae pv. oryzae* (Ishiyama) Swing *et al.*	*Bacillus sp.*
Sheath blight	*Rhizoctonia solani* Kuhn	*P. fluorescens, P. putida, B. subtilis,B. laterosporus, B. pumilus, Serratia marcescens*
Sheath rot	*Sarocladium oryzae* (Sawada) W. Gams & D. Hawksworth	*P. fluorescens, B. subtilis Pseudomonas sp.*
Stem rot	*Sclerotium oryzae* Cattaneo	*P. fluorescens, P. aeruginosa B. subtilis, B. pumilus*
Tungro	Rice tungro virus Vector - *Nephotettix* spp.	*P. fluorescens* (for vector)

(*Chen et al., 2002*)

The experiments carried out at Assam Agricultural University, Jorhat showed that *Trichderma spp.* are the most effective biocontrol agents which can suppress the activities of various pests and it showed 40-60 % efficiency under Assam condition. Some of the biocontrol agents showing their efficiency in controlling the target pests are presented in table 12.

Table 12. Works carried out on the biocontrol of plant diseases at AAU, Jorhat

Sl NO	Microbial agents	Target pests	Crop	Efficiency (%)	References
1	*Trichoderma viride*	Rhizoctonia solani *causing sheath blight of rice*	Rice	40- 50	Phookan, A.K. and Chaliha Kaveri (1997).
2	Gliocladium virens	*Sclerotinia sclerotiorum* causing collar rot	Brinjal	30-40	Phookan, A.K. and Chaliha Kaveri (1997).
3	*Trichoderma harzianum*	*Sclerotinia sclerotiorum* causing collar rot of frenchbean	French bean	30-40	Das B.C. and Phookan A.K. (2000) .
4	*Trichoderma harzianum*	*Sclerotium rolfsii* causing basal rot	Betelvine	50-60	Dutta, P.K., Sharma,D., Saikia, L., Pujari, K.C. and Dutta, K.C. (1998)
5	*Gliocladium virens* and *Bacillus subtilis*	*Rhizoctonia solani* causing damping off	Green gram	60-70	Phookan A.K. and Das B.C.
6	*Trichoderma harzianum* and *Bacillus subtilis*	Collar rot	Elephant's foot yam	70-80	Gogoi, N.K.; Phookan A.K. and Narzary, B.D. (2002).
7	Pseudomonas fluorescens	Bacterial wilt	Tomato	70-80	Bora L.C. and Talukdar N.C. (2002).

Role of biocontrol agents in insect pest management

Biocontrol of insect is the method of combating pests by making use of their natural enemies-parasites, predators, which are purely beneficial. Such natural enemies are the natures gift to man which plays a vital role in keeping a large number of potential pests under the check.

Biocontrol, especially through inundative release of the egg parasitoids, *Trichogramma spp.* has been widely practiced in several countries and it has also received a considerable attention in India. By destroying the pest in the egg stage itself, the parasite prevents the potential damage to the crop by the caterpillars. In view of their amenability to mass rearing under the laboratory condition and the relatively low operating costs of the rearing units, *Trichogramma* spp. are still being widely used in biological control and integrated control programme against lepidopteran pests.

The research works on biocontrol agents against some important pests have been initiated in Assam Agricultural University, Jorhat since 1990 (Table 13). *Beauveria bassiana* was found as the most important microbial agent which could suppress the activity of rice hispa (*Dicladispa armigera*) and tea mosquito bug (*Helopeltis theivora*) showing 80-90% and 45% efficiency, respectively (Hazarika & Puzari, 1990, 2001).Another biocontrol agent *Verticillium lecanii* showed 70-80% efficiency in controlling tea aphid (*Toxoptera aurantii*) and tea coccid, (*Coccus viridis*).

Table 13. Biocontrol agents tested against insect pest at Assam Agricultural University, Jorhat

Sr No.	Microbial agents	Target pests	Crop	Efficiency (%)	References
1	*Beauveria bassiana*(Bals.) Vuill.	Rice hispa (*Dicladispa armigera*)	rice	80-90	Hazarika and Puzari,1990
		Tea mosquito bug (*Helopeltis theivora*)	tea	45	Hazarika and Puzari,2001
2	*Verticillium lecanii Zimm.*	Red spider mite(*Oligonychus coffeae*)	tea	30-35	Hazarika and Puzari,2001
		Tea aphid (*Toxoptera aurantii*)	tea	70-80	Hazarika *et al*, 2001
		tea coccid, (*Coccus viridis*)	tea	70.	Hazarika and Puzari,2001
3	Nuclear Polyhedrosis virus(NPV)	Tea bunch caterpillar (*Andraca bipunctata*)	tea	50-80	Hazarika and Puzari,2001
		Tea looper caterpillar (*Buzura suppressaria*)	tea	50-80	Hazarika and Puzari,2001

These biocontrol agents, however, have their own limitations restricting commercial production and large scale use. Entomologists interested in biological control have been constantly working towards the goal of improving the efficacy of biocontrol agents. Through proper understanding of their ecology, behaviour, physiology, immunology and genetics, scientists can now manipulate the biocontrol organisms in such a way as to achieve satisfactory suppression of the target pests.

Biological control agents of plant parasitic nematodes

Plant parasitic nematodes pose great threat to world agriculture sustaining an annual yield loss of the world's major crops to the tune of 12.3%. Several nematicides were quite effective in reducing the nematode population and increasing the yield in many crops. With the growing awareness of limitation for use of nematicides in agriculture, the biological control of nematode becomes an important approach which comes out as more encouraging and ecofriendly. Nematode biocontrol agents are mostly either predators or parasites.

The studies conducted showed that *Paecilomyces lilacinus* , a biological agent could suppress the activity of various species of nematodes such as *Radopholus* *similes* in banana (Sosamma *et al.*,1994), *Meloidogyne incognita* in okra(Das and Sinha ,2005) and Heterodera cajani in cowpea (Bansa singh and Dhawan, 1996). Some of the important fungal and bacterial nematode bio agents tested for their effect on few crops are given in Table 14.

Table 14. Important fungal and bacterial nematodes bio agents tested for their effect on various crops

Nematode parasites in India Bioagents	Nematode	Crop	Reference
Paecilomyces lilacinus	*Radopholus similes*	Banana	Sosamma *et al.* (1994)
	Heterodera cajani	Cowpea	Bansa Singh and Dhawan (1996)
	M. incognita	Okra	Das and Sinha, (2005)
Trichoderma viride		Tomato	Sankaranarayanan *et al.*(2002)
Pasteuria penetrans	*H. cajani*	Brinjal	Kantharaju *et al* (2002)
	M .incognita	Brinjal	Karuna *et al*(2001)
Pseudomonas fluorescens	*H. grcilis*	Rice	Ramakrishnan *et al.*, (1999)
Glomus fasciculatum	*M .incognita*	Brinjal	Borah and Phukan, (2000)
		Banana	Prakash Babu (2001)

Task ahead

India has to produce more food and other agriculture commodities under conditions of diminishing per capita arable land, irrigation water resources and expanding the biotic and aboitic stresses. It is estimated that 45 Mt nutrients through mineral fertilizers and organic sources will be required to meet the needs of food production in the country by 2020. The estimates show that hardly 270/300 Mt of organic manures of different kinds contributing around 4 to 6 Mt of NPK are available in the country. Furthermore, there is a great concern about widening the ratio of $N:P_2O_5: K_2O$ (7.0: 2.7: 1 in 2000-01 as against 4:2:1 and a negative nutrient balance of 8-10 Mt of NPK in the soil leading to mining the soil reserves of nutrients, resulted in the multiple nutrient deficiencies.

To overcome the situation, focus should be laid towards organic agriculture where microbes play a dominant role in bringing out the soil sustainability and environmental protection keeping the pace with food grain production. The use of microbial inoculants play a significant role in maintenance of soil quality in that, they control the decomposition of plant and animal residues, biogeochemical cycling including the nitrogen fixation/ solubilization of P, formation of soil structure and the fate of organics applied to soils. Similarly, biocontrol agents will help in driving out the chemical pesticides commonly used for controlling plant diseases and insect pests. A better understanding of microbial processes and microbial community structure is needed before establishment of long-term strategies for implementing better management practices.

The exploitation of biofertilizer and biocontrol technology, however, is hampered due to the lack of trained personnel, lack of appreciation of the benefits of inoculation and absence of industrial support. A transfer of technology between the research institutions and industry as well as farmers is essential for better exploitation. The limited shelf life, particularly the bacterial biofertlizers and biocontrol agents need quick delivery at low temperatures. A strong extension and training programme actively supported by research and industry is a need of the hour. We should recognize that in adopting a rational approach to the use and the management of natural resources in sustainable agriculture, the microbes hold vast potential for the future. The crop-microbial-soil ecosystem, can, therefore, be energized in sustainable agriculture with considerable ecological stability and environmental quality.

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Limitations of microbial technology for organic farming

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Green revolution technologies (GRT) such as greater use of synthetic agrochemicals like fertilizers and pesticides, adoption of nutrient responsive high yielding varieties of crops, greater exploitation of irrigation potentials, etc. and have indiscriminately boosted the production output in most cases. However, continuous use of these high-energy inputs declined production and productivity of various crops as well as deterioration of soil health and environments. The most unfortunate impact of Green Revolution Technologies on Indian Agriculture is as follows:

1. Imbalance in production
2. Dependency on synthetic chemical fertilizers
3. Increase in secondary and micronutrient deficiencies
4. Increase in pesticide use
5. Unscientific water management and distribution
6. Reduction in productivity and quality of crops.
7. Environmental pollution
8. Imbalance in social and economical status

Today the rural economy is facing a challenge of over dependence on synthetic inputs and the increase in price of these inputs. Further, the Indian Agriculture faces the market competition due to the globalization of trade as per WTO. Thus, apart from quantity, quality is the important factor varieties of concern and problems of modern Indian Agriculture gave birth to various new concepts of farming such as organic farming, natural farming, biodynamic agriculture, do-nothing agriculture, precision agriculture and eco-farming, etc. The essential practices of these concept remains the same, i.e., **back to nature,** where the philosophy is to feed the soil rather than the crops to maintain soil health and a means of giving back to the nature what has been taken from it (Funtilana, 1990). Therefore, for sustaining the productivity of crop, maintaining the soil health and healthy ecosystem, there is need for adoption of an alternative farming system like the Organic Farming.

The population projection and the demand of food and plant nutrients during the next decades with in increasing manner (Table-1). To fulfill the requirement of food and plant nutrients needs, sound planning and management of organic resources.

Table 1. Projected population and requirement of food and nutrients in India

Year	Population growth (million)	Requirment (million tonnes)		Projected potential of nutrients from organic (million tonnes)
		Food	Plant nutrient	
2006	1086	248	37	30
2011	1164	266	40	32
2016	1244	284	43	34
2021	1324	302	46	36

The present level of 30 per cent of organic manures should be increased to 60 per cent by 2006 and 75 per cent from 2011 (Table-2). Of course there may be many constraints to achieve such a target, yet it becomes imperative to aim for such a practice in order to produce the required food and other nutrients besides maintenance of soil health and eco friendly environments.

Table 2. Possible supply of nutrients through biological sources in India

Year	Supply (million tonnes)				Possibility of organic farming (%)
	Organic	% P *	Biofertilizer	% P **	
2006	18	60	2.0	30	54.0
2011	24	75	3.5	50	68.8
2016	26	75	3.8	50	69.3
2021	28	75	6.0	75	73.9

* Per cent of resources to be utilized

** Per cent area to be covered by bio fertilizers to compensate for 25 per cent of N requirement.

Microbial activity is the key component in organic farming. The survival and multiplications of microorganisms are related with various factors like climatic, edaphic and plant kingdom. To know the significance of microorganism limitations of microbial activity is also essential. As a whole, limitations of microorganisms were recorded only at various stages like productions, marketing and the field levels.

Microbial technology in organic farming:

Rhizobium inoculants:

Some plants of leguminousae family form a symbiotic association with bacteria of the genus *Rhizobium* which fix the atmospheric nitrogen.

Cross inoculation group of Rhizobium

Rhizobium species	Cross inoculation group	Legume type
R. leguminosarum	Peas	Pisum, Vicia
R. phaseoli	Beans	Phaseolus
R. trifolii	Clover	Trifolium
R. meliloti	Alfalfa	Melilotus, Medicago
R. Lupini	Lupini	lupinus, orinthopus
R. Japonicum	Soybean	Glycine
R. Sp.	Cowpea	Vigna, Arachis

There is specific Rhizobium for every legume and the inoculation with efficient strains of Rhizobia are essential for the nitrogen gains and better crop yields. Inoculation of pulse crop with appropriate culture can give yield increases of the order in 15-30 per cent.

Azotobacter inoculants:

It is a common soil bacterium and the species *A. chrococcum* which is present widely in Indian soils. Soil organic matter is important factor that decides the growth of these bacteria. The poor organic matter contain in the Indian soil is a limiting factor that not only affects the proliferation of *Azotobactor* in soil but also limits its N fixing capacity.

Azospirillum inoculants:

Azospirillum is known to have a close associative symbiosis with the higher plant system. These bacteria have association with cereals like sorghum, maize, pearlmillet, fingermillet, foxtailmillet and other minor millets and also fodder grasses.

Blue green algae inoculums:

Blue green algae are referred to as paddy organisms because of their abundance in the paddy fields. Many species belonging to the genera *Tolypothrix, Nostoc, schizothrix, Calothrix, Anoboenopsis* and *plectonema* are abundant in tropical conditions. The utilization of blue green algae as a biofertilizer for rice is very promising. A judicious use of these algae could provide to the country's entire rice acreage as much nitrogen as obtained from 15-17 lakh tonnes of urea.

Phosphorus solubilizing microorganisms

In India more than 75 per cent of phosphatic fertilizers are imported. Large amount of phosphorus applied to various soils get fixed and become unavailable to the plants. Several soil bacteria particularly belonging to the genera *Pseudomonas* and *Bacillus* and fungi *Penicillium* and *Aspergillus* possess the ability to bring insoluble phosphate in soil into soluble forms by secreting organic acids in the root rhizosphere.

VAM (Vesicular arbuscular mycorrhizae) :

They form symbiotic association with plant roots and have the ability to mobilize phosphorus from soil and there by helping in absorption of P by plant roots.

Plant growth promoting Rhizobia (PGPR):

In recent years, reports are appearing indicating the specific strain of the bacteria, Pseudomonas, could colonies roots of crops like potato, sugarbeet, barley, wheat, apple, and legumes like *Phaseolus vulgaris*, *Arachis hypogaea*, and *Pueraria phyaseoloides*. PGPR belong to many genera including *Agrobacterium, Arthorobacter, Azotobacter, Bacillus, Cellulomonas, Enterobacter, Erwinia, Florabacterium* and *Rhizobium.*

The dynamics of some important microbes to their functions and response to the crops with the limits is essential to ensure their efficient utilization (Table-3).

Table 3. A profile of limitation, contribution of different bio fertilizer's

Biofertilizer	Function/ contribution	Limitations	Crops
Rhizobium (symbiotic)	• Fixation of 50-100 kg N/ha • 10-35% increase in yield, leaves residual nitrogen.	• Fixation only with legumes • Visible effect not reflected in traditional area • Needs optimum P and Mo	• Pulse legumes • Oilseed legumes • Forage legumes
Azotobacter (Non-symbiotic) and Azospirillum (Associative)	• Fixation of 20-25 kg N/ha • 10-15% increase in yield • Production of growth promoting substances	• Demands high organic matter	• Cereals crops, cotton, sugarcane, • -Vegetables and several other crops
Blue Green Algae or Cyanobacteria (Phototropic)	• Fixation of 20-25 kg N/ha • 10-15% increase in yield • Production of growth promoting substances	• Effective only in submerged Rice • Demands bright sunlight	• Flooded rice
Azolla (Symbiotic)	• Fixed 30-100 kg N/ha • Yield increase of 10-25%	• Survival difficult at high temperature • Great demand for phosphorus	• Only for flooded rice

Limitation in microbial technology:

A. Bio fertilizer Technology

At present, there are several limitations in the production and commercialization of bio-fertilizers. These may be physical, chemical, biological, technological, infrastructure, financial, market and quality related or concerned with the human resource development.

- Precautions should be taken to avoid transportation of bio-fertilizers packets in direct sunlight
- Due to high summer temperature in most of Indian states, care should be taken to store the bio-fertilizers in containers or in shades
- Care should be taken to pack the bio-fertilizers having sufficient moisture (at least 40%) , otherwise due to dry condition of the carrier materials; populations of bio-fertilizers will decrease rapidly
- Soils of acidic and saline in nature are usually unsuitable for use of bio-fertilizers due to adverse effect of introduced microorganisms. In acid soils, liming and in saline soil, gypsum is recommended

- In soils having less than 10 ppm of available phosphorus, nitrogen-fixing bio-fertilizer becomes ineffective. In this case, application of phosphorus fertilization is very essential
- Bactriophages called as rhizophages can destroy *rhizobia* added to the soil
- Some protozoa like *Vorticella* and nematodes like *Meliodogyne* can act as predators to the added bio-fertilizer.
- *Azolla* is attacked by several pests like larvae of various lepiptopterous and dipterous insects and aphids
- Cyanobacteria can be attacked by snails and mosquito larvae
- For production of high quality biofertilizers, there is need for technically well qualified (Microbiologists) and trained persons
- Some biofertilizer production units have only non-skilled labourers, which leads to sub-standard biofertilizers
- Lack of knowledge regarding the efficient field use of biofertilizers

B. Quality of bio-fertilizers

- Raw materials: Peat and lignite, the two major carrier materials of biofertilizer are available in specific places like Nilgiris and Neyveli, thus resulting in high cost of transportation of biofertilizer manufacturing units.
- **Strains:** Efficacy of biofertilizers mainly depends on the type of strains used for specific crops. Although suitable strains of biofertilizers for different crops have been identified, but due to the ignorance the producers used the strains they get, resulting in poor quality of biofertilizers for specific situations.
- **Suitable Technology:** In India, production of biofertilizer is generally done with non-sterile system, which encourages the considerable contamination. Suitable technology to minimize the contamination should be developed. For example, there is a need for gamma irradiation of the carrier materials and injection of liquid culture into polythene bags containing the sterile carrier materials, etc.
- **Lack of Quality Assurance :** The substandard quality of inoculants is one of the most important factors resulting in failure at the field and lack of farmers confidence in the product.

C. Bio-control and bio-pesticides

- Short shelf life of bio-control agents
- Absence of well equipped quality testing laboratories for bio-pesticides and bio-control agents
- Absence of well executed IPM demonstrations
- Some bio-control agents are affected by various kinds of environmental stresses like UV light, temperature, moistures, pH, etc.
- Bio-control agents are available only for few selected insect pests.
- Inappropriate application technologies and equipments

D. Marketing

- High price expectations, delayed delivery, quality restrictions, lack of certification and marketing networks are some of the constraints in marketing organic products internationally.
- In India, the major marketing constraints of bio-fertilizers include weakness in the marketing network, retail outlet, storage facility etc.
- Lack of standardization in packing, labeling and in prices of biofertilizers marketed
- Major Indian and Multinational companies are not interested in bio-pesticides

- High costs of organic products (15-29%) restricted the marketing growth
- Complicated production technology, alienation of farmers from the concept, lack of standards, and lack of large market opportunities comparable to those for non-organic produce markets.

E. Quality control

Recently, the bio fertilizer production technology has attracted much attention of the small and large producers because of its simple and cost effective nature. Though there is lot of scope for scaling up the production level, the bio-fertilizer technology faces the problems of quality control, inconsistent field performances, poor transport and storage and lack of knowledge about these inputs. This has necessitated the implementation of better quality control mechanisms to ensure the availability of quality inoculants to the farmers.

F. Interaction mechanisms among microbes

Some interaction mechanisms may reduce the efficiency of micro organisms in organic farming.

i. Ammensalism

It is a kind of relationship in which a partner suppresses the growth of other partner by producing toxins like antibiotics, harmful gaseous compounds like NH_3, CO_3, ethylene, sulphur compounds, nitrite, H_2O_2, and HCN etc. The antagonistic associations sometimes affect the useful process adversely. Sometimes the growth of *Nitrobacter* and some fungi may be affected adversely by the large amount of NH_3 released during decomposition of leguminous green manures.

ii. Competition

It is a universal phenomenon of co-existence in a community where one species is suppressed as the two species struggle for the limited supply of a nutrient or other common requirements. Such interaction in soil is harmful. Normally, a severe competition between soil microbes for limited availability of easily metabolically carbon compound is a rule rather than exception, as it is readily used by almost all soil microbes.

iii. Parasitism

It is an association where one partner lives in or on the body of the other (host) and feeds on the body fluid of the host. So this is a host-parasite relationship in which one is benefited while other is adversely affected. Parasitism is probably widespread in soil communities. Earthworms and other macro-organisms are also prone to parasitic attack by bacteria, fungi, viruses, etc. Commercial preparations are available in the market as bio-control agents of root rot and wilt diseases.

iv. Predation

It is the direct feeding of one organism on other. It is highly prevalent in protozoa. They feed on bacteria to strike a balance between the population of prey and predator. Myxo-bacteria and slime molds also feed on soil bacteria.

G. Genetic modifications in Rhizobium strains

The efforts have been made to develop genetically modified strains including the traits for better competitiveness and heat shock tolerant mutants in the process of improving *rhizobia* l strains. The gene markers (Gus) introduced in *Rhizobium* strains to monitor the release of genetically engineered strains in the environments. However, genetically modified strains have not made any impact on legume production under field conditions. *Rhizobia* are susceptible to antibiotics (produced by other micro organisms of soil) and also to the action of bacterophages. Fungicides, herbicides and other plant protectants are also toxic to *Rhizobia*.

H. Crop response

Although the legume inoculation is a long established practice to maintain soil health it has not become popular largely because of its erratic response. There are some common reasons of poor or no response to inoculation etc.

1. **Failure of seed to germinate :** This is due to the use of poor quality seed and the lack of sufficient moisture for germination.
2. **Failure of seedling to become nodulated:** This may be the results of poor quality inoculants, adverse soil conditions, inoculation with wrong inoculants, compatibility of *rhizobia* with pesticides etc.
3. **Ineffective nodulation :** This situations may result from the presence of a large native population of *rhizobia* which may compete with *rhizobia* applied for nodule formation and make it ineffective in N fixing with introduced legume.
4. **Nutritional deficiencies :** Nodule formatting is severally affected by nutritional deficiencies particularly phosphorus, calcium and molybdenum because of their role in protein synthesis, cell wall development and in nutrition of *rhizobia* , respectively.
5. **Plant competition :** Failure of the legume plant to promptly nodulate and establish is frequently due to the competition for moisture nutrients, light and space.

Conclusions

Microbial technology for organic farming seems to be effective however, following points should be considered for future development:

1. Microbial strains of different bacterial cultures should be tolerant to wide range of weather conditions.
2. Dispersion of knowledge regarding microbial technology among farmers community.
3. Microbial technology should be upgraded.
4. Infrastructure facilities, expertise and marketing network should be strengthened.

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Microbial technology in relation to organic farming

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"Organic farming is an integration of biological, cultural and natural inputs including the disease and pest management practices". Increasing population levels on a near stabilized agricultural land places a heavy burden on the soil source particularly on its nutrient supplying power. The chemical fertilizers helped to increase the agricultural production to meet ever increasing demand of human population. The excessive use of chemical fertilizers resulted in considerable deterioration of soil health, soil bio-dynamics, soil structure, quality of water, food and fodder. Thus, the organic farming has emerged as the only answer to bring sustainability to the agriculture and environment.

Microbial technologies are playing a key role in organic farming in terms of organic matter decomposition, bio-fertilizers, bio-pesticides etc.

At University of Agricultural Sciences, Dharwad revealed the results of several experiments conducted *Phanerochaete chrysosporium* to be an efficient lignolytic fungus for decomposing several agroresidues including sugarcane trash, redgram stalk, cotton stalk etc. This is known to produce lignin degrading enzymes like lignin peroxidase, manganese peroxidase, glyoxal oxidase and reduce C:N ratio. At the same time, scientists have worked out the possibility of enrichment of decomposed material by inoculating the free living nitrogen fixers like *Azotobacter* and P-solubilizers. Such attempts have given fruitful results in enrichment of vermicompost with higher amount of N and P contents.

In continuation to decomposition and enrichment of agro residues, the results of several interaction studies clearly showed that coinoculation of *Trichoderma harzianum*, a cellulolytic fungus and P- solubilisers viz P*seudomonas striata, Bacillus Polymyxa* along with the application of rock phosphate resulted in better decomposition of cotton stalks and nutrient uptake by the test crop.

The cropping system influences the soil microflora. The dynamics of soil microflora and the soil enzymes studied in a long term integrated nutrient management experiment in a fixed site in two cropping systems at UAS, Dharwad. Both, the soil microflora and the soil enzymes were highest in groundnut-sorghum cropping system as compared to sorghum-safflower cropping system. The organic C, available N, available P, soil microflora and enzyme activities increased significantly with the application of organic fertilizers along with the inorganic. The positive correlation was observed in soil microflora, soil enzymes and nutrient availability. These results highlight the significance of application of organic matter in maintenance of soil fertility and bio-dynamics.

Of late, lot of importance is given to protect the environment from pollution. Hence, the several scientists are exploiting microbial technologies for the production of bioethanol from agro residues. Bioethanol can be blended with petrol up to 20%. At present, ethanol is blended up to 5% with diesel for transportations several microbial cultures viz., *Trichoderma reesei* and *Pachysolen tannophilus* NCIM – 3445 showed their efficiency in terms of ethanol yield. Such studies certainly help to protect environment from pollution.

Another potential area which uses the microbial technology in organic farming is biocontrol of pathogens and crop pests by which the usage of chemical insecticides can be reduced and inturn environmental pollution can be avoided. Several microorganisms are known to improve the plant growth directly through nutrient mobilization and the production of plant growth hormones and indirectly through suppression of plant pathogens or by inducing systemic resistance in plants. The soil microorganisms having these multiple beneficial traits are referred to as the plant growth promoting rhizobacteria (PGPR). Recently they are also referred to as plant health promoting rhizobacteria (PHPR). Fluorescent pseudomonads play a key role in biocontrol of plant pathogens as they have rapid growth, simple nutritional requirement and ability to utilize diverse organic substrates. They are known to produce highly potent broad spectrum antifungal molecules against various phytopathogens. They are reported to produce antibiotics, siderophores, HCN etc. They also compete for space and nutrients with soil borne plant pathogens. Fluorescent pseudomonads are promising bioinoculants for agricultural system to increase the productivity as they are cost effective and ecofriendly. Another fungus, *Trichoderma harzianum* is also being used extensively. Some of the microbial pesticides NPV, GV, *Bacillus thuringiensis, B. popilleae, Metarrhizium anisopliae, Beavaria bassiana, Nomuraea riley, Verticillium lacanii etc.*, are being used under the field conditions for biological control of crop pests. All these organisms can grow well and show activity at an optimum RH (Minimum 75%-85%) and temperature $28\text{-}30^{0}$ c. The moisture and temperature play a key role on the growth of micro organisms. The environmental conditions should also be favourable for their action after spraying these microbial pesticides on the crops. Heavy rainfall/ higher temperature after spraying will result in the loss of microbial pesticides due to washing/ inactivation of enzymes. Hence, it is better to spray these microbial pesticides during late evening or early hours of the day for their efficient activity.

Both moisture and temperature at optimum level are essential for microbial action either in decomposition of agro residues or in biocontrol of soil borne pathogens crop pests. The success of microbial technologies in relation to organic farming is always depending on favourable environmental factors for microbial growth and activities.

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[illegible] as they increase efficiency and productivity. Another [illegible] Transesterification is often being used industrially. Some of the catalysts [illegible] present [illegible] Metathesis catalysts [illegible] are being used today. [illegible] All these [illegible] The [illegible] play a key role in the [illegible] should also be [illegible] for their [illegible]

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Session-X
Quality, certification and marketing of organic inputs and products

Government policies on organic farming

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The green revolution technologies involving a greater use of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient-responsive, high yielding varieties of crops have boosted the production output per hectare in most of the cases. However, this increase in production has slowed down and in some cases there are indications of decline in growth of productivity and production. The priorities in agriculture research are gradually moving from a focus on individual crop performance to a total system productivity with due attention on product quality and environment safety. Environmental and health problems associated with the agriculture have been increasingly well documented, but it is only recently that the scale of the costs has attracted the attention of planners and scientists.

The increasing consciousness about conservation of environment as well as of health hazards caused by agrochemicals has brought a major shift in consumer preference towards food quality, particularly in the developed countries. Global consumers are increasingly looking forward to organic food that is considered safe and hazard-free.

"Organic" in organic agriculture is a labeling term that denotes products that have been produced in accordance with certain standards during food production, handling, processing and marketing stages and certified by a duly constituted certification body or authority. The organic label is therefore, a process claimed rather than a product claimed. It should not necessarily be interpreted to mean that the food produced is healthier, safer or all natural. It simply means that the products follow the defined standards of production and handling, although surveys indicate that consumers consider the organic label as an indication of purity and careful handling. The organic standards will not exempt producers and processors from compliance with the general regularity requirements such as food safety regulations, pesticide registrations, general food and nutrition labellling rules etc.

To promote the organic agriculture and to ensure the fair practices in international trade of organic food, the Codex Alimentarius Commission, a joint body of FAO/WHO framed certain guidelines for the production, processing, labeling and marketing of organically produced foods, with a view to facilitate trade and prevent misleading claims. The Codex Alimentarius Commission defined "Organic agriculture as holistic food production management systems, which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activities. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using where possible, agronomic, biological and mechanical methods, as opposed to using the synthetic materials, to fulfil any specific function within the system".

In India, the National Programme for Organic Production proposes to provide an institutional mechanism for the implementation of National Standards for Organic Production, through a National Accreditation Policy and Programme (Fig. 1) with a view to;

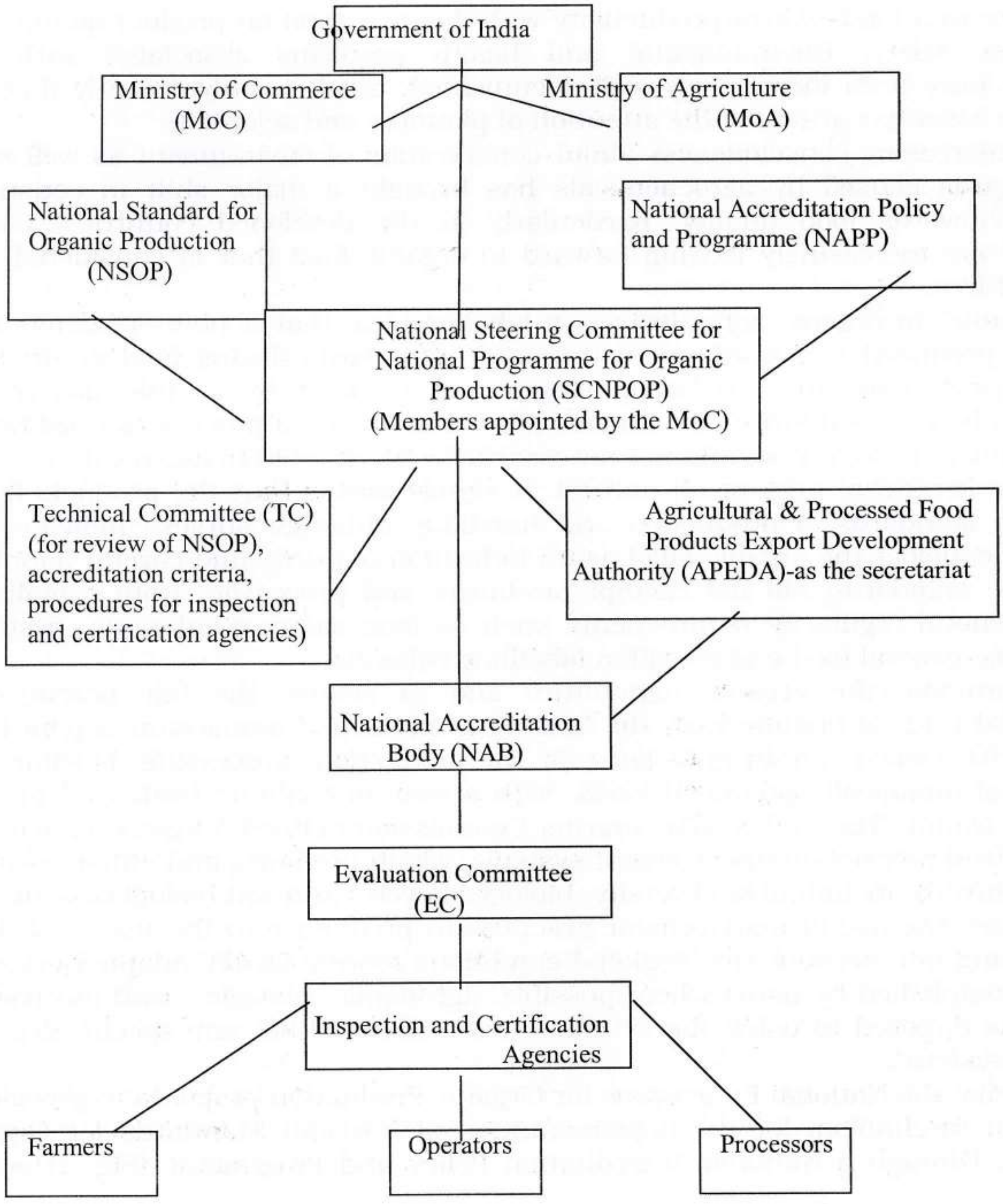
i. To provide the means of evaluation of certification programmes for organic agriculture and products as per the approved criteria.
ii. To accredit certification programmes.
iii. To facilitate certification of organic products in conformity to the National Standards for Organic Products.
iv. To encourage the development of organic farming and organic processing.

National standards for organic production – Crop production

1. Conversion requirements

- The whole farm including livestock should be converted according to the standards over a period of three years.

Fig. 1. Operational structure of national programme for prganic production (NPOP)



2. Maintenance of organic management

- Organic certification is based on continuance. Converted land and animals shall not get switched back and forth between the organic and conventional management.

3. Landscape

- Organic farming should contribute beneficially to the ecosystem.
- The certification programme shall develop landscape and biodiversity standards.

4. Choice of crops and varieties

- All seeds and plant material should be certified organically.

5. Diversity of crop production

- Diversity in crop production is achieved by a combination of versatile crop rotation with legumes and appropriate coverage of the soil during the year of production which diverse the plant species.

6. Fertilization policy

- Sufficient quantities of biodegradable material or 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.
- Manures containing human excreta shall not be used.

7. Pest, disease and weed management including growth regulators

- Weeds, pests and diseases should be controlled by a number of preventive culture techniques which limit their development, e.g. suitable rotations, green manures, a balanced fertilizing programme, early and predrilling 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.

8. Contamination Control

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

9. Collection of non-cultivated material of plant origin

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

10. Soil and water conservation

- 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.

National standards for organic production – Food processing and handling

- Any handling and processing of organic products should be optimized to maintain the quality and integrity of the product and should be directed towards minimizing the development of pests and diseases.
- 100 % of the ingredients of agriculture origin shall be certified organically.
- Processing methods should be based on mechanized, physical and biological processes.

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

Packaging

- 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.

Labelling

- Labelling shall convey the 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 in any other similar description.

Storage and transport

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

Accreditation procedures

The aims of the National Accreditation Programme is :

- To provide the means of evaluation of inspection and certification agencies for agriculture and products as per approved criteria for accreditation based on the international criteria as per ISO Guide 65.
- To accredit inspection and certification agencies.
- To provide the means of evaluation of the facilities available with the laboratories for residue testing of soil, inputs and organic products to accredit testing laboratories.

Inspection and certification agencies

Accreditation is open to Inspection and Certification Agencies engaged in the inspection and certification of organic production and/or processing operations.

The Inspection and Certification Agencies programmes must confirm with all applicable standards, structures and operating procedures as laid down in the national standards for organic products and to the accreditation criteria as per the national organic programme.

The Inspection and Certification Agency's programmes must be in operation for a minimum period of one year prior to the evaluation. It should provide all required documents for the reference.

The evaluation of the Inspection and Certification Agency will include the evaluation and selection process of the inspectors. In accordance with the accreditation criteria, the certification agency must exercise full responsibility for any services that it contracts out to third parties. The accreditation contract will be primarily with the Inspection and Certification Agency.

Guidelines for certification of grower groups

This system shall be based on the internal quality system and shall apply to producer groups, farmer's cooperatives, contract production and small scale processing units. The producers in the group must apply similar production systems and the farms should be in geographical proximity. Farms with land holding of 4 ha and above can also belong to a group but will have to be inspected annually by the external Inspection and Certification Agency. The total area of such farms shall be less than 50 % of the total area of the group.

Quality of organic inputs and their standards for organic farming

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According to Angelina Briones (1999) the food chain begins in the farms and ends on the dining table. Basically, everything absorbed by plants from the soil and water becomes part of the food chain. These things include elements and substances added through inputs for nutrient, water, weed and pest management. The organic agriculture uses a lot of inputs, which are basically organic in nature and are expected to be produced on the farm itself. A wide variation is observed in the quality of organic inputs being sold in the market. Many times farmers do not get standard inputs in the market. There is a need to develop the standards for monitoring the quality of the said products.

India has evolved the national standards for organic products keeping in view the traditional methods with the scientific approach. These standards are in conformity to the International standards of European Union (EU) and International Federation of Organic Agriculture Movements (IFOAM).

The Ministry of Commerce and Industries of the Government of India has identified following six accreditation agencies for certification of organic products.

1. APEDA [Agricultural and Processed Food Products Export and Development Agency]
2. Tea Board.
3. Coffee Board.
4. Spice Board.
5. Coconut Development Board.
6. Directorate of Cashew and Cocoa Board.

These agencies have authorized some of the certifying agencies/companies for operating the certification programmes in the following areas.

i. Organic production.
ii. Organic processing and
iii. Providing test standards.

The accredited inspection and certifying agencies undertake inspection at all stages of production and processing with regular check on all operators (farmers and processors) in accordance with the principles in the basic standards.

The organic products produced under the national standards are certified and approved by the accredited inspection and certifying agencies for labeling as 'India Organic'. The labeled products provide the consumer with the best possible guarantee of organic origin, production, processing and packaging.

Standards for organic inputs

Fertilizers and soil conditioners

1. Compost

"A solid mature product resulting from composting, which is a managed process of bio-oxidation of a solid heterogenous organic substrate including a thermophillic phase".

A. Not allowed

- Human excrement.
- Tobacco
- Leather meal
- City compost
- Treated saw dust
- Treated blood meal, meat meal, bone meal and feather meal.
- Ash from manure burning.
- Chemically synthesized mineral fertilizers – Urea, DAP etc.
- Irradiation is banned.

B. Requirements

1. Compost must be produced through a process that combines plant and animal materials with an initial C:N ratio between 25:1 and 40:1.
2. Producers using an in-vessel or static aerated pile system must maintain the composting materials at a temperature between 55ºC and 76ºC for 3 days.
3. The C/N ratio should be less than or equal to 25.
4. The maximum heavy metal concentration of the final product in mg/kg of dry matter should be as follows:
   cadmium: 0.7, copper: 70, nickel:25, lead:45, zinc:200, mercury:0.4, chromium (total):70, chromium (VI):0.
5. The Pathogenic organism content must not exceed the following limits.
   The quantity of faecal coliforms must be < 1,000 most probable number (MPN)/g of total solids calculated on a dry weight basis: and there can be no salmonellae present (< 3 MPN/g total solids)

2. Manures

"Any mixture of animal and /or plant product with or without the inclusion of minerals from natural origin, which is not composted".

A. Not allowed

- Human excrement.
- Tobacco
- Leather meal
- City compost
- Treated saw dust
- Treated blood meal, meat meal, bone meal and feather meal.
- Ash from manure burning.
- Chemically synthesized mineral fertilizers – Urea, DAP etc.
- Irradiation is banned.

B. Requirements

1. The heavy metal concentrations of the final product should be as follows:
   Maximum concentration in mg/kg of dry matter.
   Cadmium: 0.7, copper: 70, nickel:25, lead:45, zinc:200, mercury:0.4, chromium (total):70, chromium (VI):0.
2. The pathogenic organism content must not exceed the following limits.
   The quantity of faecal coliforms must be < 1,000 most probable number (MPN)/g of total solids calculated on a dry weight basis: and
   There can be no salmonellae present (< 3 MPN/4g total solids)

3. Minerals

Minerals used should be only from natural origin only and should be from any chemically synthesized sources.

Following minerals can be used:

a. Calcareous and magnesium rock.
b. Calcium chloride.
c. Calcified seaweed.
d. Calcium carbonate of network origin (chalk, limestone, gypsum and phosphate chalk)
e. Mineral potassium with low chlorine content (e.g Sulphate of potash, kainite, sylvinite)
f. Natural phosphates (e.g Rock phosphate)
g. Pulverized rock.
h. Sodium chloride.
i. Potassium Sulphate.
j. Magnesium Sulphate (Epsom salt)
k. Gypsum (Calcium Sulphate)
l. Aluminum calcium phosphate.
m. Sulphur
n. Clay (bentonite, perlite, zeolite)

4. Microbial preparations

A microbe or concoction of microbes cultured in a mass scale which are useful for plant production.

A. Requirement

1. The microbes should be from non-GM origin.

   The heavy metal concentrations in substrates or immobilizers used in the final product should have:

   Maximum concentration in mg/kg of dry matter.

   cadmium: 0.7, copper: 70, nickel:25, lead:45, zinc:200, mercury:0.4, chromium (total):70, chromium (VI):0.
2. List of all microbes along with minimum CFU's/mg or ml during the shelf life should be declared to the consumers in the labels.
3. The list of immobilizers which can be used are: a) Lignite. b) Charcoal. c) Talc.

Pest management inputs:

1. Substances from plant and animal origin:

A. Not Allowed: Tobacco, tea.

B. Permitted:

1. All plant based extracts can be used.
2. Sea weeds, sea weed meal and sea weed extracts can be used.
3. Milk, milk based products and it's byproducts can be used.
4. Only food grade emulsifiers are allowed to be used.

2. Neem based products

A. Not allowed

1. Neem oil extracted from seed collected from non-controlled sources not allowed.
2. Neem oil extracted using solvents are not allowed.

B. Permitted

1. Azardictin extraction from oils can be done either by methanol or ethanol only.
2. Only food grade emulsifiers are allowed to be used.

3. Minerals

Minerals used should be only from natural origin and should be from any chemically synthesized source.

Following minerals can be used:

1. Chloride of lime/soda.
2. Clay (e.g bentonite, perlite, vermiculite, zeolite)
3. Mineral powders (stone meal, silicates)
4. Diatomaceous earth.
5. Permanganate of potash.
6. Silicates (sodium silicate, quartz)
7. Sodium bicarbonate.

4. Microorganisms/Biocontrol agents.

A micobe or concoction of microbes cultured in a mass scale which are useful for pest management.

A. Requirement:

1. The microbe should be from non-GM origin.
2. The heavy metal concentrations in substrates or immobilizers used in the final product should have maximum concentration in ppm: cadmium: 0.7, copper:70, nickel:25, lead:45, zinc:200, mercury:0.4, chromium (total):70, chromium (VI): 0.
3. List of all microbes along with minimum CFU's/mg or ml during the shelf life should be declared to the consumers in the labels.
4. The list of immobilizers which can be used are: a) Lignite. b)Charcoal c) Talc.

Infrastructure requirements

Quality control laboratory is essential to monitor all the required quality parameters.

Labeling requirements

A. Not allowed

1. The labels cannot contain – India Organic Logo or USDA or JAS Logo.
2. The labels cannot contain words like "certified organic input" but can contain "approved organic input" or similar approved words.

B. Requirements

1. The label should provide all the details of the description of the products like ingredient list along with their quantities.
2. All the labels should have lot numbering and batch numbering systems to ensure traceability to the processing dates, processing equipments/sites and to the raw materials.

Quality standards for organic inputs – Some illustrations

1. Compost

Compost quality and maturity attributes are important for determining compost utility for different users like gardener, nursery raiser, field and horticulture crops etc. A set of physical, chemical and biological characteristics were selected out of number of parameters for determining compost quality. It was recommended that these quality and maturity attributes may be considered at national level for ensuring the uniform standards of compost quality in the country during the National Seminar held at Indian Institute of Soil Science, Bhopal on 17th January, 2004 (Anonymous, 2004)

2. Biofertilizers

In the initial years (1965-75), Soybean *Rhizobium* was in great demand, and many private companies mushroomed and distributed standard inoculants, not only for soybean but for other pulses also. The effect of inoculation was not promising. This eroded the belief of farmers in biofertilizers and it is a challenge to regenerate their faith. The current annual production of biofertilizers is 2500 tonnes while demand is to the tune of 12 lakh tonnes. This can only be achieved by supplying the standard quality material at field level. Quality standards have been set up for biofertilizers like Rhizobium, Azotobacter and PSB by the State Govt. of Maharashtra.

3. Bioagents and biopesticides

Indian standards for NPV (Nucleo polyhydroxy virus)

1. Viral units/unit of formulation.
   NPV – 1 x 10^9 POB/ml or gram (minimum polyhydroxy occlusion bodies)
   GV - 5 x 10^9 OB/ml or gram.
2. Contamination – *Salmonella, Shigella* or *Vibrio* should be absent.
3. Other microbial contaminants should not exceed 1 x 10^4 counts/ml or g.
4. The strain should be indigenous, naturally occurring and non toxic and genetically modified.
5. Identification of baculoviruses by restriction enzyme analysis.
6. Shelf life should be 18 months.

Indian standards for B.t (*Bacillus thuringensis*)

1. ELISA/Dot assay test for estimation of δ-endotoxin protein.
2. Routine test
   a. Level of β-exotoxin to be identified by housefly bioassay.
   b. Potency of product by bioassay method.
   c. Viable spore count.
3. Human pathogens like *Salmonella, Shigella* should be absent.
4. Other micro organisms not more than 10 ^{4} per gram.
5. Liquid formulation – 2000 to 4000 IU per microlitre, one year stability.
   Powder formulation – 16000 to 32000 IU per microlitre, two years stability.

Indian standards for entomopathogenic fungi.

1. C.P.U count – 1 x 10^8 CFU/ml or g.
2. *Salmonella, Shigella, Vibrio* should be absent.
3. Other contaminants should not exceed 1 x 10^4/ml or g.
4. Strain should be indigenous.
5. Maximum moisture content should not be more than 8% - for dry formulations.

Trichocard

Each trichocard should have 18,000 – 20,000 eggs.

Neem products

The commercial formulations available in the market have 100, 300, 1000, 10,000 and 50,000 ppm concentration. The major alkaloid present in neem formulations that has insecticidal property is azadirachtin. Different neem extracts are as follows:

- Water or aqueous extract of seed kernel.
- Neem seed oil suspension in water and
- Water or aqueous extract of cake.

4. Biodynamic preparations

Biodynamic farming is a method of organic agriculture, which considers farm as a living system and where one activity affects the other. A unique feature of this system is the use of eight specific preparations derived from cow dung, silica and herbal extracts to treat compost piles, soils and crops. Biodynamic farming methods are used for the preparation of food for which Demeter (tm) certification programme is used in Germany and U.S.A.

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Quality certification of organic inputs and products

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In India the development of organic agriculture is receiving attention among the farmers, processors, input manufacturers, Traders and Consumers of organic food. The awareness about the possible health hazards occurring because of indiscriminate usages of chemical fertilizers and pesticides is developing among the consumers and growers.

Organic farming in India

Unless India makes a rapid shift towards organic farming; the cost in terms of environmental degradation and health costs arising from chemical could arise sharply. The organic farming is, therefore, a welcome alternative from three angles: for the small farmer- for whom it is less financially draining; for the environment – which is now subject to more eco-sensitive mode of farming, that would help improve the soil fertility and for the government, which, by encouraging the organic farming, and thereby reducing the reliance on fertilizers, can gradually trim its subsidy bill and thus achieve a cost-savings.

India produces a wide variety of organic products, which include fresh and dried fruits (pineapple, banana, pears), processed fruit (mango concentrate), vegetables, nuts oil crops, grain, coffee, tea, sugarcane, herbs, and spices. The domestic market and Export opportunities for India exist both in niche markets, where organic product labeling is required for product certification and differentiation, and also in mainstreäm markets, where self-certification under particular corporate brands is gaining the influence with consumers. Therefore, the challenge facing India is to mainstream production and trading opportunities to ensure that a greater number of producers can take advantage of such markets and certification facilities.

Verified and guaranteed organic food market is an upcoming sector. A strong linkage between consumers and organic growers is vital for both ends and the organic movement. Farmers, processors, exporters, traders and consumers look forward to a legal trustworthy and reliable organic certification system to be established with the objective of creating a healthy and trustworthy linkage between the organic operators and the consumers through regulated certification program. The input as well as the outcome from organic management system needs to be certified for the integrity and chain of custody.

Why Certification?

Organic certification guarantees the **quality of production**_just as much as it guarantees the quality of the final product. The organic grower use an authentic organic inputs and consumers pay significant premiums for certified organic food because they trust the integrity of recognized organic trademarks.

The certification must guarantee to these consumers that the food they are buying has been produced to recognized organic standards and certified by the regulatory body, which is called as inspection and certification agency.

As a response to this development it is the need of hour to set-up a nation wide programme for organic production, quality inputs, processing and its certification.

The organic systems promote a sustainable production of food of optimum quality and quantity. The programme has been developed with reference to the

IFOAM, EEC-No-2092/91, the Codex Alimentarius Guidelines and NPOP (National Programme of Organic Production) 2005 as amended.

Certification

Is 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 and the 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.

The National Programme for Organic Production proposes to provide an institutional mechanism for the implementation of National Standards for Organic Production, through a National Accreditation Policy and Programme. The aims of the National Programme for organic production, inter alia, include the following:

a. To provide the means of evaluation of certification programmes for organic agriculture and products as per the approved criteria.

b. To accredit certification programmes

c. To facilitate certification of organic products in conformity to the National Standards for Organic Products.

d. To encourage the development of organic farming and organic processing

The process of regular evaluation should result in organic production becoming ever more friendly to humans, animals, environment and the ecosystem.

Economics of production and marketing of organic products

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The demand for organically produced food is increasing throughout the world in response to concerns about food safety, human health environmental and economic fields during the recent past. Organic agriculture is holistic production management system, which enhances the health of agro ecosystem, including biodiversity, biological cycles and soil biological activity thereby increasing the soil fertility and making the agricultural system sustainable in the long run. Moreover, as organic farming refrains from using chemical inputs, the health hazards and other side effects posed by these inputs are also prevented. The organic agriculture is not new concept to India as our traditional view about agriculture is live in partnership with, rather than exploit nature. The inorganic farming approach in India was the outcome of low production of foodgrains and vigorously increasing population. We have achieved self reliance in food grains production but the excessive use of chemical fertilizers and pesticides have posed many problems to soil and water and drastic degradation of these precious natural resources. India has only 40% irrigated area and synthetic fertilizers and chemicals are mainly used in this irrigated agriculture. Remaining 60% cropped area, can be suited for development as organic agriculture due to less degradation. The organic agriculture definitely has merits such as natural resources conservation, avoiding pollution, use of byproducts of livestock and crops, increase employment opportunities but demerits such as reduction in production or food security threat, limitations on supply of cattle dung and green manure. The economic consideration in every business is necessary, so the cost of production of organic products, marketing opportunities, taste and preferences and trade of organic products has been reviewed in the present paper.

Indian Organic Products

By February 2002, around 1,426 farms in India have been certified as organic farms with an area of around 2,775 hectares. The organic farming has been carried out an about 1.10 lakh hectares during the year 2006-07. Looking to the export potential of organic agriculture, Central Government has proposed 40% increase in area under the organic agriculture during the next year and provision of Rs. 94 crores has been made for the purpose. Andhra Pradesh, Chattisgarh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra and Rajastan have prepared projects for organic farming viz; cultivation of organic Brinjal, Banana, Grapes, Pomegranate, Wheat, Rice, Soybean, Seasamum, Pigeonpea, Basamati rice, Blackpaper, Coriander and Orange. About 80,000 farmers will be involved and additional 40,000 hectare area will be brought under the organic farming. The global organic trade is growing rapidly and total area under certified organic production was about 250 lakh hectares during 2004. This area does not include the organic farms whose production is either for own consumption or sold in local markets. The organic trade in the United States is in the range of US$ 11 billion and it will be doubled during the next five years. Total world trade is estimated US$ 31 billion during the year 2005. The annual growth rate of organic produce trade was in the range of 5 to 20 per cent in European countries and 15-20 per cent in USA and Canada during 2003 to 2005.

The North-Eastern region of India provides considerable scope and opportunities for organic farming due to least utilization of chemical inputs. It is estimated that 18 million hectares of such land is available in North East which can be exploited for organic production with the sizable acreage under naturally organic/default organic cultivation. India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world's organic market.

Production of organic produce

The most of economic studies of performance of organic versus conventional production system focuses on yield and income in a given period of time. Organic production system generates lower yields compared to conventionally grown alternatives. Some studies reported the yield loss after shifting from conventional to organic production, with the yield loss depending upon the factors such as management regime, inherent biological characteristic of land and experience of the farmer. The yield loss ranged from 8 per cent to 63 per cent in the case of fruits and vegetables (Parsons, 2002).

Table 1. Comparison of produce grown using organic verses conventional methods, Canada (2000-2001)

Sr. No.	Crop	Organic yield difference (%)	Organic Price Premium (%)
1	Dry Onions	-63	159
2	Beets	-56	229
3	Broccoli	-44	59
4	Cabbage	-37	97
5	Carrots	-40	236
6	Cauliflower	-55	26
7	Tomatoes	-23	66
8	Garlic	-8	11
9	Apples	-21	73
10	Peaches	-30	27

Source : Parsons (2002)

But at same time organic produce gets price premium of about 11 per cent to 236 per cent more than the conventional produce. The organic price premium seems to have increased over time. In the United State's, producer price premium for organic corn, spring wheat and oats increased by 154%, 91% and 103%, respectively between 1995 and 2000 (Bertram and Dobbs, 2001).

In general, the proportion of respondents willing to pay a price premium decrease as the premium increases, consistent with the law of demand. Most of consumers are not willing to pay a price premium higher than 10-20%. Analysis of specific organic food markets across the conturies suggests substantially higher actual price mark ups. The consumers from Italy (35-100%), United Kingdom (30-50%), France (25-30%), Sweden (20-40%) are ready to pay good price premium for organic food (Turcu,2002).

Table 2. Price Premiums for organic food

Sr.No.	Country	Price premium over comparable conventional food (%)
1	Australia	20-40
2	Austria	25-30
3	Denmark	30-30
4	France	25-30
5	Italy	35-100
6	Germany	20-50
7	Netherlands	15-20
8	Swiden	20-40
9	Switzerland	10-40
10	United Kingdom	30-50
11	Japan	10-20
12	United States	10-30
13	India	17.67

Source : Turco, 2002

The modern agriculture requires costly inputs viz; fertilizers, chemical insecticides, pesticides which will be either replaced by farm derived resources, crop residues, farm yard manure and bio-pesticides such *neem seed extract, dasha parni extract etc.* The mechanical control reduces the variable input cost in organic farming. In organic farming, low investments are needed than inorganic farming. It gives more per rupee return on investment than inorganic farming. The economics of organic cotton cultivation over a period of six years indicated that there is a reduction in cost of cultivation and increased gross and net returns compared to cotton cultivation in India (Rai, 2004). Also organic agriculture offers comparative advantage in areas of less rainfall and relatively low natural and soil fertility levels. It does not need costly investment on irrigation, energy and external inputs, but rather organic agriculture have the potential to improve local food security, increase employment especially in the marginal areas.

Two studies on comparative economics of production of grapes in Western Maharashtra was carried out during the year 2006 by the Department of Agricultural Economics, MPKV, Rahuri. The findings of these study are summarized below.

Economics of Organic and Inorganic Grape Production

The study was conducted in the Niphad and Nasik tahsils of Nasik district since the grape production has been undertaken organically in this area. The lists of grape growers (applying organic and inorganic practices) with their villages and acreage under grapevines were obtained separately from Sub-Divisional Agricultural Officers located at Niphad and Nasik, through which, villages viz; Kasabe sukane, Vinchur, Pimpri (S.), Ozar, Rui and Dharangaon of Niphad tahsil and Adgaon, Vadner Dumala, Nanegaon and Belangavhan of Nasik tahsil were selected purposively for the investigation. This study is based on the data collected from 60 farms (30 each of organic and inorganic grapes).The farmers using organic inputs for grape production were considered as 'organic farms', while those adding inorganic inputs in its production process were treated as 'inorganic farms'. The economic life of grape orchards under both the categories of farms was considered as 25 years. The grape growers using the inorganic inputs were selected purposively that their fields will be nearer to the fields of grape producers utilizing organic inputs. This was practiced to reduce differences in soil quality and other agro-climatic factors between two categories of farms. The data on different aspects of grape production pertaining to the year 2004-2005 were collected by survey method with the help of specially designed schedules. A tabular method of estimation was used for the analysis of data.

The study revealed that organic inputs used by majority of the ample farmers were jeevamrut, dashparni, verticillium, narkya-ud, magic solution, neem kadha, babhul kadha, heliokil and turmeric kadha. The study of comparative economics of grape production in Western Maharashtra indicated the cost saving of Rs. 63,360/-ha for organic cultivation than that of inorganic. By considering there is a price premium of 25 per cent and assuming a reduction in yield by 20 per cent, it has been estimated that net returns would be greater than by Rs. 78,00/- per ha. The major problems in organic farming for grape production were risk of low productivity in the initial period, complexity in the use of different inputs of organic farming, high cost of vermicompost, biopesticides and high rates of vermiculture.

Certification of organic products

Certification of organic produce is the key point for deciding the price and acceptability of organic produce in the domestic as well as foreign market. The certifying agencies play an important role for producers in facilitating access to organic markets, especially for the export. To regulate the export of certified organic products, the Director General of Foreign Trade, GOI has issued a public notice, according to which no certified organic products be exported unless certified by an inspection and certifying agency duly accredited by one of the accreditation agencies designated by Government of India. At present, there are six accreditation agencies approved by the central government Ministry of Commerce (MoC). They are APEDA, Coffee Board, Spices Board, Tea Board, Coconut Development Board and Cocoa and Cashewnut Board. ECOCERT, International IMO India Pvt. Ltd., INDOCERT, LACON GmbH, SGS India Pvt. Ltd and SKAL International are the other institutes, which are fully accredited under the Indian National Programme for Organic Production. High certification and inspection cost is the major constraint, different agencies have different parameters for certification, lengthier process and completed national organic certification, are the constraints in certification. There may be two standards at two different levels, for export and domestic markets separately because the standards for every importing country is different and also of a high standards.

Marketing of organic products

The organic marketing is quite different than that of regular marketing (of produce of conventional farming). The organic markets are still niche segment in which specific buyers are targeted careful selection and development of target markets and distribution is most important for organic produce marketing. As organic produce is costly than conventional produce and consumers having high income with health consensuses go for organic produce, so the taste and preference of this group is required to be taken into consideration. No specific market structure is developed for organic produce. Some organic Food Bazars, fares are being arranged by the state agricultural department, recently in Maharashtra. The efforts should be made for creation of awareness about organic produce, changing mindsets of consumers to create congenial atmosphere for marketing of organic produce. As like regular marketing producers are not getting remunerative prices for produce and delay in payments by middlemen are common problems in organic produce/food marketing. The following marketing channel are commonly observed in this trade.

Marketing channel for organic produce

Producer - consumer

Producer – wholesaler /trader- consumer

Producer- wholesaler - super market- consumer

Producer - own market stall- consumer

Producer- supermarket- consumer

Major domestic markets

Major markets for organic produce are metropolitan cities *viz*; Mumbai, Delhi, Colcutta, Chennai, Bangalore and Hyderabad. Supper market play an important role in the distribution of organic products. In India domestic sale of organic product was 1050 tonnes which is estimated to increase to 1568 tonnes during the year 2006-07. Tea, Coffee, Cotton, Spices, Rice, Wheat, Pulses, Fruits and Vegetable are the major organic produce.

The future of organic agriculture will, to a large extent, depend on consumer demands. Thus, a consumer-oriented approach to understanding organic agriculture is important not only in its own right, but also in terms of response to shifting market dynamics. From a marketing perspective, it is important to understand the concept of consumer decision-making regarding organically produced foods and thereby to promote its consumption. The product development and marketing strategies are affected by consumers' preferences, attitudes, beliefs and responses. Thus, a clear understanding of consumer attitudes and the motivations underlying the actions in responding to organically grown products is important. The Department of Agricultural Economics undertook the study viz; 'Assessment of consumers' preferences for organic products- a case study of Pune city' during the year 2006-07.

Assessment of consumers' preferences for organic products

The study was conducted in the metropolitan city of Pune, as the consumers of metropolitan cities are more health conscious and environment friendly. Presently, five shops are selling the organic products and among these, two of them have adopted the strategy of door to door delivery of organic products as per the telephonic order. For this study, we have all the regular customers of these two shops were selected and the required information was collected through specially designed schedules by taking the help of the salesmen's of these two shops. In all, the information of 45 consumers was collected with respect to age, education, income level and preferences for organic products. A consumer buying preferences survey was developed to assess the consumer attitudes related to purchase of organic products. To assess the consumers' tastes and preferences for organic products, simple analytical techniques were used. The consumers were classified according to age, income and education categories in order to draw the conclusions.

The consciousness of Indian consumers towards the good health has been consistently increasing. This is because of modern food production methods pose multiple dangers to health, environment and to the future of children. It is well known that, organically grown foods have fewer and generally lower pesticide residues than conventionally grown foods. It is reported that pesticides residues in daily diet lead to cancer and neurological disorders, suppresses body's immune system and normal growth of nervous system. Therefore, organic products are becoming popular in the global markets and demand for organic food in the developed countries has grown substantially in the recent years. The organic food consumers are characterized by their higher income levels and are willing to pay a price premium for the guarantee of buying healthy and safe products. India is now producing organic fruits like grapes, pomegranate, mango, oranges and other organic products. The major part of its production goes to the export markets. There is a less demand in domestic markets. Hence, there is a need to promote and develop the domestic markets, so that dependence on international market for exports can be minimized. Under these circumstances, it is expected that the consumers in metropolitan cities who are educated and have a higher level of income and well versed with the benefits of organic products, will be the largest buyers of organic products. The study revealed that,

1. The majority of respondents (67 %) were older than 56 years, over one-third were graduates, per month income of more than 70 per cent of the respondents was greater than Rs. 25000/-
2. The majority of consumers are concerned about the ill health effects of pesticide residues on produce and that, if given a choice, they would prefer to purchase produce grown using organic farming practices compared with conventionally produced produce.
3. The overwhelming preference for organic produce was related to a higher level of income and education.
4. Most of the respondents consider pesticide use information at the point of sale in their decision to purchase produce. This suggests that the information on pest management practices provided at the market place could be used to provide a marketing advantage for organic produce. Also the consumers would preferentially purchase organic produce over the produce grown using conventional pest control methods, if products are labeled to reflect pest management practices.
5. The consumers would accept produce with slight blemishes provided that they had knowledge that the organic practices were followed in its production. Also, the consumers are willing to pay more for organic produce than for conventionally grown produce, even if the organic produce had slight cosmetic blemishes. Based on consumers responses, an acceptable price premium would be in the 10 to 20 per cent of range, although a large percentage would pay 25 to 30 per cent more for organic produce.
6. The key factors affecting consumers preferences were freshness, healthiness, flavour, nutrition safety, appearance, price, environmental effect, certification, where it is grown and the brand. Consumers, who usually buy organic products were more concerned about food safety than price. The taste was the main food quality attribute that affected consumer's preference. Old age buyers, especially female consumers purchased more organic products.

The policy implications

1. To develop market for organic product, it is essential to involve the NGO'S having high credibility in society so that the lack of formal certification, consumers' preferences and attitudes may not come in the way, if the true assurance is available through such intermediaries.
2. The sale of organic products should be arranged with some tie-ups along with the existing product range to add and introduce new organic products for the benefits of those who want to pay more for such organic product is needed.
3. To minimize the ill effects of conventionally grown products on health, there is a need to establish a linkage between the consumers' co-operatives with the producers' co-operatives for supplying organic products with assurance and remunerative and rational prices to the producer and consumer, respectively.

Export of organic produce

India exports mainly organic rice, wheat, tea, spices, coffee, pulses, cotton fruits and vegetables, oilseeds medicinal herbs etc, The major exporting destinations are Netherlands, United Kingdom, Germany, Belgium, Sweden, Switzerland, France, Italy, Spain, USA, Canada, Saudi Arabia, UAE, Japan, Singapore, Australia and South Africa. During the year 2002 the quantity exported of organic produce was to the tune of 11,925 tonnes which is 85% of total production of organic production in the country. Among the available organic markets, Japanese market is the largest Asian market as there is high demand for organic products and strong purchasing power and low domestic supply of organic product. The annual growth rate of the organic market is about 20 per cent. US organic market is world's largest market for organic products. The main factors in this market are the strong consumer awareness of health and environmental issues and positive growth. The consumers in this market are ready to pay price premiums of 10 to 25 percent. If the price premium is higher than this level, the consumer will usually avoid buying organic product. The european market for organic food is also undergoing strong expansion. Germany has largest market volume within the European countries, but the market in the United Kingdom is also growing strongly. The european consumers are used to organic products from supermarket chains, natural food stores and direct from organic producers.

The major obstacles for low import of organic product from India are price expectations are too high in relation to quality, low consistency of quality, contamination, slow shipment, restrictions for importing Indian organic products, time consuming and complicated paper work, inconvenient modes of payment, government bank system is too slow and poor customer service from Indian traders after the sales.

The organic agriculture is growing very rapidly in the world, developed countries are the major markets and developing countries are the major suppliers. But the cost of production, food security issue, certification and standardization obstacles are the hurdles in the growth of organic agriculture. Co-ordination and active involvement amongst the Government, NGO and Farmers Associations will definitely go a long way in gearing the up the organic movement.

[illegible] organic products.

[illegible] the quantity of imported organic products [illegible] of 11 [illegible] which in case of local availability of organic [illegible] the domestic organic [illegible] High demand for organic products and strong [illegible] The annual growth [illegible] a sizable [illegible] in this market are the strong consumer awareness [illegible] health and positive growth. The competition in the market [illegible] price premiums of 20 to 40 percent. If the price premiums is high [illegible] the consumer will usually avoid buying organic products. The competition [illegible] is also increasing strong competition [illegible] within the European countries, but the market in the United Kingdom [illegible] strongly. The [illegible] supermarkets, natural food stores and direct farm organic sales [illegible].

The major obstacles [illegible] low supply of organic products [illegible]

[illegible] in the world [illegible] developed and developing countries for the organic supply [illegible] organic [illegible] for organic consumption.

Session-XI
Social aspects of organic farming

Indigenous technologies and its application challenges for Organic farming

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Progress in agriculture in Indian perspective

Before 1960, there wsa low chemical use (fertilizer and pesticide), low production, which faced problem to meet food grain demand to feed the growing population.

1960 -1990, during green revolution era high inputs states higher production which to meets food grain demand of nation.

However from **1990 onward** over exploitation of resources in irrigated states (high inputs use states) resulted into deterioration and degradation of resources like ground water – nitrate & pesticide contamination, soil – salinity, acidity, nutrient imbalance S, Zn, Fe, Mn, Cu B. Deficiency, environment pollution use of chemical, insecticide, Pesticide and bio-diversity imbalance

Progress in agriculture in Indian perspective from 2000 onwards

The India facing is problem to meet the food demand as well as dry land areas, north-east states, Eastern.

India tribal area still low inputs use zone productivity increased through sustainable agriculture with income increased through quality produce (organic agriculture)

Effect of green revolution in agriculture scenario

Change in first 20 years of the launch of green revolution

The food grain production was increased by 2 times and the fertilizer use was increased by 7 times and the pesticide use is increased by 375 times (Ramanathan, 2006).

Dependency on fertilizer need to be reduced by considering the fertilizer subsidy of Rs. 14000 crores with planning to reduce fertilizer subsidy by the end of the 11^{th} plan. Simultaneously the cost of the fertilizer will be increased. Mostly Phosphorus and Potash fertilizer imported from outside the country. The manure contains P and K desired quantity will be used efficiently.

Why organic farming is needed ?

Due to use of chemical fertilizers and heavy irrigations there is soil erosion, loss of soil organic matter, soil organism and also degradation of environment concern and contamination of food and ground water

Organic Farming : Naturally organic farming system rely on

What	Why
➢ Crop rotation, crop residues, animal manure, legume, green manure, off-farm organic wastes bio-fertilizwrs and aspects of biological control	➢ To maintain soil productivity ➢ To maintain soil tilth ➢ To maintain nutrient supply ➢ To control insect, weed and pests

Organic farming in India

Though the introduction of Green Revolution agricultural technology in the 1960's reached the main production areas of the country, there are certain areas (especially mountain areas) and communities (especially certain tribes) that didn't adopt the use of agro chemicals therefore, some areas can be classified as organic by default.

Organic Farming

USDA Definition

Organic farming is a production system, which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock additives.

What are certified organic products

Certified organic products are those which have been produced, stored, processed, handled and marketed in accordance with precise technical specification (standard) and certified as "organic" by a certification body.

"Organic" label is therefore a production process claim rather than a product quality claim.

Promotion of organic farming

Three categories identified for organic agriculture

1. Consumer or market driven organic agriculture is based on certification and labeling, premium price and contract farming.
2. Service driven organic agriculture depend on popular in European Union and subsidies are given to generate eco-friendly services to farmers by government or society for reducing groundwater pollution, create more biological diverse land scope and pollution free environment
3. Farmer driven organic agriculture - some farmers believe that conventional agriculture is unsustainable (Ex. A.P., Maharashtra) and needs some alternate models of production (ex. Cotton) provide family health, farm economics and self reliance with sale of produce without premium price and also cultivation without certification even at low productivity level there is no much reduction in yields.

Organic Farming by default

Indigenous resources

Efficient use of ingigenous resources for production of organic without extra efforts with quality and not quantity an dalso residue free food by maintaiing on farm recycling of inputs.

Use of Indigenous knowledge

Soil health managed by using green manuring, compost, recycling of nutrients, crops rotation, use of bio-fertilizer and also biodynamic preparation

Indigenous knowledge of farming

Organic manures used for improving soils and maintenance of soil productivity through composted manures, farm yard manures and green manuring practices for better quality produce.

Indigenous knowledge of farming

Composted manures by composting different wastes may used in the form of urban compost, farm compost, sewage and sludge and night soils.

Indigenes suitable material for composting (commercial and domestic kitchen garden)

For preparing ideal compost by using kitchen garden waste like vegetable and fruit scrap, fallen leaves, dead flower, plant leaves and soft stem, egg shells, used old papers, lawn clipping, wood ash, crop residues (straw, husk) etc.

Indigenous technology of nutrient management

The cow urine and dung manure, pancha gaviya, amrit pani, matka khad, panchamrit sanskar (Bhumi sanskar, beej sanskar, jal sanskar, vayu sanskar and vanaspati sanskar) and biodynamic preparation is used for nutrient management in organic farming.

Indigenous technology of pest management

Organic farming weeds considered as resources and not menace by physical, cultural and biological methods. Cultural method time of sowing, varieties etc. Green manuring, cover crops, mulching, spraying plant based preparation and traditional methods are used for pest management.

Indigenous knowledge of farming

Organic farming the crop rotation, cover crops, release beneficial insects, compost and cow dung manure and on-farm waste and residues recycling.

Weed and pest management

Encouraging predatory beneficial insects, planting companion crop, using catch crop, allowing pest to thresh hold level by using indigenous knowledge in organic farming.

Biofertilizers

Efficient use of microbial fertilizers through seed treatment, soil application by using microbial activator and vermicompost in organic farming.

Bio-fertilizers

Rhizobium

Rhizobium can fix up to 100- 300 kg N/ha in one crop season through legume.

Azotobacter

Azotobacter also can fix nitrogen in number of crops

Azospirillum

Azospirillum applications increase grain productivity of cereals by 5-20 % and millets by 30%.

Blue-green algae

Besides being a promising nitrogenous biofertilizer for rice, blue-green algae also help to reduce soil alkalinity.

VAM (Vasicular-arbuscular mycorrhizae)

VAM lies in the extension of the penetration zone of the root fungus system in the soil, facilitating an increased phosphorus uptake in most of crops.

Organic livestock practices

The organic livestock feed should free from animal by-products, there is no use of growth hormones and it should not be genetically engineered products or breed and also prevent contamination of crops, soil or water by plant nutrients, pathogenic organisms.

Major product are produced in India by organic farming

Type	Product
Commodity	Tea, coffee, rice, wheat
Spices	Cardamom, black pepper, white, pepper, ginger, turmeric, vanilla, mustard, turmeric, clove, cinnamon, chilli
Pulses	Red gram, black gram
Fruits	Mango, banana, pineapple, sugarcane, orange, cashew
Vegetables	Okera, brinjal, garlic, onion, tomato, potato
Oilseed	Sesame, castor, sunflower
Other	Cotton, herbal product

Policy Issues

The marketing of organic products should be export market as well as domestic market oriented. Organic certification quality standards is essential for regulating exports. The states using low chemicals really need to grow organic food for export.

Organic agriculture and yield

FAO Views

Area	Yield after conversion period
Industrial countries	Decrease in yield
So-called green revolution area (irrigated area)	Identical or slight reduction
Traditional rainfed area (low-input area)	Potential to increase in yield

Challenges

Interest of business sector on sale of organic produce in Europian market is based quality aspects. Basic theme of organic farming is management of inputs through on-farm resources for reducing cost of production. The organic farming is not only expectd to increase the income of the farmers but also helps in moving towards sustainable agriculture by using on-farm resources and their ingredient unknown, mode of action unknown, after effect unknown which may leads to increase the cost of cultivation.

Marketing

Organic farming standard is developed for export purpose considering IFOAM, EU and CODEX standard small farmers will not get the benefit only traders and middle man will acquire advantage of organic produce

Huge Retail Market in India

The India is a whole for as a local market needs standard for domestic market with goodwill brand name marketing with non-certification. There is a need of state level accreditation body for certification.

Safe food marketed as unsafe

- Fruit, vegetable and food crops are still safe in most part of country (low pesticide use.
- Value addition to fetch high price Banana, mango, papaya – Yellow colour by chloranthy phosphoric acid or ethereal hormone
- Colouring in Bitter gourd and other cucurbits- soil and colour coating in potato growing food by indigenous organic means and marketing with fall of poison will not serve the purpose

After effect of alkaloid is unknown

Pest control by leaves extract of number of poisness plant like- Aak, Dhatura, Kanhar etc. is being done traditionally

After effect of alkaloid in human health is need to be shorted-out

Some myth with indigenous technology

Scientific explanation and technicality for increasing yet to be established

The scientific information should e develod regarding use of Agnihotra, Hawan, Pooja. Bhusm, Biodynamic preparation, Mantra and their side effect of toxic plant spray for insect post control.

Enrichment of compost

- The use of compost or cow dung manure is age old practice
- The enrichment of compost through fertilizer is recommended under integrated farming but not under organic farming
- The effect of such manure did not affect soil or human health. Need to develop widely accepted recommendations

NSOP India Organic

Indian National Standards for Organic Production. India Organic Logo is governed by APEDA, which provides national standards for organic products through a National Accreditation Policy and Programme.

ORGANIC INDIA

Quotes from satisfied organic food users

The organic food should be safe for human health, environment friendly, no hazards of pesticide residues. It is chemical-heavy metal free with long shelf life.

Promotion of organic farming

How to proceed ?

For promoting the organic products first step is to raise the awareness among consumers, then establish domestic market, simultaneously increase number of organic farm. These should be provision of subsidy during conversion period having initiative for premium price.

Promotion of organic farming

Answer is still awaited

1. How much yield level is acceptable ?
2. Is it fulfills the food security problem ?
3. Whether available organic resources are sufficient for targeted production ?
4. Whether package of practices are available ?
5. What is the actual meaning of organic farming ? Is it relevant for developing countries ? Is it relevant for area of low fertilizer and chemical use ?
6. Whether poor farmer get the advantage of premium price?
7. Is it for crazy people ?
8. What will be the specific quality parameters for organic farming produce?

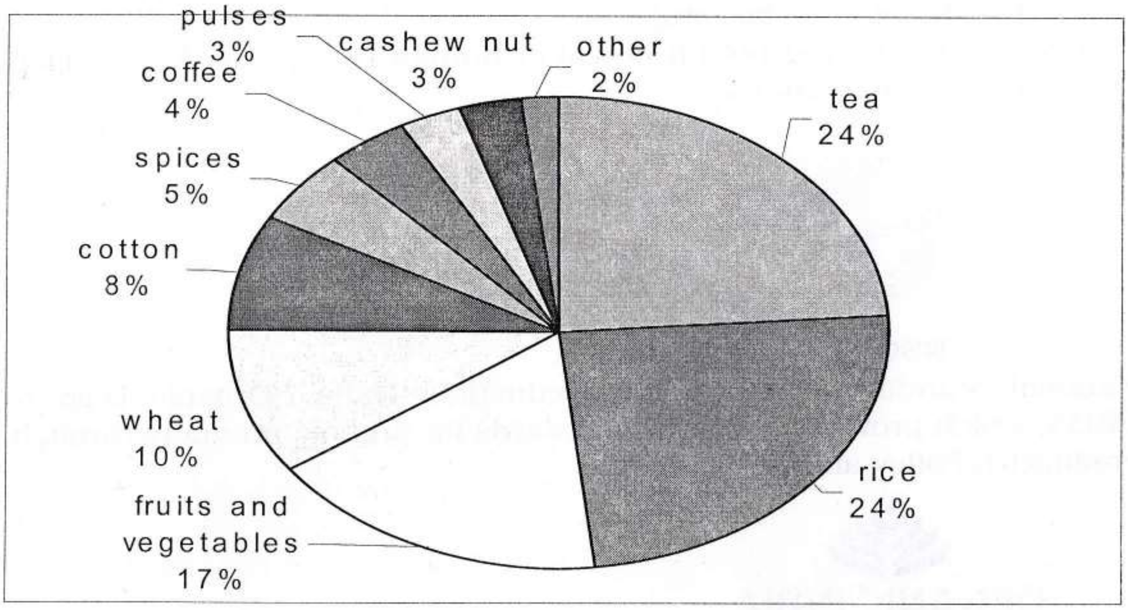
Promotion of organic farming

Issues

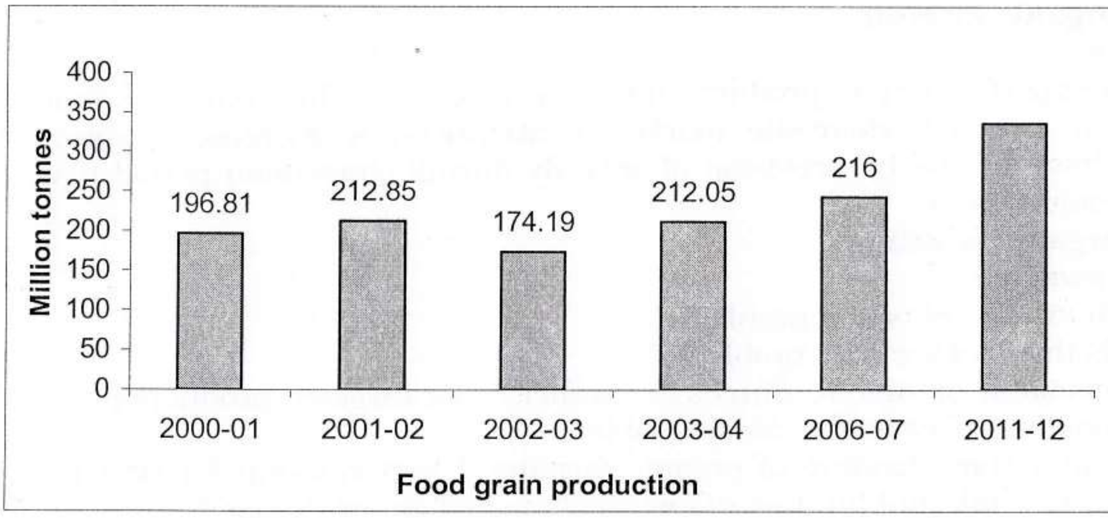
- Production and supply of quality biomanures, biofertilizers, biopesticides and bio-control agents
- Whether food security is possible in high fertilizer use area
- Quality parameter of produce need to be framed-out
- Insufficient data base for control of pest and diseases through organic means
- Identification of specific crops and varieties for particular zones
- Marketing infrastructure

Production of organic products:

Chart 2. Percentage contribution of total organic production in India (Garibay and Jyoti, 2003)



Food Grain Production in India



Scope of commercialization of indigenous technology for organic farming

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Organic farming is considered to be a self sustaining system of agriculture and a potential and attractive alternative to high input chemical-based production system. This system is believed to promise maintenance of soil productivity and control of pests and diseases by enhancing natural processes and cycles in harmony with the natural environment. The production system entails no use of synthetic fertilizers, pesticides, amendments growth regulators and livestock feed additives, while relying more on organic manures and composts, biofertilizers, crop rotations, with inclusion of legumes, mechanical cultivation, minerals bearing nutrients and biological pest control measures.

Present agriculture is an evolution of such repeated human interferences. The pressure on cultivated land continuously mounted by increased global population, necessitated the artificial supply of nutrients to increase the agriculture production. The organic farming signifies the use of any material (of organic origin) to supply plant nutrients, control of pest and improve of soil health for better agriculture production. Thus the organic farming signifies use of wide varieties of natural materials and practices. The materials may include animal dung, urine, digested/ undigested manures, oil cakes, plant residues, farm wastes, bodies of dead animals, fish meal etc. They may include many unconventional sources such as city wastes, sewage, sludge, industrial waste, by products of slaughter houses, human excreta and urine, marine wastes etc. The practices forming a part of organic farming includes green manures, green leaf manuring, microbial inoculation, several cropping practices (such as trap cropping, crop rotations, inter cropping etc) for better pest control and many other practices which aim at improvement of soil health. Such practices may also include the use of many bio-agents, predators and natural enemies for natural control of pests as well as the use of earth worms and many other soil flora/fauna as a means of building up the soil fertility to bring it to the tune of natural harmony in an agricultural eco-system.

Status of Organic Farming

Crop residues

Crop residues are the plant part or crops remains left after harvesting and or processing of the produce. There are tremendous natural resources having diverse effect on soil quality. Nearly 355 million tonnes (Table-1) of crop residues are annually available in India of which 180 million tonnes can be utilized to supply 4.54 m tonnes of plant nutrients (Hedge and Sudhaker Babu 2001) Rice, wheat and sugarcane are potential crops which ensure availability of large amount of crop residues. Three fourth of total residue are produced by rice, wheat and oil seed crops. The remaining one-fourth are from sugarcane and sorghum. A sizeable portion of crop residue i.e. about two-third is fed to animals in India and only remaining one third is available for incorporation into the soils. Of the available residues for incorporation 53% are available in kharif and 47% of rabi. The residues could be incorporated directly into the soil or used for preparation of enriched composts/ Vermicompost. Enrichment of compost with mineral additives like rockphosphate and pyrites etc. has been found to high beneficial substituting the use of phosphate fertilizers and reducing the dependence on nitrogenous fertilizer by 25 percent (Table 2).

A large quantities of combine harvested rice and wheat straw are being burnt in the Indo-gangetic plain to clear the fields for the timely sowing of crops and as a convenient mode for disposal of wastes. Its burning causes substantial loss of valuable organic matter and nutrients to the atmosphere. The loss is almost complete of N, 25% of P, 20% of K and 5 to 60% of S. It may not be prudent, therefore, to burn the huge quantities of crop residue which could otherwise be converted to value added manures like co-composting of poultry litter/manure, phospho-compost etc. or other with bio-degradable wastes effective methods to conserve the nutrients for commercialization of indigenous organic residue for the organic farming.

Crop residues and soil quality

A. Physical quality
B. Chemical quality
C. Biological quality

Green Manuring

Nitrogen production from legumes is a key benefit of growing them as green manure. N-accumulation by leguminous green manure crop range from about (40-200 kg ha^{-1}). The amount of nitrogen available from legumes depend upon legumes species, total biomass produced and percentage of nitrogen in plant tissues. A high percentage of biologically fixed nitrogen is in top growth. Dr. Greg Hoyt an agronomist at north Carolina State estimated that 60% of tissue N is released when crops are incorporated as green manure. Residual effect of green manuring are relatively small when green manure application is once year while the cumulative effects of several application highly appreciable. It was observed that the increase in soil organic matter and available NPK contents over location in continuous rice-wheat cropping system (Table 6 & 6a) followed for 13 years and fertilized with inorganic fertilizers in the conjunction with organic manures including green manuring. In addition to nitrogen green manuring of legumes helps in recycling of other nutrients viz P,K,Ca,Mg and S. Green manuring also help in reducing the leaching of micronutrients as most of them are bound to organic matter.

Under the organic farming system, this practice is widely utilized for not only improving the nutrients and organic matter supply, but also to manage weeds and pests. The most commonly grown green manure crops are *Sesbania aculeata* and *Crotalaria juncea* having potential to provide 4-5 tonne ha^{-1} of dry biomass and 80-100 kg of N ha^{-1} with 50-60 days of plant growth. Green manuring also help in accelerating the decomposition of high C:N ratio residue under field conditions. It is of interest to mention here for commercialization purpose of green manuring to increase value added nutrients, the incorporation of straw along with green manuring has been shown to rice yield similar or higher than that obtained with the application of 150 kg N ha^{-1} (Singh and Singh 1997). Nitrogen supplied through green manure crops is readily available to the subsequent crops because of its low C:N ratio and easy mineralization. Apparent recovery of green manures N in different crops varies from 30 to 58%. A number of studies have shown the efficiency of green manure N to be equal to or more that the fertilizers.

Farm Yard Manure (FYM)

FYM constitutes by far the important source of nutrients under the organic culture. The quantity of FYM was enough earlier to be applied @ 10-20 t ha^{-1} $crop^{-1}$ season to realize the optimum yields. It was further revealed that FYM and biogas slurry were available in sufficient quantities only at farms where dairy constituted an important source of farm income.

At national level, the potential availability of dung (Sundry) in the country has been estimated to be 375, 396 and 426 million tonnes in 2000, 2010 and 2025 respectively. However, only 30% of potential could be tappable for use in agriculture. Accordingly, the tappable nutrients ($N+P_2O_5+K_2O$) from dung could be 2.0,2.1 and 2.3 million tonnes in 2000, 2010 and 2025 respectively. Proper and judicious use of FYM and cakes not only improved the quality, the yield but quality also improve the soil health and maintained the soil productivity and effective in sustainable agriculture (Table-7).

Agro-Industrial Wastes

In addition to FYM and crop residues, the number of other activities generate bio-degradable waste containing nutrient and organic matter for the use in agriculture. the agro-based industries and food processing industries are developing fast due to greater incentive offered by the Government for value addition in products of farm sector. The waste generated during processing of agriculture products can be advantageously recycled to the soil for improving nutrient availability. These bio-solid and liquid-waste can be converted to valuable manures for supplementing the nutrients and organic matter requirement of the crops.

Sugar Industry Waste

Sugar industry is one of the largest agro-based industries in India. There are 448 sugar mills and 283 distilleries producing 182 million tonnes of sugar by crushing about 178.5 million tonnes of cane. Processing of cane in sugar mills and fermentation of molasses in distilleries result into production of solid and liquid wastes known as press mud and spent wash respectively. These wastes have potential to supply nutrients and organic matter provided the technology of co-composting is utilized for their conversion into valuable manures. In fact presenting almost all distilleries have started co-composting of press mud with spent wash. About 5 to 5.5 million tonnes of press mud are being produced in India annually, having a potential to generate about 3 to 4 million tonnes (60% of total pressmud) of manure with high nutrient content. Crop residues like paddy straw and sugar cane trash can also be utilized for co-composting of spent wash and thus transforming wastes into valuable manures (Table-8).

Fruit, vegetable produce waste and plantation crop wastes

India produces around 33 million tonnes of fruit and 50 million tonnes of vegetable annually. It is estimated that roughly 10 to 15% of total produce is available either as residues or bio-degradable wastes for recycling in agriculture. In addition, the processing of fruits and vegetables results in production of around 5 million tonnes of solid wastes. Most of these wastes are lignocellulosic in nature and contain macro and micro-nutrients. Mushroom production in India ranging between 30,000 to 35000 tonnes. Spent mushroom waste is half decomposed material having high nutrients concentrations. These wastes provides good quality manure for agriculture. If we manage the waste of plantation crops it will provide 165 thousand tonnes of $N+P_2O_5+K_2O$ which will definitely provide help for using indigenous materials for maintaining sustainable agriculture.

Poultry wastes

Poultry industry has achieved a significant growth in the last two decades. Presently there are about 60000 poultry farms producing 450 million broilers and 30 billion eggs. The poultry sector not only produce nutritive eggs and meat but also generates poultry manures and hatchery waste of high economic nutrients value. It is estimated that the fertilizer value of poultry manure from 3 birds on deep litter is superior in terms of nutrient content value compared to manure from one cow. The average daily fresh manure production from broilers ranges between 70-80 kg/1000 kg live weight. Poultry manure and litters contain high amounts of N,P and other nutrients (N,3.5%, P 1.6%, K 1.8%). The use of litters as soil amendment for agriculture crops provides appreciable quantities of all important plant nutrients and improves the crop yield. Co-composting of poultry litre / manure with crop residues or other bio-degradable waste is effective method of not only eliminating the pathogens from poultry wastes but also to conserve the nutrients for commercialization of manures (Table 9).

Fermentation of Industry wastes

India has made rapid progress in the production of drugs and other chemicals through fermentation processes of different substrates. After production of useful products, the left out materials contain large amount of organic matter and mineral in solids and liquid form. It is estimated that one kg of antibiotic produced through fermentation, there is generation of around 7000 to 8000 litres of waste water with solid content ranging between 40-50 g L^{-1} and BOD load about 30000 to 60000 mg L^{-1}. This waste are discharged in sewage water after treatment. For commercialization of indigenous organics i.e. fermentation Industry wastes should be used for enriching the compost or other bio-solids like crop residue and agro-industry wastes to make value addition manures.

Urban solid wastes

The total waste generated in India is over 39 million tonnes at present. The disposal of this waste is a big challenge especially in 300 class I cities having population more than 100000. Generally no processing of waste is done in the country except in a few cities where decentralized and centralized composting is done on a limited scale. The mixed Indian wastes has a large proportion of compostable materials of 30-57% containing 0.56-0.71% nitrogen, 0.52-0.82% phosphorus and 0.562-0.83% potassium. (Table 10-11). Obviously the wastes aftercan be used in better way for composting the solid plant wastes and valuable source of organic manure and plant nutrients. The value of compost, however, is questioned when it has prohibitive levels of heavy metals threatening human and animal health. The contamination of compost with the heavy metals could be avoided by segregating the industrial waste containing heavy metals and toxic chemicals from the bio-degradable wastes. For proper safeguards on its use, the regulatory authority must ensure the compliance of ISI quality standard for organic fertilizer (compost) by the manufacturers (Table-12-13).

Sewage sludge and sewage water

Solid parts which usually consists of human excreta and other solid wastes where in sewage water liquids generated from water closetters, kitchen, bath room and office. As most of these wastes are carbonaceous and therefore easily decomposable and they could be easily recycled. The treatment of sewage water may be done in four steps:

(i) removal of coarse organic/inorganic solids by screen, settling, flotation and neutralize (ii) aerobic and anaerobic biological process to decompose the organic debris through necessary structures (iii) chlorination, micro-screening, coagulation, precipitation and activated carbon adsorption (iv) upgrading the water to the level of portable water by ultra filtration by process such as ion exchange, reverse osmosis or electro dialysis etc. Although as much as 80-90 % of Indian sewage reaches farms without treatment, the sewage water collection was as much as about 35 million Cu m/day. It is equivalent to 28300 cusecs and can mean that a sewage water is available for exploitation.

According to one estimate every 10000 people in country can produce 365 tonnes of dried anaerobically digested sludge per year. In India about 60 crore adult population may be able to generate 21.9 million tonnes of dry digested sludge annually. Based on medium concentration it can supply 6.7 million tones of organic carbon, 0.72 million tonnes of nitrogen, 0.55 million tonnes of phosphorus besides of large quantities of micro-nutrients. However, the sludge equivalent to only 4 million tonnes of dry digested sludge is collected at present and can be utilized for composition with indigenous organic residues to improve the nutritional quality of organic wastes for sustaining the organic farming.

Biofertilizers

As an important component of organic farming biofertilizers can attain a very prominent position because it is the most efficient and least damaging way of supplying nutrient to crops.

The biofertilizers being cheap and ecofriendly sources of nutrients for variety of crops, are going to play a crucial role in the practice of organic farming. Presently a number of Agricultural universities, State Agriculture Department and commercial houses are producing bio-fertilizers in India. The production is about 10000 tonnes against the production capacity of 18000 tonnes with Rhizobium accounting for 40%. The response to biofertilizers have been spectacular in Southern India(Tamilnadu) with 30-50% of farmers using biofertilizers. The most common inoculants used are Rhizobium and phosphate solubilizing bacteria (PSB) for legumes and *Azospirillum* and PSB for other crops. The acceptability of biofertilizers has however been poor with farmers of northern India. The lack of availability and poor performance are stated to be the reasons for low popularity of biofertilizers. An adequate efforts are required to identify the location specific strains to develop the better production technology, avoid contamination and provide better storage and handling to increase the shelf life of the bio-fertilizers. We have to generate idea for its commercialization and its use by the farmers/cultivators in judicious manner as a value addition nutrients (Table 14 and 15).

Crop rotation

Rotation of choice crop may lead to increased nutrient content in the soil and increased availability of nutrients. The sequence of cropping may yield substantial quantity of nutrients reducing the additions of nutrients to second/third crop. In harnessing the benefits of crop rotation for organic farming, the choice of crop should be such that proceeding crop helps in making the nutrients available to subsequent crop.

Bio-control agents and bio-pesticides

In last 15-20 years, the use of organic methods to control the pest has been tried extensively. The organic methods of pest control involved:

(a) The use of natural enemies (b) The use of eco-friendly pesticides and (c) The cultural methods.

The bio control agents (natural predators) and bio pesticides of plants origin have a greater role to play in protecting the crops against pests and diseases under organic farming regimes. The predators feed the crop pests keeping their populations to minimum level. The predators on the other hand, keep thriving with no use of chemical pesticides. India is rich in bio-control agents bio-diversity ranking second after Australia amongst twelve mega-diversity countries in respect of Hymenoptera. Accordingly, a large number of naturally occurring predators are available for controlling the pest of different crops. (Table 16). The biological control system/protocols specifying dosage, time, frequency and method of application have been developed for the major pests of different crops.

Microbial control agents especially including the commercial formulations of *Bacillus thuringiensis* are very effective in the management of Lepidopterous larvae. The nuclear polyhedrosis virus (NPV) is being used to suppress the larval population of Helicoverpa armigera on chickpea, pigeonpea, cotton, maize etc. on large scale. The fungal formulations containing Beauvaria bassiana and Metarhizum (sp) are effective in controlling many pests. As regards to the exploitation of bio-control agents the egg parasitoids eq. Tetrasticlus pyrillae against the egg Pyrilla perpusilla; Trichogramma chilonis, T. braziliensis (as Trichocards) against the egg of lepidopterous is very effective pest, Epiricania melanoeuca has been widely accepted as nymphaladult parasite against pyrilla on sugarcane. Among the larval pasitoids campoletus chloridae is effective for Harmigira during autumn season on pulses and cereal crop. The larval parasites of Apanteles sp, Chelorus sp, Bracon sp. are effective for supporting the multiplication of many lepidopterous pests. However these biological agents require more specific environmental condition for their own multiplication.

Miscellaneous sources

The organic farmers presently using a variety of other local products to meet nutritional requirement of crops and protect them against pest with a good measure of success. Some of them are Amrit pani, Amrit Sanjeevani, Seengh khad, Matka khad, Murgi khad, NADEP compost etc.

Conclusion

- The global trade in organic farming is giving to pickup in the years to come and India could be a bigger beneficiary of this boom. India's exports of organic produce are still small , mainly of tea, cotton and spices. There is tremendous potential to include other commodities as well as particularly durum wheat, Basmati Rice fruits, aromatic / medicinal herbs, vegetable, coffee, pulses and sugar etc. India is competitive in world market due to the low production costs and availability of diverse climate to grow a variety of crops round the year.
- As the supply of organic manures are not adequate, hence the need to be augmented by developing a strong component of dairying, poultry and piggery etc. and composting of agro-industrial and city wastes.
- The manures require to be enriched by co-composting with mineral additives permitted under the organic agriculture.
- The use of micro organism such as phosphate solubilization / degradation of cellulose and lignin etc. should be advocated among the farmers.
- The greater research and efforts are required to identify the location specific strains develop better production technology to avoid contamination and provide better storage and handling to increase the shelf life of the bio-fertilizers.
- The urban solid wastes and other wastes are contaminating the compost with the heavy metals avoided. For proper safeguards on its use, the regulatory authority must ensure the compliance of ISI quality of standards for compost by the manufacturers.

- The biological control system/protocols specifying doses, time, frequency and method of application have developed for major pests of different crops. We need to standardize location specific manurial schedules and bio intensive pest management modules.
- The preparation of vermicompost, NADEP compost, phospho-compost etc. or other local products must meet basic nutritional requirements of the crops and protect them against pest with good measure of success.
- The organic farming is going to be a community affair, the farmers need to be sensitized in their participatory role in the new venture. The farmers may seek tie-up with private corporate for proper market outlets and better support price. The government should provide the requisite patronage and institutional support in the development, regulatory mechanism and market infra structure in the emerging new fields.

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Table 1. Crop residues available for utilization in India

Crops	Total available crop residues (million tonnes)	Crop residue available for utilization (million tonnes)	Total NPK (million tonnes)	Nutrient potential for utilization (million tonnes)
Rice	119.2	39.7	2.59	0.86
Wheat	93.9	31.3	1.71	0.57
Sorghum	19.9	6.6	0.41	0.14
Sugarcane	20.0	28.0	0.52	0.52
All pulses	17.9	6.0	0.59	0.19
Others	76.7	58.3	1.62	0.76
Total	**355.6**	**169.9**	**7.44**	**3.54**

Table 2. Characteristics of compost prepared from co-composting of poultry wastes with crop residues.

Treatment	Palampur*		Kanpur**		Ranchi***	
	N	C:N	N	C:N	N	C:N
Poultry wate (P.W.)	1.72	11.9	2.1	14.5	1.90	15.9
P.W. + R.P. + Pyrite	1.88	11.5	2.64	10.9	2.36	13.4
Paddy straw (P.S.) + P.W. (1:1)	1.28	21.6	1.81	12.4	1.84	17.7
P.S. + P.W. (1:1) + R.P. + Pyrite	2.20	12.1	2.42	8.9	2.04	13.6

* Initial analysis P.W. N= 2.31%, C:N=19.3, ** P.W., N=2.36%, C:N =19.8
*** P.W., N=2.35%, C:N=19.78

Table 3. Soil physico-chemical properties at harvest of rice as affected by recycling of crop residue

Treatment	pH	Bulk density (g/cc)		Hydraulic conductivity (cm/hr)	Water holding capacity (%)
No residue	5.5	1.43	1.53	9.58	36.76
Wheat straw 5 t/ha	5.4	1.34	1.44	11.66	50.60
Rice residue 5 t/ha	5.5	1.33	1.49	11.99	51.06
CD (P=0.05)	N.S.	0.03	0.02	0.59	3.07

Table 4. Effect of residue management for seven years in rice-wheat rotation on chemical properties of a sandy loam soil

Parameter	Residues		
	Incorporated	Removed	Burnt
pH	7.7	7.6	7.6
EC (mm hos/cm)	0.18	0.13	0.13
Organic C (%)	0.75	0.59	0.69
Available N (ppm)	154	139	143
Available P (ppm)	45	38	32
Available K (ppm)	85	56	77
Total N (ppm)	2501	2002	1725
Total P (ppm)	1346	924	858
Total K (ppm)	40480	34540	38280

Table 5. Effect of residue management for seven years in rice-wheat rotation on chemical properties of a sandy loam soil

Microbes	Population/g soil	
	No trash	Trash mulch
Bacteria	21 ± 6	43 ± 10
Fungi	23 ± 4	36 ± 10
Actinomycetes	65 ± 10	72 ± 15
Azotobacter	4 ± 2	25 ± 6
Azospirillum	2 ± 1	25 ± 8

Table 6. Change in physico-chemical properties of soil, depth basis, with addition of green manures

Treatments	0-15cm					15-30cm				
	pH	N	P	K	OC (%)	pH	N	P	K	OC (%)
	Initial									
	8.4	**174.2**	**21.6**	**119.2**	**0.52**	**8.2**	**165.1**	**20.5**	**113.6**	**0.49**
Green manuring crop										
Control	8.4	172.0	21.4	118.4	0.48	8.3	163.4	20.0	1130	0.43
Dhaincha	8.3	174.4	21.9	119.4	0.56	8.1	165.0	20.7	113.5	0.50
Greengram	8.3	174.3	21.5	119.2	0.54	8.2	165.2	20.6	113.4	0.49
Cowpea	8.4	174.2	21.5	119.5	0.53	8.2	165.0	20.5	113.2	0.47

Table 6a. Effect of green manure and crop residues on crop yield and organic carbon content of soil in rice-wheat rotation (1988-93)

Treatment to rice	Grain yield (t/ha)		Organic C (%) after rice 1991
	Rice	Wheat	
No	4.0	4.2	0.37
N120	5.8	4.2	0.34
N120	6.2	4.3	0.37
N180	6.3	4.3	0.36
Green manure (GM)	6.2	4.3	0.39
G.M.+ Wheat straw	6.4	4.4	0.48
GM+ Rice straw	6.4	4.4	0.49
Wheat straw alone	5.6*	4.2	0.47

Table 7. Effect of organics and inorganics on yield and quality of ginger and turmeric

Treatments*	Yield (t ha^{-1})		Quality(kg ha^{-1})	
	Ginger	Turmeric	Ginger oleoresin	Turmeric Curcumin
1. Check	2.80	2.88	209	169
2. FYM	3.60	4.15	281	250
3. NPK fertilizers	3.27	4.88	231	268
4. Neem cake	3.95	4.82	320	320
5. Cotton cake	3.89	4.62	278	284
6. Mustard cake	3.41	4.30	242	143
7. Groundnut cake	4.08	4.81	302	277
8. Sesame cake	3.85	4.22	266	249
CD at 5%	0.30	0.38	23	16

Source: Sadanandan and Hamza (1999)

* Note:

1. NPK for ginger and turmeric was 75-50-50 and 60-50-120 kg ha^{-1}) respectively.
2. Organics to ginger and turmeric were on equal N basis to supply 75 and 60 kg N ha^{-1}, respectively.

Table 8. Co-composting of crop residue with spent wash

Treatments	Nutrients (mg g^{-1})					
	N	P_2O_5	K_2O	C:N	Volatile	Mineral N (mg kg^{-1})
Crop residue	9.4	3.1	5.6	22.8	229.3	36.0
Crop residue + spent wash	12.6	3.8	16.0	16.0	223.1	52.2
Crop residue + spent wash + RP Pyrites	14.4	35.0	13.0	13.0	204.1	56.5

Table 9. Composition of manures prepared from co-composting of poultry litter with rice straw

Treatments	N (%)	C/N ratio	Total mineral N (ppm)	Total P_2O_5 (%)	Citrate soluble P (g kg^{-1})
T_1 : Poultry waste (PW)	1.85	12.95	2.15	2.55	17.03
T_2 : PW + Rock phosphate (12.5% w/w)+ Pyrites (10% w/w)	2.46	16.00	4.95	4.95	13.21
T_3 : PW+Rice residue + water hyacinth 1:0.5:0.5 ratio)	1.90	15.20	3.45	3.50	17.37
T_4 : T_3+Rock phosphate (12.5% w/w) + Pyrites (10% w/w)	2.0	13.40	4.35	4.25	14.0
T_5 : PW+ Rice residues + Water hyacinth (1:2:2)	1.75	11.80	2.75	2.75	18.0
T_6 : T_3+Rock phsopahte (12.5% w/w) + Pyrites (10% w/w)	2.15	12.50	3.50	3.25	14.19

Table 10. Physical characteristics of municipal solid waste in Indian cities

Population range (million)	No. of cities surveyed	Paper	Rubber, leather and synthetics	Glass	Metal	Total compostable matter	Inert material
0.1-0.5	12	2.91	0.78	0.56	0.33	44.57	43.59
0.5-1.0	15	2.95	0.73	0.56	0.32	40.04	48.38
1.0-2.0	9	4.71	0.71	0.46	0.49	38.95	44.73
2.0-5.0	3	3.18	0.48	0.48	0.59	56.67	40.07
5.0 and above	4	6.43	0.28	0.94	0.80	30.84	53.90

Table 11. Chemical characteristics of municipal solid waste in Indian cities

Population range (million)	N	P_2O_5	K_2O	C/N ratio
0.1-0.5	0.71	0.63	0.83	30.94
0.5-1.0	0.66	0.56	0.69	21.13
1.0-2.0	0.64	0.82	0.72	23.68
2.0-5.0	0.56	0.69	0.78	22.45
5.0 and above	0.56	0.52	0.52	30.11

Table 12. Heavy metal content (mg kg^{-1}) soils around Hyderabad treated with urban solid wastes for 10 years

Metals	Normal soil	Waste Treated Soil
Lead	5.0	170.00
Nickel	2.0	10.0
Cobalt	5.0	7.0
Cadmium	0.4	0.9
Chromium	6.0	47.0

Table 13. Maximum permissible limit of heavy metals in compost

Parameter	Concentration not to exceed (mg kg^{-1} dry basis)	Testing methodology
Arsenic (AS)	10.0	IS:11124-1984
Cadmium (Cd)	5.0	
Chromium (Cr)	50.0	
Copper (cu)	300.0	AOAC methoid 975.01-1988
Lead (Pb)	100.0	IS:12074-1987

Table 14. Effect of FYM, Biofertilizers, Vermicompost and Inorganic Fertilizers on yield of rice

Treatments	Yield of rice t ha^{-1}	
	Grains	Straw
1. N through FYM 50 kg + *Azospirillum* 2 kg ha^{-1}	5.72	7.76
2. N through FYM 50 kg + *Azospirillum* (2 kg) + Phosphobacteria 2 kg ha^{-1}	5.95	7.99
3. N through Bioslurry 50 kg + *Azospirillum* 2 kg	5.98	7.89
4. N through Bioslurry 50 kg + *Azospirillum* + Phospho 2 kg each	6.18	8.17
5. N through Vermi-compost 50 kg + *Azospirillum* 2kg	6.07	8.00
6. N through Vermi-compost 50 kg + *Azospirillum* + Phospho 2 kg each	6.25	8.21
7. Fertilizer N at 100 kg ha^{-1}	5.57	7.61
8. CD (P = 0.05)	0.13	0.35

Table 15. Response to phosphobacterization on crop yields

Treatments	Crops yield (t ha^{-1})			
	Wheat	Paddy	Chickpea	Moong
Un-inoculated	3.44	2.48	2.38	0.35
Inoculated	4.77	2.82	3.14	1.03
CD at 5 %	0.03	0.007	0.02	0.006

Table 16. Biological control agents of crops

Crop	Pest	Number of natural enemies
Sugarcane	Sugarcane top borer	61
Sugarcane	Sugarcane stalk borer	50
Corn	Corn borer	32
Rice	Rice yellow stem borer	72
Cotton	Cotton bollworm	53
Tobacco	Tobacco caterpillar	42
Groundnut	Groundnut leaf miner	30
Castor	Castorsemilooper	45
Mango	Mango leaf hopper	33
Mango	Mango mealybug	23
Citrus	Grain scale	23
Coffee	Grain scale	23
Crucifers	Diamondback moth	29

Table 17. Effect of organic and inorganic sources on *bhendi* yield

Sr. No.	Treatment	*Bhendi* yield (t ha-1)
1	Poultry manure (PM) to supply 40 kg N –1	6.90
2	Neem cake (NC) to supply 40 kg N ha-1	6.30
3	PM+Panchagavya 3% spray-4 times	10.27
4	PM+ herbal leaf extract sprary	9.01
5	PM+ Neem formulation sprar	8.11
6	NC + Panchagavya 3% - 4times	9.25
7	NC=Herbal leaf extract supply	8.46
8	NC+Neem formulation sprary	7.84
9	Inorganic fertilizers 40-50-30NPK kg ha-1+ inorganic pesticide monocrotophos sprary	10.39
	(CD (P=0.05)	0.54

Table 18. Efficacy of plant extract and bio-agents

Sr. No.	Name and efficacy of plant extract/ bioagents	Reference
1.	Neem products reduced fruit borer attach (*Erias* sp.) of Okra	Ambedkar *et.al* (2000)
2.	Methanol extract of *Azadirachta indica* and hexane extract of *Thevalia nerifolia* leaves showed antifeedal and insecticidal effects against *Achaea janata* (on castor)	Babu *et al.*(1997)
3.	Neem oil (2-4 %) controlled the larvae of leaf roller of rice to the tune of 56-60 percent	Baitha *et al.*(2000 b)
4.	Powdered neem leaves were found effective in controlling the poulation of bettle *Callosobruchus chinensis* on green gram	Day akar and Ray (1999)
5.	Chloroform extract of *Pongamia pinnata* @ 5% controlled the damage by mosquito bug (*Helobellis theivara*). Antifeedant property of Lantana Camona extract on tea mosquito bug was also demonstrated	Deka *et al.* (1998).
6.	*Bacillus thuringensis* formulations were very effective against *Helicoverpa armigera*	Gujar *et al.*(2000)
7.	Growth disrupting effects of hexane extract of neem seed kernel resulted in delayed development and mortality of *Spodoptera litura*	Kaur *et al.*(2001)
8.	*Bacillus thuringensis* formulations (Delfin) was effective in reducing population of leaf webber (*Crocidolomia binotalis*) of cabbage.	Malathi *et al.* (1999)
9.	Treating pigeonpea seeds with neem seed kernel powder (4% w/w) prevented egg lying of *Collosobruchus chinensis* (Pulse beetle).	

Social perspectives of organic farming

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The higher productivity of the food crops and green revolution era was achieved with high yielding, fertilizer responsive crop cultivars and the increased fertilizer usage. The recent energy crisis, the hike in the prices of the inorganic fertilizers and declining soil health and productivity necessitates the use of organic manures in crop production. Organic manures besides supplying some amount of the essential nutrients to the current crop, often leave substantial residual effect on the succeeding crops in the system and this residual effect lasts for several seasons. The modernization and fast urbanization generates large quantities of garbage and safe disposal of them is a big problem. Conversion of garbage into compost for application to soil as a source of plant nutrients in the organic farming serves as an effective disposal of wastes.

An organic agriculture is a holistic crop production and management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. Sustainability in organic farming must therefore be seen in a holistic sense, which includes ecological, economical and social aspects. Sustained production at higher levels becomes possible only when the factors leading to the continued maintenance of soil health are adequately taken care of.

Ecological sustainability

Some important aspects are:

- Recycling the nutrients instead of applying external inputs
- No chemical pollution of soil and water
- Promote biological diversity
- Improve soil fertility and build up of humus
- Prevent soil erosion and compaction
- Animal friendly husbandry
- Using renewable energies

Economic sustainability

Some important aspects are:

- Satisfactory and reliable yields
- Low costs on external inputs and investments
- Crop diversification to improve income safely
- Value addition through quality improvement and on-farm processing
- High efficiency to improve competitiveness

Social sustainability

Some important aspects are:

- Sufficient production for subsistence and income
- A safe nutrition of the family with healthy food
- Good working condition for both men and women
- Building on local knowledge and traditions

Organic farming has the potential to provide positive externalities in social aspects like job opportunities and rural development.

Social benefits arising from organic farming

Impact on employment

In general, labour use, whether in farm hours or full-time labour units, is generally higher on organic farms than on their equivalent conventional farms. Other studies observe that labour input is expected to be higher in organic farming primarily due to the manual and mechanical work needed to weed crops. Preparing the products for home and market sale also need more labour on organic farms (Padel and Lampkin, 1994).

As well as increased labour, the organic farming requires more complex management than comparable to conventional systems (Molder *et al.*, 1991). The increased levels of management and marketing skills needed by organic farmers have usually been derived practically from experience on their own or from other farms. However, the rapid expansion in the number of organic holdings will also require the rapid development of networks for support and advice, not just for conversion but also during continued organic production.

Support to local and regional economies

Organic farming and integrated farming also represent real opportunities on several levels, contributing to rural economies through sustainable development. Indeed, new employment opportunities in farming, processing and related services are already evident in the growth of the organic sector. The organic farming has advantage over conventional farming in alleviating rural poverty. The organic farming can be practiced in any situation from lowest rainfall areas to highest rainfall areas. The organic principals are location specific for improving the productivity. Managing local natural resources like seeds, manure, plant protection technique, rain water harvesting will reduce the input cost and improve the farm income. It does not involve borrowing heavy loan for input purchases. It provides more local employment opportunities.

Organic agriculture as a stimulus for social change and demonstrates how producers, consumers and governments are actively involved with the organic food supply chain. The organic agriculture puts an absolute ban on chemicals and uses instead a wide range of natural methods for plant protection. Organic farming seeks balance and harmony among the various insects. Additionally organic farming strives to maintain and enhance the soil fertility through crop rotation and composting. In a healthier soil crops suffer less from drought, which directly influences farmers income and thus their level of independence versus debt. There is a noticeable improvement in the farmers income by adopting the organic farming system. The reason for this could be the use of locally available FYM, self prepared vermicompost, which reduces the purchase cost on chemical fertilizers. The use of low-cost pest control methods also drastically reduces the total cost of production. This will result in the improved income of the farmers.

Ecology and social development go hand in hand, especially in developing countries. Ecological improvements and organic agriculture benefit (small) farmers first and foremost.

Quality of organically produced food

There is a growing demand for organic foods driven primarily by the consumer's perceptions of the quality and safety of these foods and to the positive environmental impact of organic agriculture practices. The "organic" label is not a health claim, it is a process claim. It has been demonstrated that organically produced foods have lower levels of pesticides and veterinary drug residues and in many cases lower nitrate contents. No clear trends have, however, been established in terms of organoleptic quality differences between organically and conventionally grown foods (Ramesh *et al*, 2005). The organic foods must meet the same quality and safety standards applied to conventional foods. These include the **CODEX** General Principles Food Hygiene and Food Safety Programmes based on the Hazard Analysis and Critical Control Point (FAO, 1999). Analysis of pesticide residues in produce in the US and Europe has shown that the organic products have significantly lower pesticide residues than conventional products (Woese *et al*, 1997). Nitrates are significant contaminants of foods, generally associated with the intensive use of nitrogen fertilizers. The studies that compared nitrate contents of organic and conventional products found significantly higher nitrates in conventional products.

Total dependance on insecticides for pest control in most of the developing countries has resulted in certain ecological and economic imbalances with grave consequences to crop production, human health and environmental quality (Biju, 2001). In organic farming systems pest control strategies are largely preventive, rather than reactive. The balance of cropped and uncropped areas, crop species and variety choice, and the temporal and spatial pattern of crop rotation seek to maintain a diverse population of pests and their natural enemies and disrupt the life cycle of pest species. The highly structured systems of organisms have been observed in organically managed crops maintaining a balance between pest and beneficial species; greater abundance and diversity in the arthropod community is generally reported in organic farming systems (Basedow, 1995; Berry *et al.*,1996 and Stockdale *et al.*, 2001)

Organic farm holidays

Ecological tourism to organic farms is a tool to help small farmers to earn additional income and in this way support the transition from conventional agriculture to organic agriculture. Moreover, the farms that offer tourism holidays have the opportunity to sell their products thoroughly to the consumer avoiding often expensive intermediaries.

Socio economic development of women

The utilization of earthworms for vermicompost production is one of the important component of Organic farming. Vermicompost is high grade organic manure containing vital plant macro and micronutrient besides plant growth promoting substances. The main source for production of vermicompost for organic farming is the agriculture wastes, kitchen wastes and farm yard manures, Vermitechnology can be practiced by the farm women by utilizing the agricultural and kitchen wastes in the backyard of their houses. After fulfilling their own vermicompost needs of the farms, they can sell the nutrient rich vermicompost to other farmers thereby getting extra income, improvement in the economic condition and reduced cost of cultivation. This will act as a motivational factor and will drive neighboring womenfolk to adopt organic farming.

Economics of organic farming

The replacement of external inputs by farm-derived resources normally leads to a reduction in variable input costs under organic management. The expenditure on fertilizers and sprays is substantially lower than in conventional systems in almost all the cases. In few cases, a higher input costs due to the purchase of compost and other organic manure have been reported. The studies have shown that the common organic agricultural combination of lower input costs and favourable price premiums can offset reduced yields and make organic farms equally or often more profitable than conventional farms.

In temperate zones, where conventional agriculture manages to produce very high yields, conversion to organic farming usually results in lower yields (10 to 50% lower), depending on the crops and farming system. Many farmers in tropical smallholder farms, however, report that their yields returned to the previous level after the conversion process was complete, and some even achieved higher yields than with conventional agriculture.

Returns depend not only on the yield attributes, but also on the price achieved in the market. If the quality of the product decreases after conversion to organic farming because of more damages due to pests or diseases, it may be difficult to sell the harvest at the same rate as before. Many farmers, however, hope to get a premium price for their organic products once the farm is certified.

Additional crops can be integrated in the cropping system through the mixed cropping or crop rotations, thus using the available space more efficiently. Another option is to integrate animal husbandry in the farm for getting additional products.

Possibly, the greatest impact of organic agriculture is on the mindset of people. It uses traditional and indigenous farming knowledge, while introducing selected modern technologies to manage and enhance diversity, to incorporate biological principles and resources into farming systems, and to ecologically intensify agricultural production. Instead of being an obstacle to progress, the traditions may become an integral part of it. By adopting organic agriculture, the farmers are challenged to take on new knowledge and perspectives, and to innovate. This leads to an increased engagement in farming which can trigger greater opportunities for rural employment and economic upliftment. Thus through greater emphasis on use of local resources and self-reliance, conversion to organic agriculture definitely contributes to the empowerment of farmers and local communities.

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Social aspects and challenges of organic farming

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The green revolution has increased agriculture production substantially, but also led to several new challenges like decline in productivity, degradation of soil and water resources, diminishing biodiversity, increase in environmental pollution, increased costs of production, which are challenging the sustainability of conventional agricultural production at high levels (Balak Ram, 2003). The food produced in villages was transported and consumed in cities. Thus, nutrients used for production in villages were not returned to village soil, but lost as city waste. This is not tenable in future as nutrients are limited. Increasing soil costs would increase transport cost and ultimately food cost. As the technology was money intensive, it also had its social implications (Yadav, 2006). Under such situation, the organic farming has assumed paramount importance for improving the productivity of crops and soil fertility. In its simplistic form, organic agriculture may be defined as a kind of crops and livestock are managed through use of integrated technologies with preference to depend on the resources available either at farm or locally. It emphasizes more on optimizing the yield potential of crops and livestock under given set of farming conditions rather than maximization.

Rise of organic farming

The popularity of organic farming is gradually increasing and now it is practiced in almost all countries of the world, and its share in agricultural land is growing. As per a recent report of International Federation of Organic Agriculture Movements (IFOAM), the total organically managed area is more than 24 million hectares world wide. The countries with the largest areas of organic farmland are Australia, Argentina, Italy, Canada and USA.

Social aspects and benefits arising from organic farming

Sustainable agriculture must be both ecologically and socially sustainable. The organic farming is socially sustainable when its techniques are embedded in a social organization. Basically organic farming is based on the principles of inter dependency, diversity, recycling and proximity (Altieri, 1987 and Lampkin, 1990. We will have to recycle farm wastes i.e. promote RURALIZATION. Following are the social benefits arising from organic farming:

1. Impact on employment

The substitution of chemical inputs in organic agriculture generally results in higher demand of labour in comparison with conventional agriculture and therefore, should contribute to rural employment and help keep in business small farms, which would otherwise not be able to cope with intensification and global competition (Marino etal, 1997). In general, labour use, whether in farm hours or full-time labour units, is generally higher on organic farms than on their equivalent conventional farms. Other studies observe that labour is expected to be higher in organic farming primarily due to the manual and mechanical work on weed crops. Preparing products for home and market sale also need more labour on organic farm.

2. Livelihood opportunities

One of the serious problems in dryland areas is the lack of sufficient food security and lack of economic opportunity for many people who live there. The population in these dryland areas is currently growing at a rate of 2.8 % per year.

Under the current agril. practices, many dryland farmers are unable to earn a year-round livelihood in their own villages. Since organic farming is labour intensive and relies on local inputs, it can provide both improved local food security and ample opportunities for local employment and proper utilization of this precious human resource (Gupta and Sharma, 1996).

3. Empowerment of farmers

Possibly, the greatest impact of organic farming is on the mindset of people. It uses traditional and indigenous farming knowledge, while introducing selected modern technologies to manage and enhance diversity, to incorporate biological principles and resources into farming systems, and to ecologically intensify agricultural production. Instead of being an obstacle to progress, traditions may become an integral part of it. By adopting organic agriculture, farmers are challenged to take on a new knowledge and perspectives and to innovate.

4. Support to local and regional economies

Organic farming and integrated farming also represent real opportunities on several levels, contributing to rural economies through sustainable development. Indeed, new employment opportunities in farming, processing and related services are already evident in the growth of organic sector. As well as the environmental advantages, these farming systems can bring significant benefits both to the economy and to the social cohesion of rural areas.

5. Organic farm holidays

Italy has about 400 organic farms, offering environmental friendly holidays. They range from a simple meal to weeklong stays, and may offer the possibility of joining in the farm work, or participating in traditional handicrafts workshops. They have set certifying standards on eco-tourism. The standards require organic holiday farms to comply with a set of rules that includes ecological practices and principles, and connection to the values of the local landscape and cultural heritage of a territory. The ecological tourism to organic farms is a tool to help small farmers to earn additional income which support the transition from conventional agriculture to organic agriculture. Moreover, the farms that offer tourism holidays have the opportunity to sell their products directly to the consumers avoiding expensive intermediaries.

6. Local marketing and Gender aspects

Organic farming encourages local marketing, thus it brings people together and establishes relationships between producers and consumers, which for the long term are beneficial and sustainable for both sides.

Prevailing attitudes to gender are very progressive in the organic movement giving women equal rights and respect.

7. Globalization

Organic farming can be seen as a positive kind of globalization, harmonized by the idea to serve people now and in future generations, as well as the environment.

The long term influence organic farming can have on trade depends on whether specific economic structures on the financial and company level are needed to make the trade more sustainable.

Thus organic farming aids rural development, which has a significant positive impact on the social revival.

Challenges before organic farming

Indian farmers use nearly Rs. 1.75 lakh crores per year on agro inputs like seed, fertilizer, pesticide etc. (Mehta, 2005). This suggests that there is certainly an ample scope for organic farming. But the organic farming has before it, several challenges, of which some of them are discussed below:

Issues related to soil fertility and agril. inputs

1. The food security, increasing the crop productivity and feeding the rising population is a major challenge today. For this purpose fertile soil is an important pre-requisite for sustainable organic farming. Improving the soil status is a major challenge before the farmers and scientists. A good fertile soil requires sufficient microbial count and active micro-organisms. The transition phase from the present farming to organic farming pose a vital challenge to the farmers. Another problem is that of pollution free irrigation to organic crops. Production of quality seed and planting material as per location and climatic conditions are needed. In the name of organic fertilizers, many times farmers end with adulterated fertilizers, which have no organic contents and quality. Thus, inadequate availability of different organic inputs, such as organic seeds, bio-fertilizers, bio-pesticides etc. pose a serious challenge before organic farming.
2. With regard to the social aspects, there are several challenges like risk i.e. fear of drop in productivity and income, patience, adoption of technology by late adopters, lack of conviction etc. for promoting the organic farming.
3. Pest control through organic means is another challenge in organic farming. Hence, research on natural plants which could be utilized for control of crop pests and diseases and their application, is needed from plant protection researchers.
4. Water stress and drought conditions are obstacles in organic farming. The interval and frequency of rainfall, particularly in dryland areas could hamper the progress of organic farming. Therefore, techniques like mulching with farm bio-mass should be popularized in water scarcity areas.
5. Lack of access to relevant knowledge and information on organic farming is another hurdle. This coupled with dearth of training facilities for organic farming and lack of coordination, linkages between scientists, farmers, planners on this issue lead to confusion on the mindset of farmers who are adopting organic practice.
6. The enormous amount of mandatory documentation involved in the process of inspection and certification of organic products, is cumbersome especially for illiterate and small farmers.
7. Difficulties in obtaining reliable information on domestic and international market for organic products (suppliers, prices, quality parameters etc.) is another obstacle in the growth of organic farming. Scattered markets for organic produce along with the price fluctuations undoubtedly hamper the producers.

Strategies for overcoming the challenges of organic farming

There is immense potential for adoption of organic farming in India. The socio-economic and ecological reasons also favour it. Many aspects which pose constraints for intensive agriculture system can be converted into opportunities for organic farming (Arora and Mohan, 1986). Following an appropriate strategies could certainly assist in encountering these problems:

1. Integrate efforts of supporting agencies

Several government agencies and NGOs are working individually to promote organic farming. This individual approach, however, may result either in lack of adequate funding or lack of adequate knowledge of organic farming and/or marketing techniques. Thus, there is a need for all related agencies to create integrated programmes, linking the technologies with financial institutions in order to effectively promote organic farming. Representatives from farmers organizations should also be involved in planning and implementation process.

2. Encourage decentralized input supply

Local decentralized production of all inputs for organic farming should be encouraged, so that local resources can be utilized, which will lead to village level employment. Locally produced inputs are also much less likely to be adulterated. All this organic input production should be legally categorized as cottage industry. Subsidies or micro-financing to help set up small scale input production units could be provided to village co-operatives and self help groups.

3. Increase public awareness and capacity building

The conferences, seminars and farmers fairs may be organized to raise awareness and encourage adoption of organic farming. Organic farmers' field schools may be established. Programmes demonstrating how to produce and manage organic inputs, may be started at the village level. Under the National Project on Organic Farming (NPOF), launched in 2004, sufficient provision has been made to train farmers for organic production and to develop model organic farms. The capacity building of extension personnel for promotion of organic farming is also required (Das, 2004).

4. Improving the hygienic conditions through proper methods

In general, farmers understand the importance of adding organic matter to soils, but the majorities apply undecomposed animal and crop wastes. This not only reduces the availability of nutrients to plants, but also invites several pests. It would be better to apply these materials after composting them (Durgude *et al.*, 1996). This would help reduce diseases and improve local sanitary conditions, which ultimately will improve the hygienic and health conditions at village level.

5. Promoting livestock keeping

Animal is an important component of organic farming. India produces about 1800 mmt of animal dung per annum. Hence, technologies to enrich the nutrient supply potential from manure are needed, through which this waste is converted into wealth, which can be efficiently utilized for organic farming. Hence, livestock keeping should be promoted. In addition to this, the ongoing research by ICAR institutes and SAUs on organic farming may be integrated and the studies on survey and scientific validation of traditional organic farming practices, use of locally available resources for production of manures and bio-pesticides is needed (Sharma, 2001).

6. Develop organic farming clusters of villages

Since the dryland areas are already an area of focus for governmental development programmes, based on watershed approach, clusters of villages established for such programmes (Khan, 2002) may be converted into organic clusters of villages by providing technical support. This will be cost-effective and make the eventual certification process of organic produce easier for these villages once the local organic produce market has been well established. The support structures may also be introduced for small farmers' group certification.

Conclusions

Thus, organic farming sustains itself with minimum human intervention and does not use inorganic fertilizers or pesticides. It is a kind of diversified agriculture, with the optimum use of local available resources. Looking to the social aspects of organic farming, it is undoubtedly socially sustainable. It has several social benefits like adoption of innovative methods, entrepreneurship development, employment opportunities and progressive gender attitudes, which aids rural development. It contributes to the empowerment of farmers and local communities. At the same time there are several challenges before organic farming. The transition phase, improving soil fertility, quality supply and adequate production of required organic inputs, relevant knowledge and information, inspection and certification process of organic produce and scattered organic markets are some of the challenges before organic farming. Hence, the strategies like integrated efforts of supporting agencies, micro-financing for organic input production, public awareness, developing organic farming cluster of villages and appropriate Govt. policies are required to overcome these challenges for promoting the organic farming.

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Session-XII
Plenary session
Recommendations

Inaugural Session

The inaugural session was chaired by Dr. S.N. Puri, Hon. Vice Chancellor, Central Agricultural University, Imphal. The Chief Guest for the inauguration function was Dr. S.A. Patil, Director, Indian Agricultural Research Institute, New Delhi. Dr. R.B. Deshmukh, Hon. Vice Chancellor, MPKV, Rahuri; Shri. Nanasaheb Patil, Principal Secretary, Agriculture, Govt. of Maharashtra; Dr. Krishna Lavekar, Commissioner, Agriculture, Pune; Dr. S.K. Dorge, Ex. Vice Chancellor, MPKV, Rahuri; Dr. A.G. Sawant and Dr. S.S. Magar, Ex. Vice Chancellors, Dr. BSKKV, Dapoli and Dr. R.P. Singh, Secretary, IAUA, New Delhi were the guest of honour for the inaugural function.

Dr. A.S. Jadhav, Dean, Faculty of Agriculture, MPKV, Rahuri welcomed the guests, delegates, faculty, students and media. Dr. R.P. Singh, Secretary, IAUA, New Delhi narrated the activities of the IAUA during this year. Dr. R.B. Deshmukh, Hon. Vice Chancellor, MPKV, Rahuri delivered the keynote address. He stressed the need for organic farming and also hoped that the deliberation and recommendation of this national symposium will be useful for formulating policies regarding organic farming at state as well as national level. Dr. Krishna Lavekar, Commissioner of Agriculture pointed out the role of organic matter for maintenance of soil health and suggested remedy for sustainable production. Shri. Nanasaheb Patil, Principal Secretary of Agriculture emphasized the need of strengthening horticulture, floriculture and dairy activities for the benefit of farming communities. Dr. S.A. Patil, Chief Guest and Director, IARI suggested that the integrated nutrient management approach be adopted for sustainable production. Farmer's participatory approach be strengthened and experiences of the farmers be considered while formulating the policies on organic farming. It is necessary to document the success stories of the farmers dealing with organic farming under different agro ecological conditions. There should be an independent project in each SAU dealing with the issues of organic farming. Dr. S.N. Puri, Chairperson of the Programme and Vice Chancellor, CAU, Imphal expressed the concern about availability of the markets for organic produce. He also pointed out that North-Eastern states are declared by the Central Government as organic states. He suggested that rules, regulations and policies for certification of organic products should be easy and at an affordable cost. Dr. C.B. Gaikwad proposed the vote of thanks at the end of the session.

Session–I

"Organic farming and natural resource management"

Chairman : Dr. S. S. Magar
Ex-Vice Chancellor, Dr. BSKKV, Dapoli

Co-Chairman : Dr. V. B. Mehta
Vice Chancellor, Dr. BSKKV, Dapoli

Raporteurs : Dr. A. S. Jadhav
Dean F/A, MPKV, Rahuri
Dr. A. L. Pharande,
Head, Department of Soil Science and Agril. Chemistry,
MPKV, Rahuri

There were four papers presented in Technical Session I. The keynote paper was presented by Dr.A.S.Jadhav, Dean, Faculty of Agriculture, MPKV, Rahuri on "Organic Farming in the past, its relevance in present and future agriculture." In his presentation, he focused on the issues and the need of organic farming and explained the components and constraints in organic farming. Dr. Jadhav reviewed in detail the data base of organic farming activated in past, the present status at international level with special reference to India along with future thrust areas of organic farming.

Prof. D.D. Pawar, Head, Department of Inter Faculty and Water Management, MPKV, Rahuri presented the paper on "Water management in organic farming". He explained the scientific, judicious and efficient use of water resources for conservation of vital resources, and to attain the sustainable crop production. He also focused the data base on utility of micro irrigation and fertigation modules in organic farming. He suggested the use of vermiwash through drip irrigation as a viable option to enhance soil biological fertility and to reduce the adverse effect of soil salinity and sodicity on plant growth. He narrated the significance of organic mulches for soil and water conservation and for improvement of soil tilth. The paper was discussed at length.

Dr. A.L. Pharande, Head, Department of Soil Science and Agricultural Chemistry, MPKV, Rahuri presented the paper on "Soil resources and organic farming". He presented the data on soil resource of India, its distribution, characteristics, constraints and the extent of land degradation. He also narrated the suitable soil groups for organic farming and different edaphic factors influenced by organic farming. He discussed the role of soil organic carbon, their interactive effect on soil quality parameters and dynamics of organic 'C' pools. He stressed the need to have appropriate crop, land and water management practices to improve the soil organic carbon through carbon sequestration.

Dr. R. N. Sabale, Associate Dean, College of Agriculture Pune presented his paper on "Organic Farming in relation to climate change". He explained the natural and anthropolic factors, which are responsible for global warming due to green house gases and its effect on soil moisture storage, soil temperature and crop performance.

The Chairman and Co-Chairman gave their critical and constructive remarks on each presentation and concluded the technical session – I with a vote of thanks.
Following recommendations were emerged from discussion :

1. For achieving optimum productivity and to meet the nutrient requirement for organic crops, full package of practices specifically manurial schedules based on agro-ecological regions be developed for organic farming system which shows improvement in physico-chemical and biological properties of soil and helps to enhance the soil resource quality.
2. It is necessary to formulate rules, regulations and policies for organic produce certification at an affordable cost in conformity with international standards.
3. The development of suitable crop, land and water management practices based on agro-ecological regions of India are essential for improving soil organic carbon status of soil.
4. The micro-irrigation systems (MIS) have definite advantage in organic farming, which not only save water and improve the soil health but also enable us to apply optimum water at frequent interval as per requirement of crops. Moreover, the application of liquid organic nutrients through fertigation is possible for improving the nutrient use efficiency and to achieve optimum crop production with better quality of crop produce.
5. The practice of minimum tillage, crop cover and mulching be practised for arresting the land degradation and efficient soil water conservation.
6. There is a need to develop long range, location specific rainfall and temperature forecasting models to develop disease and pest forewarning model for different agro-ecological regions of India.

Session-II

"Recycling of crop residues and animal waste for organic farming"

Chairman : Dr. Sushil Kumar, Director, NDRI, Karnal.

Co-chairman : Dr. B. Venketshwaralu, Head of the Division and CPI (NAIP), CRIDA, Hyderabad

Rapporteurs : Dr. S.S. Mehetre, Director of Research, MPKV, Rahuri.
Dr. A.G. Wani, Chief Agronomist, CSRP, MPKV, Rahuri

The Chairman, Dr. Sushilkumar narrated the importance of livestock in organic farming. The following four papers were presented :

1. Organic farming in rainfed agriculture : Prospects and limitations {Dr. B. Venketshwaralu, CRIDA, Hyderabad}.
2. Synergies between livestock of production and organic farming {Dr. Sushil Kumar, Director, NDRI, Karnal}.
3. Recycling of organic wastes for organic farming {Dr. S.W. Jadhav, Bacteriologist, College of Agriculture, Pune}.
4. Production technology of phospho-manures and its effect on the cropping system {Dr. R.N. Sabale, Associate Dean, College of Agriculture, Pune}.

Following recommendations were emerged from discussion :

1. Organic crop and livestock farming need to be integrated.
2. Soil and water conservation practices should be integrated for sustainable organic farming
3. The research is needed for generating the validated field data on production packages and viability in organic dairy - comparative animal performance, animal health, milk quality, recycling of nutrients (soil - plant - animal - milk) and cost of production.
4. The crop residues of plantation crops, sugarcane trash, animal and other solid waste from restaurants are useful for organic farming.
5. Region specific strategy should be formulated for production of organic inputs.
6. Overcoming the constraints of certification procedure and the costs of organic produce.

Session-III :

"Transgenic crops and environmental aspects of organic farming"

Chairman : Dr. S.A. Patil, Director, IARI, New Delhi.

Rapporteurs : Dr. S.S. Mehetre, Director of Research, MPKV, Rahuri.

Dr. R.W. Bharud, Head, Department of Botany, MPKV, Rahuri

There were two lead papers for the presentation during the session. Dr. S.A. Patil, Director, IARI, New Delhi presented a key note paper on genetically modified crops and organic farming. In his presentation he narrated the situation of population increase and pointed out that India and China consist of 38 % World's population and hence the requirement of food grains will be higher in this area as compared to other parts of the world. This challenge can be met through the growing of genetically modified crops. The status of genetically modified crops (area and production) countrywise was presented. The situation of Bt cotton in India during 2002-06 was highlighted and benefits of genetically modified crops including Bt was also highlighted. Dr. S.S. Mehetre, Director of Research, MPKV, Rahuri presented the paper on environmental aspects of organic farming.

Following suggestions / recommendations were made.

1. The use of transgenic crops containing pest resistant genes should be used to reduce the toxic chemicals in environment.
2. Vegetable crops should be grown under organic farming as very high levels of pesticide residues are observed in fruits and vegetables.
3. Co-existence of genetically modified crops and organic farming needs to be clarified by the organic certification organization as it is stated that wide ranging cultivation of genetically modified crops in an area of Organic farms will loose their organic status and face severe problems to grow their crops according to their regulations.
4. The use of protective safety zones around organic feed is recommended for reducing the risk of genetically modified pollen dispersal.
5. Research and modelling of crop specific requirements should be worked out.
6. For environmental protection, agro-ecosystem and conservation of nature, conversion of conventional farming into organic agriculture should be encouraged.
7. Conventional products contain higher nitrates due to use of high nitrogenous fertilizers and hence the chemical fertilizers need to be replaced by organics.
8. The rainfed and hilly regions provide opportunities for organic farming due to the least utilization of chemical inputs and hence organic farming needs to be promoted in this area on large scale.
9. Sugar factory waste can be converted by microbial decomposition into nutrient enriched organic fertilizers.
10. The influence of environment and farming system needs to be separated by systematic research.

Session-IV :

"Crop production through organic resources"

Chairman : Dr. S.N. Puri, Vice Chancellor, CAU, Imphal

Co-Chairman : Dr. Dilip Kumar, Director, Central Inland Fishery Institute, Mumbai

Rapporteurs : Dr. R.N. Sabale, Associate Dean, AC, Pune
Dr. A.G. Chandele, Head, Department of Entomology, MPKV, Rahuri

Dr. P. V. Wani presented paper on Biofertilizers – an essential component of organic farming, emphasizing that organic content of soil plays an important role in enhancing the microbial activity and there is necessity of microbial cultures for nitrification, micronutrient mobilization, phospho-solubilization, etc. The present bio-fertilizer production in Maharashtra is sufficient to cover 10 % area, and there is a good scope for establishment of bio-fertilizer units.

Dr. J.R. Kadam, I/c Bio-control Laboratory, MPKV, Rahuri has given brief account of various bio-agents and bio-pesticides used for management of insect pests. He explained the production strategies of different bioagents including microbials in bio-control laboratory at Rahuri. He stressed on timely availability and quality parameters of bioagents / biopesticides, which are the major constraints. Further, he stressed that the location specific requirement of bioagents needs to be worked out and accordingly the mass production units of bioagents needs to be established with the help of co-operatives, NGOs, private entrepreneurs.

Dr. C.B. Gaikwad presented paper on Nutrient management for organic farming. Organic farming practices are depend upon the limited scientific research and the extensive practical experiences by farmers. He stressed the need of crop diversification, careful soil management, crop rotation and green manuring. Residual effect of preceding crops is important for efficient and sustainable nutrient management. According to him, the influence of organics *viz.*, Jeevamrut, Bijamrut and Vermiwash was found beneficial for increasing the yield of sorghum.

Dr. S.N.Puri, Vice Chancellor, CAU, Imphal, in his keynote address on Bio-pesticides and bio-agents for organic crop production brought out the importance of biological control of insect pests as the key in organic farming to curb the crop losses. There is a need to take further research to find out bio-control agents for pests. He emphasized that the quality products and timely availability are the major constraints. The fine tuning of production technologies by SAUs is necessary, so that it can readily be accepted by the private entrepreneurs. He suggested the need for provision of subsidy for bio-agents to promote their use. He also emphasized the need for effective transfer of technology for use of bio-agents by the farmers.

He informed the house that DBT is planning to establish 25 mobile bio-control advisory units in the country for the said purpose alongwith the equal number of bio-control production units to support the activity. He revealed that among the botanicals, only neem is being exploited, however, the use of other botanicals for the management of pests also needs to be researched. He suggested the need to simplify standards for bio-agents so that more entrepreneurs are encouraged to take up the production activities.

The following recommendations were emerged :

1. Fine tuning of bio-agent production technology be done to ensure its take-off by entrepreneurs.

2. Subsidy for users of bio-agents and bio-pesticides to promote their use.
3. Simplification of standards for bio-agents and bio-pesticides to encourage the small entrepreneurs.
4. The Government may consider relief in excise duty for the import of *B. thuringiensis* (thuricides).
5. Research to find out new bio-agents and their mass production technology for soil borne pests be taken up.
6. Perfection of bio-fertilizer technology and its application is necessary to promote the use of bio-fertilizers by farmers as essential inputs.
7. Market tie-up by establishing the farmers' groups to work out the requirements before the season to ensure the availability in the market.

Session-V :

"Experiences in organic farming"

Chairman : Dr. R.B. Deshmukh, Vice Chancellor, MPKV, Rahuri

Co-Chairman : Dr. A.K. Yadav, Director, National Centre of Organic Farming, Gaziabad

Rapporteurs : Dr. P.G. Khalache, Head, Department of Agril. Extension, MPKV, Rahuri
Dr. V.S. Shirke, I/c Professsor, Agril. Extension, College of Agriculture, Pune.

In this session, there were farmers and officers of the NGOs and other institutes *viz.*, Shri. Namdeao Mali, Shri. Padmakar Chinchole, Shri. P.R. Chiplunkar, Shri. Dilip Deshmukh and Shri. Vikram Boke.

Following recommendations, suggestions and observations have been generated.

Shri. Namdeo Mali, who is practising organic farming specified with rearing local cows, use of FYM, Jeevamrut, non-application of chemical fertilizers and thereby getting good crop of banana, papaya, pulses, vegetables and other food crops. On the basis of his several years experience and experiments in organic farming, he suggested that -

1. the spray of urine, neem leaves pulp, butter milk is useful to protect the crop from disease and pests;
2. permitting proper sunlight and maintaining *wafsa* condition leads to better crop;
3. Organic produce has good demand and value in the market.
4. Enriching the soil fertility has prime importance in organic farming.

Shri. Padmakar Chinchole focused on the need of organic farming so as to make farming more sustainable. He appealed for production of farm literature having high readability level i.e. the use of simple words, short sentences in more understandable way.

Shri. P.R. Chiplunkar suggested that recycling of crop residue, rotational cropping, integrated use of organic and inorganic inputs are the important practices to be followed in organic farming. He also suggested that the process of composting should take place in the soil itself. Providing food for micro-organisms in the soil is more important rather than mere existence of strains of micro-organisms.

Shri. Dilip Deshmukh suggested that there is need to strengthen the small and marginal farmers, which is a prime need of the time. He stressed that every farmer should produce their own organic manures.

Shri. Vikram Boke, President of Maharashtra Organic Farming Federation, Pune emphasized the situation of farmers in the country with respect to the need and the role of organic farming. He appealed for imparting need based and the applied knowledge with demonstrating models of organic farming to the location. specific farmers so as to make their farming more sustainable.

Dr. A.K. Yadav, Director, NCOF presented the keynote paper on Scenario of organic farming. He focused on status, opportunities, export, domestic market, Govt. policies, issues, national projects, financial provisions, etc. related to the organic farming at Indian scenario and has made following recommendations.

1. The organic farming is equally sustainable.
2. Integrating animal components with crop, crop rotation, use of crop residues as manure is a pre-requisite for organic farming.
3. The sufficient knowledge and proper utilization of resources is a key for organic farming.

Session-VI :

"Organic farming for horticultural crops"

Chairman : Dr. D.P. Ray, Vice-Chancellor, OUA &T, Bhubaneswar.

Reporters : Dr. R. S. Patil, Head, Department of Horticulture, MPKV, Rahuri.
Dr. S. D. Warade, I/c Principal and Professor, College of Horticulture, Pune.

Dr. Ray presented key note paper on *In situ* organic farming for horticultural and medicinal crops. During his presentation, he narrated that most of the horticultural crops are organically grown in the country with certain exceptions. He reviewed increased potential of organic produce in international markets and emphasized management of soil health and plant protection.

Further papers on organic cultivation of fruits, vegetables and floriculture crops were presented by Dr. R.S. Patil and Dr. S.B. Gurav.

After thorough discussion, following recommendations were made:

1. Taskforce on organic farming technologies is to be formed to formulate the future guidelines on organic farming.
2. The following horticultural crops are proposed for organic farming on priority-
   a. **Fruits** : Arid zone fruits like custard apple, anola, jamun, tamarind and local ber, irrigated fruit crops like guava, mango, sapota, banana, pineapple and jackfruit.
   b. **Vegetables and spices** : Turmeric, ginger, cucurbitaceous crops, colocasia and drumstick.
   c. **Flowers** : Gladiolus, tuberose, lilies, jasmine, aster and marigold.
   d. Medicinal plants.

   The following horticultural crops are sensitive for organic farming and research efforts are required for integrated plant protection management to keep the residual levels below the detectable limits:-
   a. Fruits : Grapes, pomegranate, citrus and papaya.
   b. Vegetables : Solanaceous and cole crops, okra and onion.
   c. Flowers : Rose, gerbera, chrysanthemum, etc.
3. The standardization of combination of organic manure with concentrates and biofertilizers to replace the present recommended dose of fertilizer in different horticultural crops.
4. Strengthening of research on development of resistant varieties along with the identification of suitable rootstocks for biotic and abiotic stresses.
5. The extensive use of organic mulch alongwith organic herbicides should be encouraged.
6. The organic cultivation of horticultural crops should be undertaken under recommended soil and climatic conditions for better quality, yield and to minimize the pathogenecity.
7. Water management should be judiciously followed.
8. The post harvest handling especially for ripening and processing should be promoted with natural ripening hormones and organic preservatives, respectively.
9. The quality standards for organic inputs and products need to be formulated to meet the requirement of importing countries.
10. By considering lower initial yields, perishable nature and lower shelf life, premium prices and well-equipped marketing infrastructural facilities should be made available.

Session-VII :

"Processing technology for organic foods"

Chairman : Dr. S.S. Kadam, Vice Chanceller, MAU, Parbhani

Rapporteurs : Dr. H.G. More, Associate Dean, Dr. A.S.College of Agril. Engineering, MPKV, Rahuri.
Prof. V.L. Kanawade, Associate Professor, Dr. A.S.College of Agril. Engineering, MPKV, Rahuri.

During this session two papers were presented. Dr. S.S. Thorat, Associate Prof., MAU, Parbhani, presented his paper on Processing technology for future organic foods. In his presentation, he narrated the number of hazards with respect to food, toxic substances like synthetic agrochemicals, environmental pollutants, animal feed contaminants, drugs, natural plant toxins, pathogenic microbes, additives and microbial toxics. He also mentioned about the sources of contamination, spoilage, invisible chemical hazards, visible biological hazards and physical hazards. The details of the processing methods, food safety standards, certification, principles of organic food processing, opportunities in processing and hurdles in processing technology were discussed. If proper care is taken during the processing, it will protect health, environment, preserve bio-diversity and promote healthier habits.

Dr. S.V. Munjal, Head, Department of Food Science, MPKV, Rahuri presented paper on Organic farming influencing food safety and quality. He discussed about the concept of organic farming and organically produced food. He also stated that organically produced and processed foods are safe, nutritious and enjoyable. The present status of organic foods and the steps in processing organic foods, the benefits of organically produced and processed foods, cost, environment and quality were discussed.

Dr. S.S. Kadam, Chairman in his concluding remarks stated that the two papers presented have given glimpses on some aspects of the organic food processing. He emphasized the need of indepth research on processing and improving the quality of food. He further mentioned that the accumulation of nitrates in plants is due to the chemical fertilizers which are toxic. Therefore, more information needs to be generated on this aspect.

Session-VIII :

"Organic dairy farming"

Chairman : Dr. Sushil Kumar, Director, NDRI, Karnal

Repporteurs : Dr. S.M.Pokharkar, Associate Dean,
Lower Agril. Education, MPKV, Rahuri
Dr. B.R.Ulmek, Associate Dean,
College of Agriculture, Dhule

The paper on organic dairy farming was presented by Dr. B.R. Ulmek, Associate Dean, College of Agriculture, Dhule and the paper on production of organic milk and milk products was presented by Dr. J.N. Khedkar, Associate Professor, Animal Science and Dairy Science, MPKV, Rahuri.

After a thorough discussion, following recommendations were made :

1. Organic dairy farming has quite good scope in our country being small holder's low input, crop residue/ fodder based production system contributing 70 % of total milk produced.
2. In order to tap the organic milk produced in interior rural area the cooperative organization should come forward for certifying, procurement, processing and marketing of organic milk.
3. The dairy farming can play a crucial role in transforming the conventional farming to organic farming at a faster pace by efficient utilization of animal wastes.

Session–IX

"Microbial technology in relation to organic farming"

Chairman : Dr. S. S. Baghel, Vice-Chancellor,
Assam Agril. University, Johrat

Co-Chairman : Dr. J. H. Kulkarni, Vice-Chancellor,
University of Agril. Sciences, Dharwad

Raporteurs : Dr. D. M. Sawant,
Associate Dean, College of Agriculture, Kolhapur
Dr. S. G. Borkar,
Head, Department of Plant Pathology and Microbiology,
MPKV, Rahuri

Two papers were presented in this session.

i. Role of microbes for efficient organic farming – Dr. S. S. Baghel.
ii. Microbial technology in relation to organic farming – Dr. J. H. Kulkarni.

In these papers, the speakers pointed out the need for organic farming, which is mainly due to loss in productivity and negative balance of nutrients in soil. They also emphasized the need for increasing production of food grain at least by 50% in next 15-20 years *vis-à-vis* improve the soil health and productivity. They enumerated the role of soil microbes in the soil and soil environments. The role of P solubilizers/cellular/organic waste decomposing microbes, protein mineralizers, plant growth promoting microbes, N fixer like BGA, Azolla, earthworm were dealt in detail along with the carbon cycle, nitrogen cycle, organic residues decomposer, etc.

Various types of microbes in soils with their population and impact of this population on soil health were stressed. It was said that soil biological populations are improved with organic source. Organics own the basic requirement for soil microbes and thus to maintain the soil health.

The role of microbes as biological agents were also stressed upon. Role of microbes in biodegradation of pesticide residues were indicated. The Co-chairman emphasized that micro-organisms are the wheels of organic farming and source of nutrient balance without any loss through mobilization and immobilization. Improving the organic carbon in tropical soil is difficult but the organic farming is a tool for a success.

Following issues were emerged :

1. Screening of carriers to retain efficiency of microbial cultures.
2. Quality assurance of bio-fertilizers.
3. Awareness not only at farmers' but also of all stakeholders level including policy makers.
4. Harmony in application of organic and inorganic.
5. Packaging of 'N' fertilizer for long distance transport without adversely affecting the quality.

Task Ahead:

1. Identification of more efficient stain of microbes.
2. Identification of high temperature tolerant stains of EM.
3. Enrichment of organic with EM.
4. Production of more bio-fertilizers for distribution.
5. Identification of more efficient strains of bio-pesticides.

The lectures were ended with following querries :

1. Drumstick leaves increases earthworm population, which needs experimentation

2. *Melilotus alba* weed has big size nodulation which can be used as green manure crop- instead of dhaincha. Microbes isolated from these nodules do not work true-to-type.

Following recommendations were made :

1. Identify more efficient strains of EM.
2. Enrich the compost with EM for better soil health and productivity.
3. Quality assurance of bio-fertilizers and organic inputs must be regularly varified and maintained.
4. Production of more organic input at on-farm and their use in an integrated manner with best minimum inorganic.
5. Study the biodiversity in microbes in relation to organic farming.

Session-X :

"Quality, certification and marketing of organic inputs and products"

Chairman	:	Dr. R.C. Maheshwari, Vice Chancellor, SKDAU, Dantiwada, Gujarat
Co-Chairman	:	Prof. M.C. Varshneya, Vice Chancellor, Anand Agril. University, Gujarat.
Rapporteurs	:	Dr. A.S. Jadhav, Dean, F/A, MPKV, Rahuri. Dr. D.B. Yadav, Head, Department of Agril. Economics, MPKV, Rahuri.

In all, four papers were presented under this sub-theme.

The paper on Quality of organic inputs and their standards for organic farming was presetned Dr. Talashilkar, Professor of Soil Science and Agril. Chemistry, Dr. BSKKV, Dapoli and elaborated the need for adaptation of the standards for organic goods. The farmers should be made aware of the producing products in the organic manner. There is need for developing standards for promoting organic farming, nationally and internationally.

Shri. Sanjay Deshmukh in his paper on Quality certification of organic inputs and products have mentioned that there is an increased awareness amongst the farmers and consumers of organic products. There is a vast potential for exploring the market for organic products domastically and internationally. There is a need for a nationwide programme for organic production, quality inputs processing and its certification.

The paper on Economics of production and marketing of organic products was presented by Dr. D.B. Yadav, Head, Department of Agril. Economics, MPKV, Rahuri stated that the organic farming has a potential as a agri-business. The initial yield aberrations can be compensated through price premiums. India has a wide potential for export of organic products. The better off families are willing to purchase with a price premium of 10-30 per cent. There is need for rationalization of certification of organic products. Appropriate measures for marketing of organic products and consumer orientation is necessary.

Paper presented by Prof. Varshneya M.C., Vice-Chancellor, AAU, Anand concluded that for healthy society, health environment and healthy production is a must. For better soils, water and air, organic farming needs to be promoted on large scale.

The following recommendations were emerged from the deliberations,

1. There is need for supply of organic inputs through the certified / authorised supplier.
2. There is need for rationalization of standards, simplification of procedures for promoting organic products nationally and internationally.
3. There is need for a nationwide programme for organic production, quality inputs, processing and the certification.
4. Appropriate measures for marketing of organic products needs to be followed.
5. Orientation of consumers for the use of organics will add further to the cause of promoting organics.

Session-XI :

"Social aspects of organic farming"

Chairman : Dr. C.R. Hazra, Vice-Chancellor, Indira Gandhi Agricultural University, Raipur.

Co- Chairman : Dr. V.K. Suri, Vice Chanellor, CS Azad University of Agriculture and Technology, Kanpur

Rapporteurs : Dr. K.D. Kokate, Director of Extension Education, MPKV, Rahuri

Dr. P.G. Kalache, Head, Department of Agril. Extension, MPKV, Rahuri

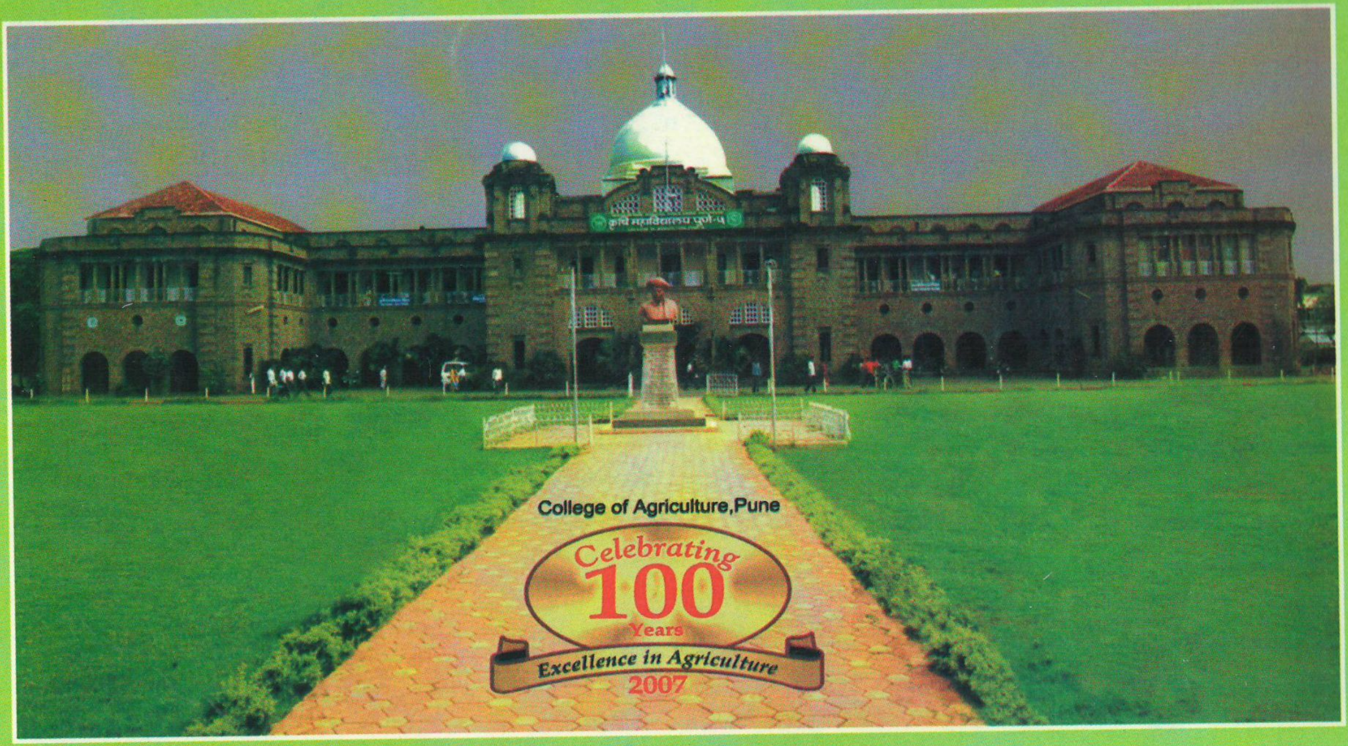
In this session one keynote paper on Indigenous technologies and its application challenges for organic farming by Dr. C.R. Hazra, VC, Indira Gandhi Agricultural University, Raipur and two invited papers on Scope of commercialization and its indigenous technology for organic farming by Dr. V.K. Suri, Vice-Chancellor, CS Azad University of Agriculture and Technology, Kanpur and Social aspects and challenges of organic farming by Dr. K.D. Kokate, Director of Extension Education, MPKV, Rahuri were presented.

After a good deal of discussions, the following recommendations were made :

1. The traditional agriculture in India was essentially organic and most of the tribal dominated districts/ states are still using less than 20 kg NPK/ha with little or no use of chemicals. Such area need to be exploited with on-farm recycling and utilization of inputs as default categories of organic farmers. These categories of farmers are socio-economically poor and having low literacy too. Under present system of organic certification for export purpose, such farmers will not real beneficiaries, rather middle traders will get the advantage of it. Therefore, there is need to develop organic farming standard/ norms at state level and also accredited the accreditation agencies for indigenous market. The big retailer shops culture is coming very fast in big cities and organic product sale based on good brand name provide future avenue for marketing.
2. In indigenous technologies, most of the practices such as preparation of compost by different methods, vermicompost by different methods, green manuring, crop rotation, residues management, pest management through cultural, mechanical, agronomical and herbs extracts are well established and recommended practice of modern package of integrated crop production.
3. In the name of organic farming and indigenous technology, number of products are flooding in the market with unknown results and ingredient. Such off-farm product will increase the cost of cultivation, reduce faith of organic farming and encourage cheating to farmers. Such product should not be recommended. If it is really effective, the protocol should be advocated for on-farm preparation of products at farmers level to reduce the cost of cultivation.
4. Bulk of the energy requirement is met from fossil fuel. Fossil fuels if exploited at a limitless rate will be exhausted without renewal.
5. Future organic agriculture may not be the agriculture of 40's but may use new technology, varieties, newer ways of recycling of crop residues etc.
6. There is a need to strengthen bio-fertilizer resources especially with respect to identification of location specific strains of various beneficial soil microbes and converting them into microbial inoculant. Above strategy will have a special relevance to organic farming.
7. The use of micro-organism such as phosphate solubilization/ degradation of cellulose and lignin etc. should be advocated among the farmers.
8. State Agricultural Universities need to be recognized as certification agency for organic farming.

AUTHOR INDEX

Centenary Celebration



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