Status and Future Prospect of Organic Agriculture for Safe Food Security in SAARC Countries

SAARC

SAARC Agriculture Centre

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Editors

Dr. Muhammad Musa
Senior Program Specialist (Crops), SAC

Dr. S.M. Bokhtiar
Director, SAC

Dr. Tayan Raj Gurung
Senior Program Specialist (NRM), SAC

SAARC AGRICULTURE CENTRE

SAARC Agriculture Centre (SAC)
BARC Complex, Farmgate, Dhaka-1215, Bangladesh
Phone: +880-2-8115353, Fax: +880-2-9124596
PABX: + 880-2-8141655, 8141140, 9122808
Web: www.sac.org.bd

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Compiled and Edited by
Dr. Muhammad Musa, Senior Program Specialist (Crops), SAC, Dhaka, Bangladesh
Dr. S.M. Bokhtiar, Director, SAC, Dhaka, Bangladesh
Dr. Tayan Raj Gurung, Senior Program Specialist (NRM), SAC, Dhaka, Bangladesh

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Foreword

To provide food for all and in sufficient amount is not enough but to provide safer and healthy food is also imperative to build a healthy nation. Organic agriculture is considered to be a suitable agricultural production process to ensure harmonization between human welfare and sustainable development. It sustains the health of soils, ecosystems and people. Promotion and practice of organic farming is not only important for SAARC countries for maintaining safety of its environment and ecology, it is also important in the global organic market context. Global concern over use of chemicals in agriculture is also increasing. It is not likely to have an overnight conversion but a planned practical approach supported by research and development programmes is required to find specific solutions to the problems farmers are facing in pests diseases, weeds and soil fertility over years. This needs investment in human resources, technology development and sector support to stimulate the organic sector growth and give value to the organic products in the domestic and export markets. Apart from marketing advantage, safe food is also a key to healthy living which builds productive and happier citizens. It is quite obvious that the safe and sustainable farming practices like organic agriculture will ensure us safe and quality food. So, the time has come to focus on quality along with quantity; food security is not enough but we need safe food security.

To develop the organic agricultural sector in SAARC member countries, Governments of SAARC countries need to develop appropriate policies providing incentives for organic research and adoption. Besides support to the primary producers of organic products, there is a need for the regional countries to come together to develop a regional organic standard with common system of assessment and conformity to have a regional certificate that will enable organic products to flow from one country to another without barriers.

This book is based on the country status reports presented by professionals from six member countries (Bangladesh, Bhutan, India, Maldives, Nepal and Pakistan) in a consultation meeting organized by SAARC Agriculture Centre (SAC), Dhaka in collaboration with the National Organic Programme, DoA, MoAF, Bhutan during 26-27 August 2015. The regional initiative also generated a variety of recommendations which can be implemented by member countries. Summary and synthesis are also incorporated to provide a comprehensive picture of R&D progress and prospects in the field of organic agriculture in SAARC region.

I would like to acknowledge the contribution made by the focal point experts of SAARC member countries in preparing a comprehensive paper and participating in the consultation meeting. I personally hope that this publication will provide detail information on available resources and research activities related to organic agriculture in the SAARC region. I would welcome receiving feedbacks, comments and suggestions from readers for our future endeavours.

Dr. S. M. Bokhtiar
Director
SAARC Agriculture Centre, Dhaka

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Executive Summary

Agriculture in SAARC Countries

South Asia is the second most populated region in the world with 1.7 billion population, which is 24% of the world population. By 2050, the population of SAARC countries is predicted to be 4.3 billion (based on current rate of increase). The Food and Agriculture Organization (FAO) forecasts that global food production will need to increase by over 40% by 2030, and 70% by 2050. In addition, global demand for energy and water may be doubled by 2050 (Foresight, 2011). Although South Asia is one of the fastest growing economies (6% GDP growth rate per annum during 1990-2010), nearly half of the world's poor live in this region. Agriculture (crops, livestock, poultry and fisheries) continues to be the vital source of livelihood for 75% of its rural population. On an average, it contributes 21% to GDP and employs about 42% population. While agriculture in India, Pakistan, Bangladesh, and Sri Lanka contributes GDP ranging from 12 to 38% where it is rapidly transforming; agriculture in Afghanistan, Bhutan, Maldives, and Nepal adds 40% or more as their economy is mainly agriculture-based.

South Asia has demonstrated remarkable leap in food production between 1970s and 1990s which was particularly possible due to the introduction of high yielding varieties of wheat and rice and application of fertilizer, irrigation, good quality seed, and mechanization. It was so successful that it came to be widely known as Green Revolution. These technological innovations could not keep pace in alleviating poverty, hunger and malnutrition. The major challenges to achieving poverty free region are;

a. Population growth of 2% annually
b. One-third of population suffers from poverty and malnutrition
c. Declining land and water resources
d. Increasing soil salinity, drought and unavailability of irrigation water
e. Low productivity
f. Weak supply chain
g. Climate change impacts on agriculture and food production
h. People moving from rural livelihoods to cities

According to FAO, higher productivity holds key to fight against rural poverty. One of the major challenges of SAARC countries is to enhance agricultural productivity to feed the increasing population. In order to provide adequate food for all, there is no alternative but to develop crop varieties which have multiple resistance and capable of producing higher yield. The gains in food production provided by the “Green Revolution” have reached their ceiling while world population is continuously rising.

Agriculture remains the key sector for the economic development for most developing countries. It is critically important for ensuring food security, alleviating poverty and conserving the vital natural resources that the world's present and future generations will be entirely dependent upon for their survival and well-being.

Organic Agriculture in SAARC region

Organic farming was to be the principal farming method before "modern agriculture". After two World Wars, chemicals that were used as weapons were converted into fertilizers and pesticides for "peaceful" use. Rural people came to adopt "modern" technology in order to lessen workload while the societal base shifted from agriculture to manufacturing and services. Consequently, organic farming became marginal and regarded as old-fashioned and laborious technique with low productivity.

The conventional agriculture of SAARC countries after the green revolution depended on chemical compounds that had a negative impact on soil, human health and the environment. Increasing global concern over the use of chemicals in agriculture is behind a growing trend of using organic methods of agricultural production. Organic Agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects (IFAOM, 2005). It combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. It is considered to be a suitable agricultural production process to ensure harmonization between human welfare and sustainable development. According to USDA, it 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.

In today's terminology, it is a method of farming system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (bio-fertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment. Organic farming system relies on crop rotations, crop residues, animal manures, legumes, green manures, safe off-farm organic wastes and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and to control insects, weeds and other pests. In its simplistic form, organic agriculture may be defined as “a kind of diversified agriculture wherein crops and livestock are managed through use of integrated technologies with preference to depend on resources available either at farm or locally”.

However, organic agriculture is the outcome of theory and practice in the early 20th century involving combination of various production methods primarily in Europe, but also in the United States with 3 central movements: (i) Biodynamic agriculture, originated in Germany under the inspiration of Rudolf Steiner, (ii) Organic farming, initiated in England based on the theories developed by Albert Howard and (iii) Biological agriculture, which was build up in Switzerland by Hans-Peter Rusch and Hans Muller. Tate (1994) cited some giant personalities who inspired the movement: Rudolf Steiner from Austria, Hans Muller, the German-Swiss, Lady Eve Balfour in Britain; J.I Rodale in the United States; and Masanobu Fukuoka in Japan. Pioneers of the organic movement believed that healthy food produced healthy people and that healthy people were the basis for a healthy society.

In recent years, some organic agricultural technologies have proven to be effective and accepted by the farmers in SAARC region. These include integrated rice-duck farming practices, organic vegetable production in sack, pheromone-trap for insect control, compost (kitchen waste, vermin-compost, pile compost, basket compost) and so on.

Until now, however, a domestic market that pays for organically produced food has not emerged and SAARC countries have not been able to benefit from the growing global organic market. The Asian countries together currently account for only 7% of the total global organic land, China and India being major contributors. To develop the organic agricultural sector in SAARC member countries, the Governments need to develop appropriate policies providing incentives for organic research and adoption. Promotion and practice of organic farming is not only important for SAARC member countries for maintaining safety of its environment and ecology, it is also important in the global organic market context.

SAARC member countries being a major agro-based populated country, the global organic industry will benefit from its participation in the international organic market.

Overview of organic agriculture in the SAARC region

India has the largest number of producers and also the largest agricultural land used in organic production including wild collections (Table 1). However, Bhutan has the highest percentage share of organic market (1.21%) at global level. Essential oil of wild crafted lemon grass is certified in Bhutan, and exported to Europe. There is no organized census of organic land in Bangladesh, although many organizations claimed they are doing organic. Bangladesh Agricultural Research Institute (BARI) is the public research institute initiated research and development on 2006 by converting 3000 m^2 land under Olericulture Division of Horticulture Research Center. Moreover, BARI is developing three organic model villages where ten hectare land was converted to organic practices.

Table 1: Overview of Organic Agriculture (O.A.) in SAARC Region

Country	Share of World O.A. (%)	O.A. Land (ha)	Aquaculture Land (ha)	Wild Collections (ha)	Total O.A. (ha)	Organic Producers
Afghanistan	-	61	-	-	61	264
Bangladesh	-	68,660	9,338	-	77,998	9,337
Bhutan	1.21	6,156	-	15,605	21,761	-
India	0.28	500,000	-	4,700,000	5,200,000	600,000
Maldives	-	-	-	-	-	-
Nepal	0.12	10,273	-	24,422	34,695	247
Pakistan	-	22,397	-	-	22,397	105
Sri Lanka	0.75	19,517	-	-	19517	404

Organic cultivated area in SAARC region accounts for 0.627 m ha (11.66%) while 4.740 m ha (88.16%) is wild organic collection area (Fig. 1). Countries with regulations on organic agriculture fully implemented are Bhutan and India. Bangladesh, Pakistan and Nepal are in the process of drafting the organic agriculture regulations.

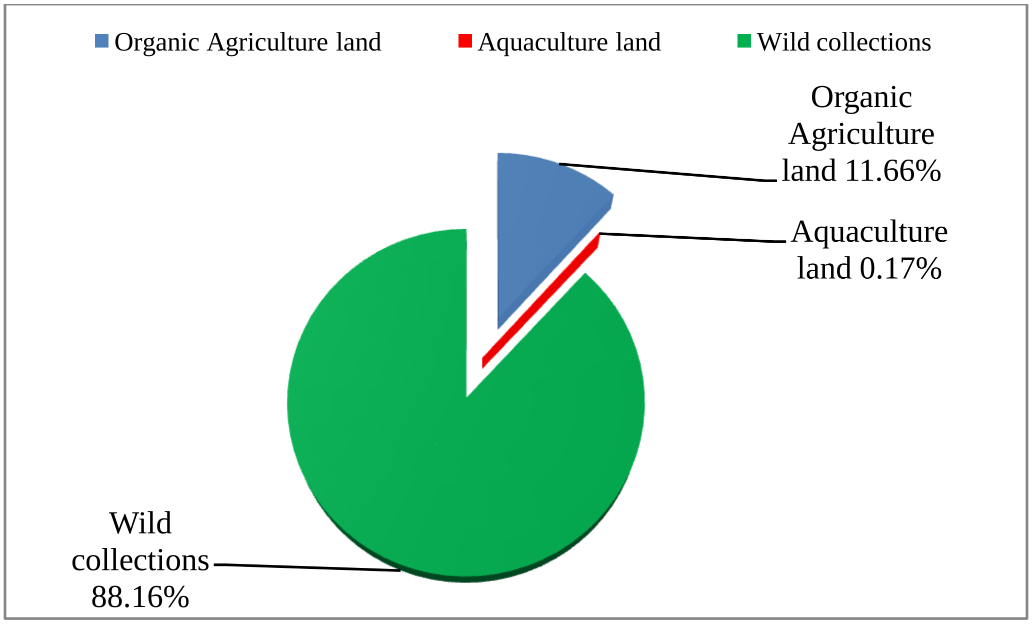


Fig. 1: Share of area under organic production in SAARC countries

Food safety concern and need

There is another growing concern called "food safety". The food available in the market must be safe and healthy. The excessive, uncontrolled use of chemical fertilizer, pesticides, GMO seeds, use of contaminated water in food production and processing, unhealthy processing of food, use of toxic colours in food, giving high antibiotic and growth hormone to our chicken, cows and goats, using formalin in fish, milk and fruits, using hazards chemicals to ripen fruits are very open and known food adulterations in our country. The consumers are panic and they are looking for safe food in affordable price.

The major challenges for agriculture in the region are to raise and sustain agriculture growth, and ensure food and nutrition security. Hunger Free World in SAARC region is promoting organic agriculture and a holistic lifestyle, sustainable with nature so that food production and harvesting system is present at grassroots. Only criticism will create panic but we need concrete actions on the ground as solution. If we take one bold step today, then gradually many others will join together. We need a paradigm shift towards the organic and sustainable agriculture and a holistic sustainable lifestyle.

Organic farming is environment friendly, sustainable, healthy and can reduce many existing challenges that our countries are currently facing like shortage of power and water contamination. Organic farming is not only a production method but it is a system that strengthens the social bondage and unity in a community. It restores the respect between men-women on equality.

It aims to increase household income from higher-value agricultural products sold in the market; improved nutrition due to higher-quality food consumed in the households; and a stronger base of agricultural and organizational knowledge and capabilities.

Food and nutrition security

The conventional agriculture focused merely on yield rise to meet growing food needs of increasing population, and paid little concerns to sustainable use of locally available both natural and human resources. This resulted in mere intensive use of agro-chemical inputs but a wide productivity gap between the best possible and the farm practice; agricultural lands continued to shrink, and farming system led to environmental degradation such as depletion of soil and soil fertility, decline in water availability and increase in different forms of pollution. At the same time, such practice upset both environmental resources and indigenous knowledge system rendering the agriculture system unsustainable. Realizing the facts, importance of organic farming is increasing, and the goal of agricultural development in many countries shifted from mere increased production and productivity to achieving sustainable and environment friendly production system.

Nutrition and livelihood are two factors that contribute significantly to an individual's health. Consumers world-wise are becoming health conscious and are concerned about nutrition. ACNielsen, recently surveyed about 21,000 regular Internet users in 38 countries to find their preference for functional foods – foods that have additional health benefits. A survey done by a leading market research firm revealed that India was among the top ten countries where health food, including organic food, was demanded by the consumers.

Benefits of Organic Agriculture

1. Ecological Sustainability

- Recycling nutrients instead of applying external inputs
- Preventing the chemical pollution of soil, water and air
- Promotion of biological diversity
- Improving soil fertility and the buildup of humus
- Preventing soil erosion and compaction
- Promoting the use of renewable energies

2. Social Sustainability

- Supporting sufficient production for subsistence and income earning for small farmers
- Providing safe and healthy food
- Supporting the adoption of good working conditions
- Building on local knowledge and traditions

3. Economic Sustainability

- Helping farmers achieve satisfactory and reliable yields
- Providing a lower reliance on and associated cost for external inputs
- Promoting crop diversification to improve income security
- Promoting product value addition through quality improvement and on-farm processing
- Promoting the adoption of efficient farming systems to improve overall profitability and competitiveness

Goals of organic agriculture

1. Employing long-term, ecological, systems-based organic management
2. Assuring long-term, biologically-based soil fertility

3. Avoiding/ minimizing synthetic inputs at all stages of the organic product chain and exposure of people and the environment to persistent, potentially harmful chemicals
4. Minimizing pollution and degradation of the production/ processing unit and surrounding environment from production/ processing activities
5. Excluding certain unproven, unnatural and harmful technologies from the system
6. Avoiding pollution from surrounding environment
7. Maintaining organic integrity throughout the supply chain
8. Providing organic identity in the supply chain

Principles of organic agriculture

The organic community has adopted four basic principles (FAO 2001/ IFOAM), and broadly speaking, any system using the methods of organic agriculture and being based on these principles, may be classified as organic agriculture.

Principles of Organic Agriculture	Description
Principle of Fairness	**Pillar 1: Sustainable and Equitable Socioeconomic Development** Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities. - Equity, respect and justice for all living things
Principle of Care	**Pillar 2: Preservation and Promotion of Cultural Values** Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and wellbeing of current and future generations and the environment.
Principle of Ecology	**Pillar 3: Preservation of Environment** Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them. - Emulating and sustaining natural systems
Principle of Health	**Pillar 4: Good Governance - Certification** Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. - Healthy soil, plants, animals, humans: a healthy planet

Objectives of organic farming

Principally, we need a high yielding, income generating, science-based, farmer-empowering and eco-friendly agriculture system that provides nutritional and food security first to small-holder farmers and eventually to the nation. Organic farming principles have all these features with major objectives as follows.

- Production of high quality food, fibre and other products in sufficient quantity in harmony with natural systems and cycles
- Enhancing biological/ natural cycles within the farming system involving microorganisms, soil flora and fauna, plants and animals in the entire production system
- To recognize the wider social and ecological impact of, and within the organic production and processing system
- To maintain and encourage agricultural and natural biodiversity on the farm and its surroundings through the use of sustainable production systems and the protection of plant and wildlife habitats
- To maintain and increase long-term fertility and biological activity of soils using locally adopted cultural, biological and mechanical methods as opposed to reliance on external inputs
- To maintain and conserve genetic diversity through attention to on-farm management of genetic resources
- To use, as far as possible, renewable resources in production and processing systems and avoid pollution and waste
- Promoting healthy use with proper care of water resources and all life therein
- To utilize biodegradable, recyclable and recycled packaging materials
- Creating harmonious balance between crop production and animal husbandry
- Minimizing all forms of pollution
- To provide everyone involved in organic farming and processing with a quality of life that satisfies their basic needs, within a safe, secure and healthy working environment

- To support the establishment of an entire production, processing and distribution chain which is both socially and ecologically responsible
- To recognize the importance of, and protect and learn from, indigenous knowledge and traditional farming systems

Components of organic farming

The farming system is the main component of organic farming, but the major trusty sector is crop which including crop rotation, maintenance and enhancement of soil fertility through biological nitrogen fixation, addition of organic manure and use of soil microorganisms, crop residues, bio-pesticide, biogas slurry, waste etc. Vermiculture has become a major component in biological farming, which is found to be effective in enhancing the soil fertility and producing large numbers of horticultural crops in a sustainable manner.

Essential components of organic farming are keeping the soil alive through effective management natural resources. They are as follows.

1. **Enrichment of soil**: Abandon use of chemicals, use crop residue as mulch, use organic and biological fertilizers, adopt crop rotation and multiple cropping, avoid excessive tilling and keep soil covered with green cover or biological mulch.

   a. Crop rotation

   b. Crop residue

   c. Organic manure
      - Bulky organic manure (FYM, Compost, Green Manuring)
      - Concentrated organic manure

   d. Waste
      - Industrial waste, Municipal and Sewage waste)

   e. Biofertilizers
      - Symbiotic N-fixation (Rhizobium)
      - Asymbiotic N-fixation (Azotobacter, Azospirillium, Blue Green Algae, Azolla, Mycorrhizae)

   f. Bio-pesticide

   g. Vermicompost

2. **Management of temperature**: Keep soil covered, plant trees and bushes on bund
3. **Conservation of soil and rain water:** Dig percolation tanks, maintain contour bunds in sloppy land and adopt contour row cultivation, dig farm ponds, maintain low height plantation on bunds
4. **Harvesting of sun energy:** Maintain green stand throughout the year through combination of different crops and plantation schedules
5. **Self-reliance in inputs:** Develop your own seed, on-farm production of compost, vermicompost, vermiwash, liquid manures and botanical extracts
6. **Maintenance of life forms**: Develop habitat for sustenance of life forms, never use pesticides and create enough diversity
7. **Integration of animals**: Animals are important components of organic management and not only provide animal products but also provide enough dung and urine for use in soil
8. **Use of renewable energy**: Use solar energy, bio-gas and other eco-friendly machines

Organic and inorganic sources of nutrients available in different SARRC countries

Organic Sources	Inorganic Sources
Farmyard manure	Urea
Poultry manure	DAP
Crop residues	NPK
Green manure	Nitrophas
Filter cake and silage	Ammonium Nitrate
Slaughter house waste	Ammonium Sulphate
Other solid and liquid based materials	SSP
Compost	TSP
Biogas compost/ slurry	MOP
Biofertilizer	SOP
City refuse	
Others (Rural, vermicompost and other agricultural wastes)	

Legal Framework and Policy of Organic Agriculture in SAARC Countries

1. Bangladesh

There is no separate policy for supporting organic farming in Bangladesh. The Agriculture Policy (1999) has no specific clause or agenda on organic farming. The government in its New Agricultural Extension Policy (NEAP) 1996 defined strategies to attain the prime objective of integrated environmental support. It defines that it would integrate environment into the overall agricultural policy to ensure a policy of sustainable agricultural development. The National Food Policy of 2006 is Bangladesh's main policy document on food security. Recently, cabinet approved the Safe Food Law 2013 to save the people from adulterated and contaminated food. Unfortunately, organic food production, distribution and marketing imposed restriction in this law.

During recent days, Bangladesh Agricultural Research Institute (BARI) initiated the Participatory Guarantee System (PGS) for authentications. It will add more value to the consumer and organic promotion as well. PROSHIKA and Unnyan Dhara created organic consumers group and selling their products directly to the farmers.

2. Bhutan

Bhutan has become globally well known as a country with goals to be 100% organic by 2020. Bhutan has an economic development policy (EDP, 2010) that targets to promote Bhutan with the organic image and brand Bhutan to be organic. The Ministry of Agriculture and Forests have a *"National Framework for Organic Farming in Bhutan"* that provides policy guidelines for organic sector development within the agriculture sector.

Organic regulation, national certification system or a certification body is not in place yet but there is an interim condition for exports of organic products. Currently, there is no regulation for domestic trade. Bhutan has a National standard that has been approved in principle, and is in the process of assessing it for Common Requirements of Organic Standards (COROS) with IFOAM for international equivalence. A local assurance system based on registration with the NOP is in the process of development, which is a modified form of PGS that is run and managed by the Ministry of Agriculture and Forests to enable domestic trading and link to exports for third party certification through registration with Bhutan Food and Agriculture Regulatory Authority (BAFRA) when required. Certification is voluntary for domestic trade by mandatory for exports. Certification for local assurance is planned to be free to growers and operators.

3. India

India's first internationally certified organic product emerged in the mid 70's, supported by UK's Soil Association. Currently, India ranks 10th among top ten countries having the cultivable land under organic certification. In terms of wild collection, India ranks 3rd next to Finland and Zambia. Around 6.50 lakhs producers are engaged in the country in various forms.

National Programme of Organic Production (NPOP) launched by the Ministry of Commerce during 2001 and National Project on Organic farming (NPOF) launched during 2004 by the Department of Agriculture and Cooperation, Ministry of Agriculture were the two milestones towards institutionalization of organic farming in the country. National Programme of Organic Production (NPOP) was initiated in the year 2000 to provide a focused and well directed development of organic agriculture and quality products under the Ministry of Commerce and Industry, Government of India which was formally notified in October 2001 under the Foreign Trade and Development Act (FTDR Act). It provides information on standards for organic production, systems criteria, and procedures for accreditation of inspection and certification bodies, the national organic logo and the regulations governing its use.

The standards and procedures have been formulated in harmony with international standards such as those of Codex and IFOAM. The NPOP provides an institutional mechanism for the implementation of National Standards for Organic Production, through a National Accreditation Policy and Program. National Accreditation Body (NAB) is the apex decision making body. Certification and inspection agencies accredited by NAB are authorized to undertake certification process. The NPOP notified under FTDR act and controlled by Agricultural Processed Foods Export Development Authority (APEDA) looks after the requirement of export while Organic Agricultural Produce Grading and Marking Rules, 2009 notified under Agricultural Produce (Grading & Marking) act, 1937 controlled by Agriculture Marketing Advisor, Directorate of marketing and inspection looks after domestic certification. Efforts are on to have NPOP standards to be included under the Food Safety and Standards Act, 2006. In 2006, India's organic certification process under NPOP has been granted equivalence with European Union and Switzerland. The Bureau of Indian Standards is under process of developing domestic standards for organic farming in consultation with ICAR, APEDA, MoA, QCI, FSSAI and SAUs.

4. Maldives

Maldives fresh food market is heavily dependent on imported goods. That is why no emphasis has been given on drafting of organic agriculture regulations in Maldives. However, there is scope in expanding the present productions, which are organic by production like taro, mangoes, papaya, coconuts and few horticultural crops. Consumers are aware of agricultural inputs used in production and also in post-harvest management, which has raised public concerns through various media outlets.

5. Nepal

Agriculture system in Nepal is mostly "non-certified organic agriculture or products". Organic agriculture took momentum in Nepal during 1990s along with introduction of Integrated Pest Management (IPM) and Integrated Plant Nutrient Management System (IPNS) programmes. Currently, organic agriculture promotion policies are enacted and certification procedures are initiated by public and private sectors. Farmers healthy crop production scheme is in practice.

National Agriculture Policy 2004 for promotion of organic agriculture, Agriculture Enterprises promotion policy 2006 based on the market demand special pocket area for Organic production and Poultry policy 2012 are implemented by the Government. Directives on National technical standards for organic agriculture production and processing system 2007, organic fertilizer subsidy directives 2011 and directives for Internal Control System for collective certification of organic agriculture production 2012 are issued. Working procedures for National Organic Agriculture Accreditation Body 2012 and guidelines for Participatory Certification of Organic Agriculture Production 2012 were also formulated in Nepal.

6. Pakistan

Efforts are on the way to establish organic certification system in Pakistan with the collaboration of IFOAM. Recently, a project centered in PARC/NARC/NIOA and supported by IFOAM, NO, USDA has been launched in which partners will together form the Network for Organic Research and Training. Steps and Strategy of organic farming and certification system in Pakistan are taken to establish sustainable infrastructure for organic farming in Pakistan.

Issues and challenges of organic produce

- Conversion and maintenance of organic field.
- Poor support for developing organic farming in most of the SAARC countries.
- No premium price for organic produce to attract for adopting organic for high returns
- High cost of production, inputs and lack of subsidies for organic farming poses a challenge competing with cheaper imports from neighbouring countries.

- Acute shortage of labour for organic farming
- Week situation of value addition, branding and labeling of organic produce
- Produce aggregation costs for distributed small growers
- Certification complexities
- Unawareness of consumers about the specific attributes that differentiate organic products from conventional ones, as well as certification standards.
- Unwilling of producers to become involved in organic agriculture either due to lack of information throughout production, post-harvest and marketing process or due to lack of financial support during the first stages of transformation farm from conventional to organic.
- Marketing problems related to the supply, distribution and promotion of the product.
- Higher Prices of organic products than those of conventional ones
- Urgent need to find a safer alternative to the herbicides
- Limited capacity and resources (HR and facilities) for organic program – mobility for support coverage
- Lack of pesticides residue testing facilities and bio-control laboratories
- Bio-pesticides development programme with laboratories
- Lack of microbiology laboratories to promote bio-fertilizers
- Lack of research mandate for organic alternatives.
- Lack of reliable supply chain
- Lack of sufficient retail chains
- Limited size of domestic market
- Lack the skills and creativity to find profitable markets

The main challenge for SAARC countries is the establishment of the authenticity of the organic claim. Besides support to the primary producers of organic products, there is a need for the regional countries to come together to develop a regional organic standard with common system of assessment and conformity system to have a regional certificate that will enable organic products to flow from one country to another without barriers.

RECOMMENDATIONS

The experts from the SAARC region, through the regional consultation meeting, drew series of recommendations in areas of (A) Standards and Conversions, (B) Research and Development, and (C) Information Exchange (D) Policy Support.

A. Standards and Conversions

1. SAARC organic standard and certification systems should be developed in line with the existing policies and standards of SAARC nations. SAARC Agriculture Centre (SAC), Dhaka should initiate a plan to implement this recommendation.
2. Each SAARC nation should develop a model organic village using the proposed SAARC standards.
3. Conversion period should be crop and area specific depending on the nature of the crop and land use history. This should be noted while making SAARC standards.
4. Free flow of organic commodities among the member countries should be allowed under SAARC organic standard.

B. Research and development

1. Organic agriculture is constrained mainly due to lack of practical solutions to weed, pest and disease management practices in all the member countries. Hence, there should be a network of research among SAARC nations to address the issues at the cross country level. In the process, the indigenous practices adopted by the farmers should also be documented and shared.
2. Each member states could lead research and development in specific components (bio-pesticides, bio-manures, crop varieties, packaging etc.).
3. Cross country capacity building programme including training of researchers, extension functionaries, farmers and other relevant stakeholders among member nations should be developed and coordinated by SAC, Dhaka.

4. Country specific model should be prepared for safe and secure food. The model proposed by India having the components of scientific organic agriculture in default organic areas and towards organic approach with integrated management and non-pesticide use can be adopted. This will compliment to the safe food production in the region. SAC, Dhaka can synthesize the model for SAARC region.

C. Information exchange

1. Each SAARC country should nominate a focal point expert through governing board member of the respective country for seamless information exchange on research and development related to organic agriculture including the technologies, package of practices and farm level success stories. An information exchange system should be developed by SAC, Dhaka to share the information received from focal points.
2. In the national agricultural census, there is a need to include information on the organic farming. The data should be shared with the member nations through SAC, Dhaka for creating better markets.

D. Policy support

1. Considering the contribution of organic agriculture to safe food, health of environment and people; the organic growers/ movement should be suitably supported with better incentives to enhance the percolation of organic farming in member nations. While providing the incentives the conversion period; should be taken care with appropriate policies, if yield declines.
2. It is noted that the status of organic agriculture in education, research and development in member nations are in infancy stage. Hence, adequate allocation of human, financial and physical resources to organic agricultural education, research and development in all the countries is required.
3. Inputs for organic farming should be generated through government-controlled mechanisms to ensure quality and timely availability.
4. To capture high end domestic market in the region, potential organic agricultural zones should be identified and be named as special organic system zone. These zones can also be made as agro-ecotourism centre for attracting the nature-loving tourists. Tax holidays for those private investors

who will invest in the zone can be considered. These zones should be planned in such a way that all requirements of inputs, certification, processing or packing are met within the zone itself.

5. Inter-ministerial coordination among agriculture, health and environment is essential to promote organic agriculture.
6. Regional level recognition for researchers, extension functionaries and farmers involved in organic farming can be made SAARC by providing award and certificate.
7. Periodic/ annual review of the progress of recommendations should be made by SAC, Dhaka.

Dr. Muhammad Musa
Senior Program Specialist (Crops)
SAARC Agriculture Centre
Dhaka, Bangladesh
Email: mum96@hotmail.com

Status and Future Prospect of Organic Agriculture for Safe Food Security in Bangladesh

Muhammad Nazim Uddin

Scientific Officer, Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh
Email: nazim.hrc@bari.gov.bd, nazim.68@gmail.com

Summary

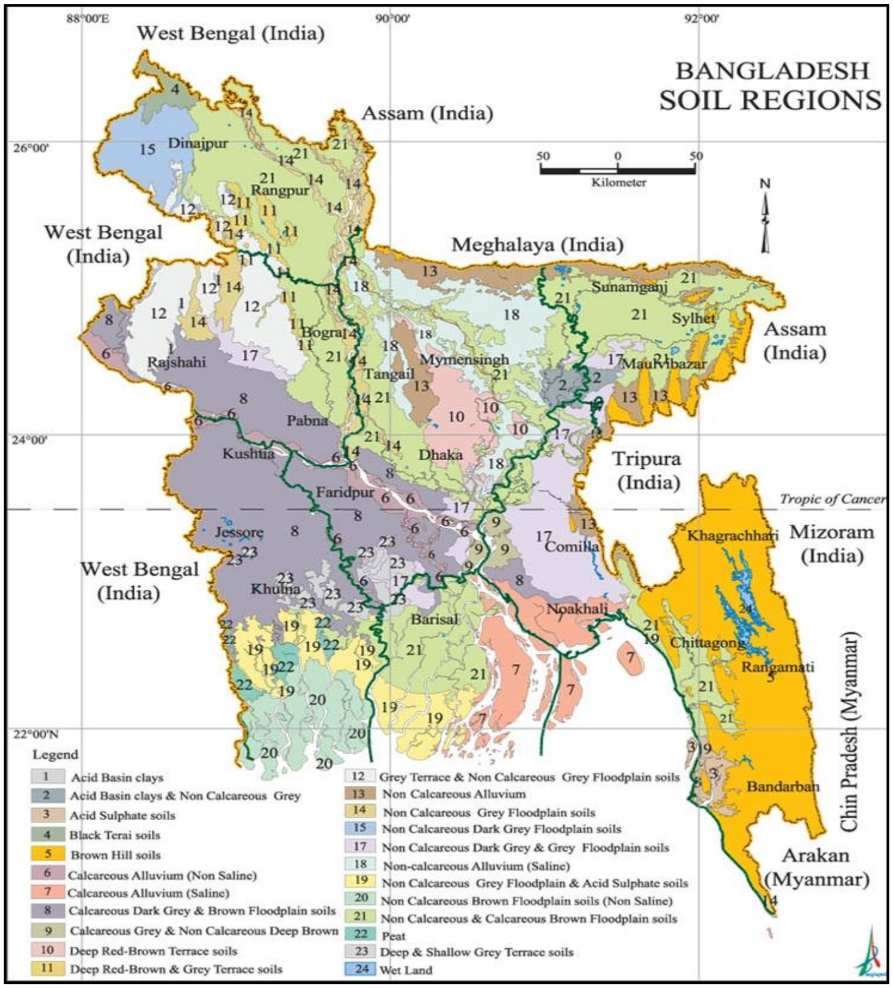
Bangladesh is an agro-based country lying between 20.34^0 and 26.38^0 North latitudes, and between 88.01^0 and 92.41^0 East longitudes. The soil of Bangladesh divided into three broad types, which are floodplain (78.96%), Hill (12.69%) and Terrace (8.35%). The country is small but has diverse ecosystems like hills, plains, coastal and wetlands posing tropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures, and high humidity. Traditional farming in Bangladesh is organic what is still found in the homestead production system. Homestead also possesses huge diversity of fruits, vegetable, spices and tuber crops. Country has no national standards of organic. BARI recently introduced a standards and PGS system. There are 68660 hectares of land under certified organic but many of the farmers still they did not apply any synthetic chemicals and pesticides. There are ample scope to ensure organic fertilizers and biopesticides from wide ranges of source. In the mid fifties of last century chemical farming has been stated and already lost its OM of the soil, introduced monoculture and lost many indigenous variety of local rice, many of the species of fishes has become disappear and some under threat. NGOS are the main initiators of the organic farming as campaign, later government organization specially; BARI has taken initiative in favor of organic farming through research and development. Two private entrepreneurs are being exporting organic tea and shrimp to global markets (USA, Japan, EU) standards and certifications by third party. Legal frame is being in favored of organic but have some opposite trend too in the safe food act 2013. More than 90% of the farming communities among the SAARC countries are smallholders who are innovators historically and having cultural harmony in farming,

therefore, a common standards and certification system is recommended. The name of the standards could be Common Organic Standards for the SAARC Countries (COSSAC) as most of the countries have no national standards. Conversion time is the common problem for the smallholder, therefore, conversion time could be 2 cropping cycle instead of 2 years. As the marketing is the common problem due to authentication, therefore, a common vision should be set for the SAARC countries. Opportunities have to create free exchange of organic product among the member countries under a common brand SAC Organic.

Country profile

Bangladesh is an agro-based country lying between 20.34^0 and 26.38^0 North latitudes, and between 88.01^0 and 92.41^0 East longitudes. It is bounded by India in the North and West, South by Bay of Bengal and East by India and Myanmar. The country has a total area of 147570 km^2 with a population of about 160.3 million (www.worldometers.info on 21 June 2015). The country is located as an interface of two different environment; Bay of Bengal in the south and the Himalayas in the north. It is the world largest deltaic country and is formed by the three great rivers of Brahmaputra, the Meghna and the Ganges. It is the low lying riverine country and roughly 80% of the landmass is made up of fertile alluvial lowland called the Bangladesh Plain.

FAO/UNDP (1988) classified the Bangladesh soil into three broad types, which are floodplain (78.96%), Hill (12.69%) and Terrace (8.35%). The country is small but has diverse ecosystems like hills, plains, coastal and wetlands (Fig. 2). Bangladesh has a tropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures, and high humidity. Regional climatic differences in this flat country are minor. Three seasons are generally recognized: a hot, muggy summer from March to June; a hot, humid and rainy monsoon season from June to November; and a warm-hot, dry winter from December to February. In general, maximum summer temperatures range between 38 and 41 °C. April is the hottest month in most parts of the country. January is the coolest month, when the average temperature for most of the country is 16–20 °C during the day and around 10 °C at night.



Bangladesh Soil Regions

Heavy rainfall is characteristic of Bangladesh causing it to flood every year. With the exception of the relatively dry western region of Rajshahi, where the annual rainfall is about 1,600 mm, most parts of the country receive at least 2,300 mm of rainfall per year. Because of its location just south of the foothills of the Himalayas, where monsoon winds turn west and northwest, the region of Sylhet in northeastern Bangladesh receives the greatest average precipitation. Average daily humidity ranged from March lows of between 55 and 81% to July highs of between 94 and 100%. Agriculture is predominant with a cropped area of 8.51 million hectare and 190% cropping intensity (MOA, 2015). Agro-ecology of the country is divided in to 30 AEZs. Lands are categories into high, medium high, medium low land, low land and extremely low land. There are 14.9 million farm household having wide range of biodiversity of fruits vegetables spices, tuber crops and medicinal plants and house hold rare poultry and livestock traditionally. Three cropping seasons are recognized;

1. Rabi (cool and dry months) : October - March
2. Kharif-I (hot) : April - June
3. Kharif-II (hot and humid months) : July - September

Average landholding of a farm household is less than 1,000m^2, and more than 10% had no farmland (Ministry of Agriculture, 2010).

Concept, brief history and strategic importance of organic farming

The wartime chemistry of WWI (1914-1918) opened a Pandora's Box of cheap nitrogenous compounds and poisonous gases. However, young men dying an ugly death from toxic gas seemed the antithesis of a heroic death and the perpetrators of this novel lethality seemed ungentlemanly. For the purposes of modern warfare, the box was more or less snapped shut by the Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare- but not for agriculture. Repurposing the chemistry of poisons and the output of the Haber-Bosch ammonia process of ‘fixing’ nitrogen, for application to the food chain, seemed, to many, and in particular to policy makers, to be ‘scientific’ and to epitomize ‘progress’. In the early months of WWII, Lord Northbourne expressed the anxiety of a generation about the shift to the ‘chemicalization’ of the food chain. Northbourne first use the terminology Organic Farming in his book ‘*Look to the Land’.* Jerome Irving Rodale was the first major international author and publisher of books and magazines on organic farming. His primary magazine was called “Organic Farming and Gardening’’. It was based in the USA; however this publication was widely read by many thousands of people around the world. He actively promoted the name “organic farming’’ in this and other publications and the name “organic” quickly dominated over the numerous other names like natural, permanent and ecological that were being used at the time to describe the faming system.

The organic agriculture movement arose over the concern over the loss of quality in crops with an increase in diseases and pest attacks affecting yields in the later part of the 1800s in Europe and the USA, after the introduction of chemical fertilizers.

These chemical fertilisers were based on the published research of Sir Humphrey Davy and Justus von Liebig were the key founders of this theory and published their ideas in Elements of Agricultural Chemistry (Davy, 1813) and Organic Chemistry in its Application to Agriculture and Physiology (von Liebig, 1840). Baron Justus Von Liebig, in Germany, in the 1840s, the first modern chemist to look at the plant growth in a laboratory and determined that plants needed minerals from the soil and carbon dioxide from the air. He showed that although plants are surrounded by nitrogen in the air, they needed nitrogen in the form of ammonia that they took up through their roots. Liebig stated that nitrogen was the most important mineral and proved that synthetic chemical fertilizers could replace natural ones such as animal manures as the source of nitrogen. Liebig's research fundamentally changed the direction of agriculture and became the basis of conventional agriculture that is practiced around the world.

The people involved in the movements that would lead to modern organic agriculture believed that there was direct relationship between the health of the soil, the crops that were grown in it and ultimately with the animals and people who consumed these crops.

Ironically one of the first persons to write about his concerns over the damage that these chemicals were doing to the soil and crop quality was Baron Justus Von Liebig. In the latter part of his life he felt that other researchers were using his research out of context and this was causing problems.

The most significant origins of the formal movement began in Germany in 1924 when the philosopher Rudolf Steiner published book '*Agriculture*' after series of lectures to the farmers on declining quality of soil and crops since the introduction of synthetic fertilizers and pesticides**.**

Pfieffer invented one preparation and started 'Biodynamic' (a new farming concept) movement around the Europe. No long after beginning of the movement a range of other organization concerned over the health of the soil and human health began to form in the 1930s to 1940s.

First use of "Organic" to describe this form of agriculture was in the book '*Look to the Land*' by Lord Northbourne, published in 1940. The book from that time that had the most significant influence was "An Agricultural Testament" by Sir

Albert Howard. Howard had spent much of his time in India and had pioneered efficient forms of composting that achieved high yields of healthy plants. Howard had an enormous influence on Rodale who widely publicized his methods and disseminated the name “organic farming” based on the widespread use of recycling organic matter through composting that was advocated by Howard.

The publication of Silent Spring in 1962 by Rachel Carson had a significant effect in raising the public awareness about the dangers of the pesticides that were being used in farming at the time. Silent Spring created a huge controversy and a massive concern about the chemical residues in food and in the environment. The public pressure saw strengthening of pesticide regulations and most importantly the beginning of the consumer movement that demanded food that is grown without toxic chemicals. It also saw the beginning of the awareness of how farming was impacting on the environment and gave rise to a number “whole of systems” approaches that fit within the broad organic paradigm.

It also saw the beginning of the awareness of how farming was impacting on the environment and gave rise to a number “whole of systems” approaches that fit within the broad organic paradigm.

Examples of these are “The One Straw Revolution” by the Japanese farmer Masanobu Fukuoka. Fukuoka had published earlier books however “The One Straw Revolution” was published in English in 1978 and quickly became one of the most influential books at the time. His “Natural Farming” methods were based on observing how nature works and then designing the system so that nature did the work for you. This is why it was sometimes called “Do-nothing farming”. Unfortunately some people misunderstood the concept and instead of having carefully planned systems where nature did the work for you, they did nothing and then criticized Fukuoka by saying that it failed. He was one of the pioneers of organic no-till grain systems that did not use herbicides. These systems are easily applied to small-holder farms.

The formal international movement began in Versailles, France on November 5th, 1972 when at the invitation of Roland Chevriot of “Nature et Progrès” in France, Lady Eve Balfour, a founder of the UK Soil Association in the UK, Kjell Arman from the Swedish Biodynamic Association, Pauline Raphaely from the Soil Association of South Africa, and Jerome Goldstein from the Rodale Institute held a meeting and formed the International Federation of Organic Agricultural

Movements (IFOAM). IFOAM is the international umbrella movement that has the role to both lead and unite the organic sector around the world. It is the organization that sets the international standards, policies, definitions and positions around the multi-functionality of organic agriculture through consulting with its members that cover the whole spectrum of the sector in the majority of the countries in the world.

According to IFAOM 2005, **Organic Agriculture** is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects.

According to USDA, **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.

However, organic agriculture is the outcome of theory and practice in the early 20th century involving combination of various production methods primarily in Europe, but also in the United States with 3 central movements: (i) Biodynamic agriculture, originated in Germany under the inspiration of Rudolf Steiner, (ii) Organic farming, initiated in England based on the theories developed by Albert Howard and (iii) Biological agriculture, which was build up in Switzerland by Hans-Peter Rusch and Hans Mu¨ ller. Tate (1994) cited some giant personalities who inspired the movement : Rudolf Steiner from Austria , Hans Mu¨ ller, the German-Swiss, Lady Eve Balfour in Britain; J.I Rodale in the United States; and Masanobu Fukuoka in Japan. Pioneers of the organic movement believed that healthy food produced healthy people and that healthy people were the basis for a healthy society.

Bangladesh farmers used to fertilize the land and protect the crop with organic fertilizers and botanicals from ancient. Long experience and traditional knowledge was so powerful that they feed the whole nations and even export. The country forced to follow the Liebigs theory in the mid fifties as to increase the food production to feed the ever increasing populations. The petroleum based green revolution offered to contribute significantly to increased agricultural productivity. Almost, all the farmers are relied on synthetic products due to their quick responses. However, some of the philanthrophic also initiated organic movement although it did not produced momentum like the developed countries. Food adulterations and conscious to health the movement now is being shaped up.

Organic and inorganic area, types of organic and inorganic manure

Food productions system of Bangladesh is mostly based on chemical fertilizers and pesticides. The concept of production is ‘use high input and receive high output’, although economic benefit and environmental consequences are not being considered. The total cultivated land under conventional practices is 8.51 million hectare (MOA, 2015).

There is no organized census of organic land in Bangladesh, although many organizations claimed they are doing organic. The author personally tried to make database of the vendors and there converted field. Bangladesh Agricultural Research Institute (BARI) is the public research institute initiated research and development on 2006 by converting 3000 sqm land under Olericulture Division of Horticulture Research Center. Moreover, BARI is developing three organic model villages where ten hectare land was converted to organic practices.

Kazi and Kazi Tea Estate (KKTE) the only company producing world class organic tea, vegetables and herb to their 1400 hectares certified land both for domestic and export market. Recently, Sahbazpur Tea Company was joined the organic club. Organic shrimp now a days is the leading and growing sector in Bangladesh and WAB Trading Int. (Asia) exporting organic shrimp to global market especially Europe. Therefore, the estimated area used in Bangladesh for organic production (including aquaculture) is about 68660 hectares which 0.19% of total land (FIBL 2015).

Principles of Bangladesh organic agriculture

As quality food is the basis human right therefore, the principle is being set to address this statement. Although Bangladesh yet have not been developed national standards, however, BARI has approved standards and PGS system by the stakeholders on 14 May 2015 which was developed following IFOAM basic standards and Asian Regional Organic Standards (AROS).

Moreover, the major concerns and concepts that were advocated by the founders and key opinion leaders of the organic movement over the last century, such as soil health, ecology, care, and using the precautionary principle with new technologies have been clearly articulated in IFOAMs four principles of organic agriculture.

Organic agriculture is based on:

1. The principle of health
2. The principle of ecology
3. The principle of fairness
4. The principle of care

Based on IFOAM principles, following principle are being set in BARI standards

1. ***Produce of safe and high quality food:*** Produce safe and high quality food in sufficient quantities to contribute to healthy diet
2. ***Protection of the environment:*** Minimize the amount of environmental pollution and destruction that results from agriculture to ensure the health of the ecosystem, including microorganism, soil organisms and plants and animals
3. ***Harmonious coexistence with Nature*:** Utilize local renewable resources and energy and make use of Nature's productive capacity
4. ***Local self-sufficiency and recycling:*** Establish a base of food self sufficiency as well as local renewable resource and energy self sufficiency and recycling in order to achieve local self sustainability.
5. ***Maintenance and promotion of soil fertility:*** Maintain and promote soil fertility by producing 'living' soil.
6. ***Promote Biodiversity:*** Ensure that biodiversity is maintained by ensuring the diversity of cultivated varieties, feed varieties, and wild varieties.
7. ***Safeguarding of a healthy food environment:*** Respect the natural diets of animals to ensure the health of feedstock.
8. ***Ensuring human right and fair employment conditions:*** Guarantee a safe, healthy working environment, independently fair employment conditions, sufficient pay and a sense of satisfaction.
9. ***Cooperation between producers and consumers:*** Build an amicable, prominent relationship between producers and consumers to create a

foundation of mutual understanding and trust from which to promote organic agriculture together.

10. ***Promotion of the value of agriculture and creation of a society that values life:*** Build a society that respects life and value the social , cultural, educational and ecological significance of agriculture and agricultural commodities

Scope and Objectives

Organic farming is a holistic system that focuses on improvement of soil health, use of local inputs, and relatively high-intensity use of local labor, fits admirable for rural Bangladesh in many ways. The rural Bangladesh offers much remuneration that would make organic cultivation (Fruits, vegetables, rice, livestock etc.) methods relatively easy to implement. The production method is not new for Bangladesh farmers. Although most of the field crops land under chemical cultivation/ conventional, but the homestead are still under organic cultivation by default. At present there are 22.1 million total (Farm and Non-Farm) household and 14.9 million-farm household and there is enormous biodiversity of vegetables, fruits, tubers and livestock. In addition to this, Bangladesh posses 10% of hill area and these are organic by default too. In the recent years, food quality and safety have been attaining a growing importance to consumers and recent food adulterations scandal also created ample scope to produce safe food. Moreover, many of the farmers have rich traditional knowledge, which is incompliance, the organic principles. Government and NGO's are also advocating ensuring safe food to nourish healthy population. Many of the researchers of the modern world ensured organic is safe compared to exiting production practices following now-a-days.

Objectives

1. To ensure safe and quality food
2. Ensuring long-term, ecological, systems-based organic management
3. Confirming long-term, biological based soil fertility
4. Avoiding/ minimizing synthetic inputs at all stages of the organic product chain and exposure of people and the environment to persistent, potentially harmful chemicals

5. Minimizing pollution and degradation of the production/ processing unit and surrounding environment from production/ processing activities
6. Excluding certain unproven, unnatural and harmful technologies from the system
7. Avoiding pollution from surrounding environment
8. Maintaining organic integrity throughout the supply chain
9. Providing organic identity in the supply chain

Components of organic farming

The farming system is the main component of organic farming, but the major trusty sector is crop which including crop rotation, maintenance and enhancement of soil fertility through biological nitrogen fixation, addition of organic manure and use of soil microorganisms, crop residues, bio-pesticide, biogas slurry, waste etc. Vermiculture has become a major component in biological farming, which is found to be effective in enhancing the soil fertility and producing large numbers of horticultural crops in a sustainable manner. The various components of organic farming have been discussed in details below.

1. Crop rotation

It is a systematic arrangement for the growing of different crops in a more or less regular sequence on the same land covering a period of two years or more. The selection of optimal crop rotation is important for successful sustainable agriculture. To maintain soil fertility, manage weed, insect and disease crop rotation is a effective tool. Legumes are essential in any rotation and should 30 to 50 percent of the land. A mixed cropping and livestock system is desirable or even essential for the success of sustainable agriculture.

2. Crop residue

There is a great potential for utilization of crop residues/ straw of some of the major cereals (rice, wheat), oils (mustard) and pulses (lentil, mung bean etc.). About 50% of the crop residues are utilized as animal fed, the rest could be very well utilized for recycling of nutrients. Adequate care is required to use the residues after proper composting with efficient microbial inoculants. While the incorporation of crop residues e.g. Rice straw, as such or inoculated with fungal species (Trichoderma, *Azotobacter,* etc.) have beneficial effects on crop yields and important in physico-chemical properties of soil.

3. Organic manure

The organic manure is derived from biological sources like plant, animal and human residues. Organic manure act in many ways in augmenting crop growth and soil productivity. The direct effect of organic manure relates to the uptake of humic substances or its decomposition products affecting favourably the growth and yield of plants. Indirectly, it augments the beneficial soil microorganisms and their activities and thus increases the availability of major and minor plant nutrients.

a. Bulky organic manure: It generally contains fewer amounts of plant nutrients as compared to concentrated organic manure. It includes farm yard manure, compost and green manure.

- **Farm yard manure:** It refers to the well-decomposed mixture of dung, urine, farm litter and left over or used up materials from roughages or fodder fed to the cattle. The waste material of cattle shed consisting of dung and urine soaked in the refuse is collected and placed in trenches. The material is allowed to decompose undisturbed 4-5 months for aerobic/ anerobic microorganism for completion of composting. FYM becomes ready to apply after 4-5 months.

- **Compost:** Large quantities of waste material are available as vegetable refuse, farm litter, such as weeds, stubble, sugarcane trash, Sewage sludge and animal waste in houses and in areas like human and industrial refuse; therefore, excreta can be converted into useful compost manure by conserving and subjecting these to a controlled process of aerobic/ anerobic decomposition. Compost is used in the same way as FYM and is good for application to all soils and all crops.

- **Green manuring:** It is a practice of ploughing or turning into the soil undercomposed green plant tissues for the purpose of improving physical structure as well as fertility of the soil. From the time immemorial the turning in a green crop for improvement of the conditions of the soil has been a popular farming practice. Green Manuring, wherever feasible, is the principal supplementary means of adding organic matter to the soil. It consists of the growing of quick growing crop and ploughing it under to incorporate it into the soil. The green manure crop supplies organic matter as well as additional nitrogen, particularly if it is a legume crop, which has the ability to fix nitrogen from the air with the help of its root-nodule bacteria. The green manure crops also exercise a protective action against erosion and leaching. The most commonly used green manuring crops are Sunhemp (*Crotalaria juncea*), Dhaincha (*Sesbania aculeata*), Cowpea (*Vigna catjang, Vigna sinensis*).

b. Concentrated Organic Manure: Concentrated organic manures are those materials that are organic in nature and contain higher percentage of essential plant nutrients such as nitrogen, phosphorous and potash, as compared to bulky organic manures. These concentrated manures are made from raw materials of animal or plant origin. The concentrated organic manures commonly used are oilcakes, blood meal, fishmeal, meat meal and horn and hoof meal.

4. Waste

a. Industrial waste: Among the industrial by products, spent wash from ditilisers and molasses and pressmud from sugar industry have good manurial value. It is important to use only well decomposed pressmud at 10 tonnes ha^{-1}. Addition of pressmud improves the soil fertility and enhances the activity of microbes. Coir waste is the by-product from coir industry and can be used as manure after proper decomposition.

b. Municipal and Sewage waste: It also forms an important component of organic waste. In the urban and rural areas of Bangladesh every day around 1 kg organic waste are being produced. Organic waste collected from urbn area might be contaminated with heavy metals and these pose hazards to plants, animals and human beings. Separation of the toxic waste at the source will minimize the concentration of such elements in the sludge.

5. Biofertilizers

It has been observed that there is decline in crop yield due to continuous apply of inorganic fertilizers. Therefore, increasing need is being felt to integrate nutrient supply with organic sources to restore the health of soil. Bio-fertilizer offers an economically attractive and ecologically sound means of reducing external inputs and improving the quality and quantity of internal sources. Bio-fertilizer is microorganism's culture capable of fixing atmospheric nitrogen when suitable crops are inoculated with them. The main inputs are microorganisms, which are capable of mobilizing nutritive elements from non-usable form to usable form through biological process. These are less expensive, eco-friendly and sustainable. The beneficial microorganisms in the soil that are greater significance to horticultural situations are biological nitrogen fixers, phosphate solubilisers and mycorrhizal fungi.

The Biofertilizers containing biological nitrogen fixing organism are of utmost important in agriculture in view of the following advantages:

- They help in establishment and growth of crop plants and trees.
- They enhance biomass production and grain yields.
- They are useful in sustainable agriculture.
- They suitable organic farming.
- They play an important role in Agroforestry / silvipastoral systems.

Types of Bio-fertilizers

There are two types of bio-fertilizers.

a. **Symbiotic N-fixation:** These are Rhizobium culture of various strains which multiply in roots of suitable legumes and fix nitrogen symbiotically. Almost 50% demands of N are met by these microorganisms in legumes.

   Rhizobium: It is the most widely used biofertilizers, which colonizes the roots of specific legumes to form tumours like growths called rot nodules. It is these nodules that act as factories of ammonia production. The Rhizobium legume association can fix upto 100-300 kg N ha^{-1} in one crop season.

b. **Asymbiotic N-fixation:** This includes Azotobacter, Azospirillium, BGA, Azolla and Mycorrhizae, which also fixes atmospheric N in suitable soil medium. They grow on decomposing soil organic matter and produce nitrogen compounds for their own growth and development, besides that they leave behind a significant amount of N in surroundings.

Azotobacter: Application of Azotobactor has been found to increase the yields of wheat, rice, maize, pearl millet and sorghum by 0-30% over control. The beneficial effect of Azotobactor biofertilizers on cereals, vegetables, tubers and spices under both irrigated and rainfed field conditions have been substantiated and documented many researchers. Apart from nitrogen this organism is also capable of producing antibacterial and anti-fungal compounds and hormones.

Azospirillium: It is an important bacterium, which colonize the root zones and fix nitrogen in loose association with plants. The crops which response to Azospirillum is maize, barley, oats, sorghum, pearl millet and forage crop.

Blue Green Algae: The utilization of blue-green algae as biofertilizers for rice is very promising. Recent researches have shown that algae also help to reduce soil alkalinity and this opens up possibilities for bio-reclamation of such inhospitable environments.

Azolla: A small floating fern, Azolla is commonly seen in low land fields and in shallow fresh water bodies in Bangladesh. This fern harbours blue-green algae, anabaena azollae. The Azolla anabaena association is a live floating nitrogen factory using energy from photosynthesis to fix atmospheric nitrogen. This fern may add 3 times higher nitrogen than legumes.

Mycorrhizae: Mycorrhizae are the symbiotic association of fungi with roots of Vascular plants. The main advantage of Mycorrhizae to the host plants lies in the extension of the penetration zone of the root fungus system in the soil, facilitating an increased phosphorous uptake. In many cases the Mycorrhizae have been shown to markedly improve the growth of plants. The beneficial effects of Vascular-arbuscular Mycorrhizae (VAM) have been observed in fruits and vegetables crops.

6. Bio-pesticide

Biopesticides are certain types of pesticides derived from such natural materials as animals, plants and microorganisms (bacteria, fungi etc.) including natural ingredient pesticide, microranisms pesticide and bio chemical pesticides. Natural plant products belong to the so-called secondary metabolites, which include thousands of alkaloids, terpenoids, phenolics and minor secondary chemicals. These substances have usually no known function in photosynthesis, growth or other basic aspects of plant physiology; however, their biological activity against insects, nematodes, fungi and other organisms is well documented. Microbial pesticides consist of a microorganism (a bacterium, fungus, virus or protozoan) as the active ingredient. The most widely used microbial pesticides are subspecies and strains of *Bacillus thuringiensis* (*Bt*). Each strain of this bacterium produces a different mix of proteins, and specifically kills one or a few related species of insect larvae. Biochemical pesticides are naturally occurring substances that control pests by non-toxic mechanisms. Conventional pesticides, by contrast, are generally synthetic materials that directly kill or inactivate the pest. Biochemical pesticides include substances, such as insect sex pheromones that interfere with mating, as well as various scented plant extracts that attract insect pests to traps. Botanical insecticides are ecologically and environmentally safer generally affect the behavior and physiology of insects rather than killing them. Among the botanical pesticides investigated, Neem (*Azadirachta indica*) has justifiably received the maximum attention. All parts of the Neem tree possess insecticidal property but seed kernel is most active. Biopesticides and other preparations of plant origin used in agriculture seem to have a good scope especially in view of the environmental problems being faced with the synthetic agrochemical. Some of the commonly used botanical Insecticides are Pyrethrum, Rotenone, Subabilla, Ryanin, Quassia, etc.

7. Vermicompost

It is organic manure produced by the activity of earthworms. It is a method of making compost with the use of earthworms that generally live in soil, eat biomass and excrete it in digested form. It is generally estimated that 1800 worms which is an ideal population for one sq. meter can feed on 80 tonnes of humus per year. These are rich in macro and micronutrients, vitamins, growth hormones and immobilized microflora. The average nutrient content of vermicompost is much higher than that of FYM. Application of vermicompost facilitates easy availability of essential plant nutrients to crops. In Bangladesh, vermicompost is good product livelihood improvement rural women.

Country status of agriculture today, including pesticide and fertilizers used (Organic, inorganic, cultivation system, adoption of their environmental conditions)

Crop cultivation systems of Bangladesh shifted into primitive to highly intensive like other developing countries of Asia. In the non-fallow system the economy devoted exclusively to the cultivation of grain gave way to more diversified agricultural production with improved stock raising and the cultivation of industrial and feed crops. Soil fertility was maintained and improved by the alternation of crops, such as grains, legumes, and row crops, by the application of larger quantities of fertilizers, especially mineral fertilizers, and by careful soil tillage. To increase the productivity of the farm and to feed the ever-increasing population, Bangladesh forced to move to synthetic chemical fertilizers- and pesticides-based high yielding varieties and production methods.

In the early 1950's, farmers applied organic manures such as cow dung, bone meal etc. to Aus and Aman rice field and farmyard manure (FYM), mustard oil cake and fishmeal to mustard and vegetable crops (EPBS, 1950). Ahmed (2004) pointed out that the use of inorganic fertiliser started in the country in 1951 with the import of 2,698 tonnes of ammonium sulphate, phosphates in 1957 and muriate of potash in 1960. Quasem (1978) reported that fertiliser was introduced at farm level in 1959. Then, in 1965, the Government launched a 'Grow More Food' campaign and provided fertilisers and low lift pump (LLP) at a highly subsidized rate with pesticide at free of cost to popularize these inputs among the farmers and meet the country's food shortage. Thus, fertiliser consumption began to increase rapidly with the introduction of HYV rice (IR5 and IR8) and LLP use.

The chemical fertilizers application in the soil has increased tremendously last 3 decades (Table 2). In 1992-93 fiscal year, the total use of chemical fertilizer was 2316.2 thousand tonnes after 21 years it is being used 3995.0 thousand tonnes which was 72% higher than the base year. Use of nitrogenous fertilizers is higher than any other chemicals fertilizers, and 1537.4 thousand tonnes was applied in 1992-93. After 56.8% incrementing, it raised to 2575.0 thousand tonnes in 2013-14 fiscal years (Table 3). Recent day, the use of Di-ammonium phosphate (DAP) has increased enormously and Single super phosphate (SSP) is not using no more from 2009-10. DAP is the source of both P and N and this fertilizer is being popularized. However, the received chemical fertilizers raised 272 kg ha^{-1} to 470 kg ha^{-1} last 20 years (Fig. 2).

Table 2: Use of various chemical fertilizers (000 tonnes) during 1992-93 to 2013-14 in Bangladesh

Year	Urea	TSP	DAP	SSP	MoP	Total
1992-93	1537.4	407.0	2.0	119.8	126.1	2316.2
1993-94	1579.0	234.2	28.7	170.6	103.9	2217.7
1994-95	1748.5	123.0	1.8	533.5	154.2	2640.6
1995-96	2045.5	111.1	0.0	596.9	155.9	3022.7
1996-97	2119.9	72.6	0.0	525.3	219.3	3036.6
1997-98	1799.2	57.2	5.8	450.4	190.7	2618.7
1998-99	1902.0	170.2	38.7	362.4	210.7	2824.9
1999-00	1923.3	225.4	94.9	197.2	204.6	2826.4
2000-01	2121.1	399.4	90.1	138.6	123.8	2991.3
2001-02	2247.4	401.5	127.0	127.1	233.2	3285.1
2002-03	2247.0	375.1	122.0	132.5	270.6	3338.8
2003-04	2324.1	361.0	90.0	148.0	240.0	3364.1
2004-05	2523.4	420.0	140.7	170.9	260.4	3754.8
2005-06	2451.4	436.5	145.0	130.4	290.7	3682.7
2006-07	2575.0	340.0	115.0	122.0	230.0	3551.0
2007-08	2685.0	380.0	240.0	100.0	380.0	4090.0
2008-09	2400.0	200.0	50.0	25.0	150.0	3005.0
2009-10	2300.0	300.0	90.0	0.0	210.0	3134.0
2010-11	2540.0	435.0	24.0	0.0	365.0	3802.0
2011-12	2293.0	678.0	409.0	0.0	613.0	4233.0
2012-13	2247.0	596.0	451.0	0.0	615.0	4211.0
2013-14	2411.0	486.0	400.0	0.0	477.0	3995.0

Table 3: Percent increase of different chemical fertilizers during 1992-2014 in Bangladesh

Fertilizers	% Increased use
Urea	56.8
TSP	19.4
DAP	19800.5
MoP	278.3
Total	**72.5**

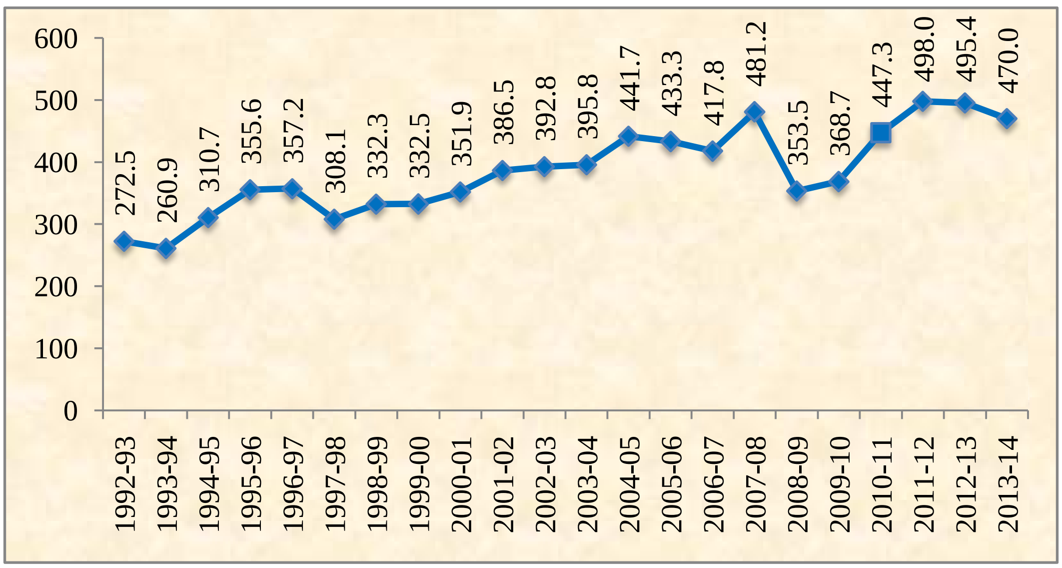


Fig. 2: Use of chemical fertilizers (kg ha^{-1}) durng 1992-93 to 2013-14 in Bangladesh

Use of petroleum based pesticides has started on 1956 with the import of 3 tonnes of insecticides. From that time pesticides were procured by government and supplied to the farmers free of cost. After liberation the subsidy become halved in 1974 and entirely withdraw in 1979 also give the sales authority to private sector. Sales of pesticides have substantially been increased during eighties. Figure 3 showed the use of pesticides during 1996-97 to 2013-14 and revealed that the pesticide application was 11.2 thousand tonnes in 1996-97, whereas it rose to 62.8 thousand tonnes in 2011-12, which is 5.6 times higher (Fig. 3). Side by side, crops received 1.32 kg ha^{-1} pesticides in 19996-96 and 7.39 kg ha^{-1} during 2011 - 122, which is 5.6 times higher (Fig. 3).

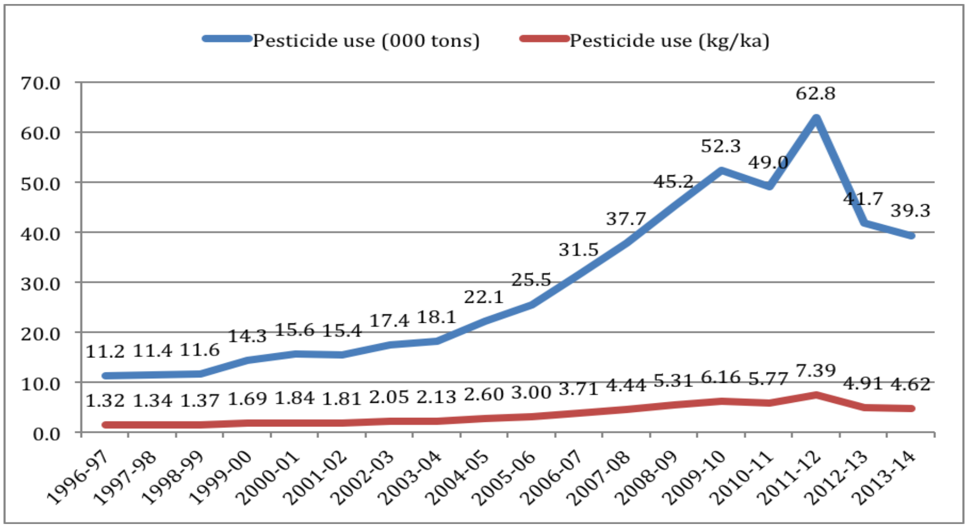


Fig. 3: Trend of pesticide use during 1996-97 to 2013-14 in Bangladesh

A visible success has been obtained in the self-sufficiency of food grain (Table 4) especially rice; increased the availability of vegetable and fruits too. The increased production of crops becomes possible at the cost of losing diversity in rice and many more indigenous vegetables and fruits.

Table 4: Food grain production trend last 10 years (2003-2014)

Food grain	**2002-03**	**2008-09**	**2009-10**	**2013-14**
Aus Rice	18.51	18.95	17.09	23.27
Aman Rice	111.15	116.13	133.07	130.23
Boro Rice	122.22	178.09	183.41	190.07
1. Total Rice	**251.88**	**313.17**	**322.57**	**343.57**
2. Wheat	**15.07**	**8.44**	**9.69**	**13.02**
3. Maize	**1.57**	**7.30**	**8.87**	**26.16**
Total (Food Grain)	**268.7**	**328.96**	**341.13**	**382.75**

Source: Bangladesh Economic Review 2010 and DAE 2015

Chemical fertilizers were applied to produce the crops in the soil ignoring the biological properties. Moreover, the breeding strategy was high input and high output, therefore, a trend has been adapted to use synthetic chemical for having green growth and pesticides for protecting the crop from the pest among the growers. As a result, Bangladesh soil lost its organic matter (OM) (70% land possess <1% OM) and enriched biological properties. Excessive use of petroleum based synthetic product to the crop built the food safety questionable.

The shift to monoculture cropping system meant transformation to consumer society. This change was accelerated by the increase of off-farm job opportunities, infrastructure development that facilitates population transfer, and admiration for urban lifestyle amplified by mass media. Currently, the rice cultivation in the dry season surpasses that in the rainy season, and the use of chemical fertilizers and pesticides has been increasing (Fig. 2, 3). More than 8000 local rice varieties existed before the Green revolution nationwide, but now only 1500 varieties are kept at gene banks, and varieties actually cultivated in the field are far less (Gregow 2002). Bangladeshi people are now suffering from severe health problems caused by arsenic in drinking water contaminated through irrigation. It was estimated that more than 3.2 million people in 47 out of 64 districts are drinking arsenic-contaminated water (more than 0.05mg l^{-1} level) (School of Environmental Studies, Jadavpur University 2010), and are in danger of skin diseases and consequential skin cancer as well as cancers in the respiratory organs and urinary organs. It is said that the heavy use of underground water and excessive dose of chemical fertilizers after the Green Revolution are deeply related to the contamination.

Recent study observed that Bangladesh rice contained heavy metal cadmium (Cd) which is coming from as the phosphate fertilizers (Daily Sakaler Khobor 2013). However, study also listed 12 countries including Thailand, Ghana, India, Japan, USA, Sri Lanka, France, Spain, Italy, Cambodia, and Nepal. Rapid and unplanned industrialization also making situation exacerbate as the industrial debris entered to the cropland.

Moreover, to increase the self-life of perishable goods (vegetables, fruits, fish etc.) vendors taint the food with dangerous chemicals very often. Considering whole activities, the total food chain become vulnerable those are affecting the public health and environmental health too. Increased number of cancer, cardiovascular disease, diabetic patients and extinction and endangered of many indigenous fish and crop species is the outcome of the total activities.

Considering the above situation it may be concluded that exiting production practices of Bangladesh are no longer safe for human health as well as for the soil health. Moreover, the practices made disappear the biodiversity of flora and fauna of Bangladesh and some are ready to extinct.

Soil fertility management in organic agriculture in Bangladesh

Soil fertility management principal to make balance of minerals and organic matter is the source of minerals. A critical area of soil health is to have adequate levels of all minerals. It is important to ensure that there are no mineral deficiencies or large excesses of minerals. Deficiencies in macro and trace elements will limit yield and also incline plants to disease and pest attacks. Large excess of nutrients can cause other minerals to be locked up. Decomposition by micro-organisms within the soil is the reverse of the process represented by plant growth above the soil. Growing plants, using the energy of the sun, synthesize carbon, nitrogen, and all other elements into complex compounds. The energy stored up in these compounds is then used more or less completely by the microorganisms whose activity within the soil makes nutrients available for a new generation of plants. Organic matter thus supplies the ‘life of the Soil’ in the strictest sense. When measured in terms of carbon dioxide output, the soil is a live, active body. The level of crop production is often dependent on the capacity of the soil to produce and accumulate this form of readily usable nitrogen. The adequate levels of organic matter would act as a buffer where the ratios were not exact and ensure that plants would receive the correct amounts of nutrients.

1. **Application of Compost**: Adding organic matter to the soil is the most effective way to increase soil quality. This can be done in a variety of ways including using composts, mulches, both living and dead as well as green manure cover crops. Compost is the ideal way to improve soil quality, build up soil organic matter levels and to correct mineral balances. The best way to balance the soil minerals is to work out the amounts needed through a soil test and adding these as ground minerals such as rock phosphate, potassium sulphate, gypsum etc. into the compost material when starting a compost pile. The biological processes that form compost will make these minerals readily available to plants in both quick release and slow release forms. The resulting mineral rich compost is spread around the crops. Periodically trace elements can be applied. The trace elements can be mixed with molasses and/or

compost tea/ BAOFER, and brewed for several days to make them bio available. These can be sprayed out over the field. The sprayer ensures an even spread throughout the field. It is the intention that most of the nutrients go into the soil. This system ensures that the soil's biological activity releases a steady flow of all the nutrients needed by the crop to produce a good yield. The complete nature of the nutrition program ensures that there are no deficiencies. To adjust the nutrient imbalance, green manure crops (*Sesbania rostrata*, cowpea etc.) may be cultivated and incorporated to the soil. Some composting materials and their nutrient materials are in Table 5.

Table 5: Composting substances, Nutrient contents (%) and relative efficiencies of different substances

Materials	**Nutrient (%)**			**Relative Efficiencies**
	N	**P**	**K**	
Cattle dung	0.5-1.5	0.4-0.8	0.5-1.5	Medium
Cattle Urine	1.0	Trace	Trace	Rapid
Poultry manure	1.0	1.5	0.89	Medium Rapid
Farmyard Manure	0.5-1.5	0.4-0.8	0.5-1.9	Medium
Compost (water hyacinth)	2-3	1-2	3-4	Slow
Compost (General)	0.4-0.8	0.3-0.6	0.7-1.0	Slow
Compost (Urban)	1-2	1.0	1.5	Medium
Dried blood	10-12	1.0-1.5	0.6-0.8	Medium rapid
Bone meal	4.0	9.0	-	Slow
Fish meal (dry)	4.0-10	3-4	0.5-1.5	Slow
Fish scrap dry	3.5-12	1-12	0.08-1.6	Slow
Fish emulsion	5.0	2.0	2.0	Rapid
Mustard oil cake	5.1-5.2	1.8-1.9	1.1-1.3	Slow medium
Rice bran	18.7	6.3	4.1	Rapid
Ground nut oilcake	7.0-7.2	1.4-1.6	1.3-1.4	Slow medium
Sesame oilcake	6.2-6.3	2.0-2.1	1.2-1.3	Slow medium
Soybean meal (Non GMO)	6.7	1.6	2.3	Slow medium
Rice straw	0.52	0.52	1.6	Very slow

Sugarcane leaves	1.29	0.52	0.86	Slow
Ash	-	-	2.3-12	Rapid
Animal tankage	7.0	4.4	0.6	Medium
Garbage tankage	2.7	1.3	1.2	Very slow

2. **Conversion of conventional to organic farming**: Conversion time of organic is almost similar to other global standards (IFOAM Basic, AROS etc.) in the BARI and proposed organic standards of NWG. It is the critical factor for promoting the organic agriculture around the globe too. A common conscious may be come up in the SAARC countries to minimize the conversion time. Here we would like to propose that conversion time could be 2 cropping cycle instead of 2 years. As the most of the farmers in this region are smallholders and this piece of land is for his livelihood. Moreover, during the conversion time the product will be termed as organic green in the PGS system.

3. **Farm waste recycling, organic mulches**: Farm waste produced in the organic farm is being suggested to be utilized as mulching and compost. The easiest way to recycle yard wastes in the backyard is as mulch, which can be applied to gardens, flowerbeds, and even lawns. Mulches help conserve soil moisture, reduce annual weed growth, and reduce extreme fluctuations in soil temperatures. Dried grass and clippings make excellent mulches for organic field. Recycling grass clippings, leaves, and shredded branches as compost has a number of significant advantages over mulching alone. Not only can compost be used as mulch - it is also a source of macro and minor elements used for plant growth, even if they occur in relatively small amounts. Elements also occur in organic forms that tend to make them more available in alkaline soils and less likely to leach. Humic acid produced in the composting process also makes other elements in the soil more available for plant uptake. Compost will also help improve soil structure, improving the drainage of clay soils and the water holding capacity of sandy soils. The ability of sandy soils to retain nutrients will also increase significantly with the addition of compost. Government has also various programs other than organic to motivate farmer for recycling the farm waste on the farm side through DAE. NGO's are also active in this connection.

Scope of organic agriculture including organic manures produce

Organic fertilizers are the main ingredients to feed and improve the soil. Various resources are available in the country, which could be vital sources for organic fertilizer.

1. **Livestock:** Livestock is the important sources of organic manures and around 21 million cattle, 1.5 million buffalo, 255 million poultry and 49 million duck available (Table 6). Every year a cattle discharge 6000 kg dung and 2000 litres urine, a buffalo 8000 kg and 2500 litres urine, birds (poultry and duck) 20 kg which is huge resource for organic manures. There is a substantial amount of NPK may come from this amount of excreta (Table 6). Moreover, after application these amounts also accelerate the microbes' concentrations in the soil, which might increase the organic matter of soil and stabilized from sustainable crop production.

Table 6: Status of livestock and potentialities to supply mineral nutrient (NPK) from existing in Bangladesh

Name of Animal	Number (M)	Dung * /year/unit (kg)	Urine * /year/unit (L)	Estimated Available		
				N (Mkg)	P (Mkg)	K (Mkg)
Cattle	20.89	6000	2000	1671.2	752.04	1253.40
Buffalo	1.46	8000	2500	153.3	70.08	116.80
Poultry	255.01	20		89.76	76.50	43.35
Duck	48.86	20		17.20	14.66	8.31

M = Million, L = Litre, kg = Kilogram (**Source**: DLS, 2015, *Sharma, 2005)

2. **Waste production and composition of Bangladesh**

   In Bangladesh, there are 22 million households. Everyday around 1kg of organic waste is being produced, which is amounted to 8.03 million tonnes per year containing 0.8-2.0% N, 1.0% P and 1.5% K and could be used for composting. Moreover, kitchen market wastes also potential sources for organic manure. The organic wastes of some major cities are given in Table 7.

Table 7: Amount of organic, compostable waste major cities of Bangladesh (t day^{-1})

Waste component	Dhaka	Tungi, Gazipur	Narayangaj	Rajshahi	Rangpur	Barisal	Chittagong	Khulna	Sylhet	Other cities	Total
Organic waste (t)	5660	184	122	277	126	69	1756	476	93	8664	17759
	6646	217	144	325	148	81	2062	559	109	10173	20852
Compostable waste (t)	4245	138	92	208	94	51	1317	357	70	6498	13319
	4985	162	108	244	111	60	1547	420	82	7630	15639

Preparation of organic matter and organic compost

Increase organic matter in the soil is the main concern and desirable in organic farming. Farmers are advised to be attentive during application of organic substances. Usually fresh cattle dung/ immature composts are not advised apply directly in the field instead of matured compost. The matured compost will not give foul smell.

1. **Commercial Organic Fertilizers:** Government of Bangladesh is giving registration to the company for commercial fertilizers on basis of some set characteristics (Table 7). There are 29 organic fertilizers so far been registered and marketing to growers. A good number of fertilizers are waiting for approval. However, there are around 40 thousand vermicompost producers they also sale those to the nearby farmers. The criteria of giving approval of organic fertilizers are given in Table 8.

Table 8: Characteristics of organic fertilizers to be followed for approving the registration

Component	Recommended dose/ character
Physical	
Color	Dark grey to black
Physical condition	Non granular form
Odor	Absence of foul odor
Moisture	Maximum 10-20%
Chemical	
pH	6.0-8.5
Organic Carbon	10-25 %
Total Nitrogen	0.5-4.0%
C:N ratio	Maximum 20
Phosphorus (P)	0.5-3.0%
Potassium (K)	0.5-3.0%
Sulphur (S)	0.1-0.5%
Zinc (Zn)	Maximum 0.1%
Copper (Cu)	Maximum 0.05%
Arsenic (Ar)	Maximum 20ppm
Chromium (Cr)	Maximum 50ppm
Cadmium (Cd)	Maximum 5ppm
Lead (Pb)	Maximum 30 ppm
Mercury (Hg)	Maximum 0.1ppm
Nickel (Ni)	Maximum 30 ppm
Inert materials	Maximum 1%

The aspirant stakeholders have to fulfill the criteria for having the registration and they market it. There is direct instruction is that no synthetic source is allowed in the organic fertilizers. A list of organic fertilizers is mentioned in the Table 9.

Table 9: List of Organic fertilizer Factories Registered with DAE

Sl No.	Name of Organization & Address	Registration No/ Brand	Registration No and Issue date
1.	M/S Northern Agro Services Ltd Pulhat, Ramsagor Road Mohorompur, Dinajpur	Northern organic fertilizer	M-65 Date-24/05/2003
2.	M/S Faruque Fertilizer Ltd 116/C, Monipuripara, Krishibid Institution, Farmgate, Dhaka	Chuk Chuk-102	M-10 Date-02/05/2005
3.	M/S Faruque Fertilizer Ltd 116/C, Monipuripara, Krishibid Institution, Farmgate, Dhaka	Chuk Chuk-150	M-11 Date-02/05/2005
4.	M/S Annyapurna Agro Services Ltd	Annyapurna organic fertilizer	M-348 Date-5/11/2006
5.	M/S Waste Concern A H M Maksud Sinha Vulta, Rupgonj, Narayangonj	Waste Concern organic fertilizer	M-462 Date-20/05/2009
6.	M/S Grameen Shakti Depal C Barua 6, Borobag, Mirpur, Dhaka	Poultry litter based fertilizer jaiba Sar	M-465 Date-27/05/2009
7.	M/S Grameen Shakti Depal C Barua 6, Borobag, Mirpur, Dhaka	Cow dung based jaibo sar	M-470 Date-10/06/2009
8.	M/S Meghna Fertilizer Company Ltd Prop: Md. Saydur Rahman Khan, Managing Director Musurikhola (Hemayetpur), Savar, Dhaka	Megna jaibo sar	M-491 Date-08/04/2010
9.	M/S Mojumder Agro Services Torikul Islam Mojumder Ratanpur, Bijoypur Bazar, Comilla Sadar South,Comilla	Super green field	M-492 Date-26/04/2010
10.	M/S Intefa	Hisan jaibo sar	M-498

	Prop: Kazi M A Daud Ibrahim 491, Wireless Rail gate, Boro Mugbazar , Dhaka-1207		Date-30/05/2010
11.	M/S CoCo Fertilizer Mills Prof. Dr. Hasina Bnu, Chachra Check post, Jessore	CoCo dust compost sar	M-504 Date-18/10/2010
12.	M/S Agro Organic Food Complex Ltd, Comorpur, Faridpur	Urbora shakti jaibo Sar	M-600 Date-13/07/2011
13.	M/S Agro Arina Associates Zohir Hasan Maruf , R B K Road ,Chachra, Jessore	Orko Jaibo Sar	M-601 Date-31/07/2011
14.	M/s Surma Fertilizer Industries Ltd Md. Shahin Mia Notun para (vorari), Rajfulbaria, Savar, Dhaka.	Laltir compost jaibo sar	M-602 Date-17/11/2011
15.	M/S R K Agro Products Ltd M A Kuddus, Paiti, Damra, Dhaka.	R K Taza jaibo Sar	M-603 Date-22/11/2011
16.	M/s Rurul Development Academy, Bogra	Palli jaibo Sar	M-604 Date-27/11/2011
17.	M/S Seed Bangla Agro Industries Md. Rofikul Islam Sha-45/ka, Hossain Market, North Badda, Dhaka-1212.	Seed Bangla jaibo Sar	M-605 Date-07/03/2012
18.	M/S Molla Productivity Corporation Ltd., Md. Abdur Rauf Block-A, Road-20, Khilgao Tilpara, Dhaka-1219	Molla jaibo Sar	M-606 Date-13/05/2012
19.	M/S Ria fertilizer Prop: Md. Abul Kalam Azad Domdom, Shahbajpur, Sirajgonj	Manik Ratan Jaibo Sar	M-609 Date-23/07/2012
20.	M/S Paragon Agro Ltd. Prop. Md. Moshiur Rahman Paragon house 5, Mohakhali, Dhaka	Paragon Jaibo Sar	M-611 Date-6/10/2012
21.	CMES	Sey o sey vermin	M-612

	Prop. E/D-Hasna Banu House 823, Road 19, Dhanmondi R/A , Dhaka	compost	Date-11/11/2012
22.	Reyna Associates Prop. Md. Mostafizur Rahman 174/175 East tejturibazar, Tejgaon, Dhaka	IGL Jaibo sar	M-613 Date-2/02/2013
23.	Rustic Prop. Morol Nazrul Islam House 11, Road 6, Sonadanga, Khulna	Rustic compost jaibo sar	M-614 Date-12/03/2013
24.	Sebok Agrovet Ltd. Prop. Khaled Md. Arafat Amin Hossain Madrasa Road, Pukuria, Khondokar para, Bashkhali, Chittagong	Sebok Jaibo sar	M-615 Date-20/04/2013
25	Mati Organics Ltd. Prop. Md. Khairul Alam Bhuian Vawal Mirzapur, Purbo para, Sadar, Gazipur	Biojen Jaibo sar	M-617 Date-20/07/2013
26.	Mazim Agro Industries ltd. Prop. Md. Mogoljan Rahman Chakpara, Maona, Sripur, Gazipur	Mazim Organic fertilizer	M-618 Date-16/12/2013
27.	Nafco (pvt) Ltd. Prop. MS Huda Zadurchar, Hemayetpur, Savar, Dhaka	Nafco Jaibo Sar	M-619 Date-16/12/2013
28.	Nirvana Agro Ltd. Prop. Monwar Hossain Saidabad, Sadar, Sirajgonj	Nirvana Jaibo Sar	M-621 Date-2/04/2014
29.	M/S Krishibid Farms Ltd Prop. Md. Ali Afjal 801 Rokeya Soroni, Kazipara, Mirpur, Dhaka	Krishibid Jaibo Sar	M-625 Date-19/07/2014

Source: FSW, DAE 2015

2. **BARI developed organic fertilizer (BAOFER):** Olericulture Division of Horticulture Research Center, BARI, Gazipur has developed a organic fertilizer namely, Biologically active organic fertilizer (BAOFER) is constituted of rice bran, mustard oil cake, fish debris, poultry refuge, ash, water, agricultural soil and half composted cow dung. All the ingredients were mixed together at the rate of rice bran, mustard oil cake, fish debris; poultry refuge, ash, water, agricultural soil and half composted cow dung 200kg, 100kg, 50kg, 300kg, 25kg 10kg and 15kg respectively. Fifty percent water is being applied in the heap and mixed thoroughly. The heap was covered with bamboo mat and allowed for aerobic composting. After completing the mesophilic and thermophilic stage, the compost has been matured. To accelerate the composting and protection from nutrient combustion, the heap was broken down to remove the heat during the composting. A thermometer was also put on the heap to observe the temperature. Matured compost was tested using panel test and finally sampled for assessing the nutrient status. The physicochemical characteristics were given in Table 10.

Table 10: Physicochemical characteristics of matured compost

BAOFER physicochemical characteristics			
Physical conditions	= Non-granular form	Potassium(K)	= 1.93%
Colour	= Dark gray	Sulphur(S)	= 0.40%
Odour	= Absence of foul odour	Zinc(Zn)	= 0.05%
Moisture	= 16.1 %	Copper(Cu)	= 0.002%
pH	= 8.0	Chromium(Cr)	= 0.00ppm
Organic Carbon	= 19.8%	Cadmium(Cd)	= 0.00ppm
Total Nitrogen(N)	= 2.27%	Lead(Pb)	= 0.00ppm
C:N	= 9.2:1	Nickel(Ni)	= 0.00ppm
Phosphorous(P)	= 3.67%	Inert material	< 1%

Soil and crop management

1. **Tillage:** Organic systems tend to utilize shallow rather than deep ploughing, as this retains crop residues near the soil surface, where they break down more rapidly and where most rooting occurs (Table 11), while achieving sufficient

aeration (Lampkin, 1990; Lampkin *et al*., 2007). Cultivation itself leads to an increase in nutrient availability, particularly N, as microbial activity is stimulated and organic matter breakdown occurs (Balloni and Favalli 1987; Torbet *et al*. 1998; Silgram and Shepherd, 1999). Mechanical weed control can thus provide a mid-season boost to crops by stimulating mineralization although at other times additional stimulation of mineralization may cause losses by leaching or denitrification. Tillage is known to decrease soil organic nitrogen (N) and carbon (C) pools with negative consequences for soil quality. This decrease is thought to be partly caused by exposure of protected organic matter to microbial degradation by the disturbance of the soil. Ploughing device also play vital role for degrading soil organic matter (Glanz, 1995). Therefore, farmers are advised to choose better tillage implement.

Table 11: Ploughing device and loss of organic matter

Types of tillage	**Organic matter lost in 19 days (kg ha^{-1})**
Mould board plough + disc harrow (2x)	4300
Mould board plough	2230
Disc harrow	1840
Chisel plough	1720
Direct seeding	860

Source: Glanz, 1995

2. **Intercropping:** Organic farming does not advocate monoculture rather it encourages the multiple cropping in the same field. In Bangladesh intercropping is very common specially for vegetables based farming and farmers are very innovative in this connection. The main crops cultivated in organic system paddy, potato, mustard, masur (*Ervum lens*), khesari (*Lathyrus sativa*), blackgram (*Cicer arietinnum*), and vegetables. According to Rasul and Thapa (2004), cropping intensity, crop diversification and mixed cropping have significant variation with organic in Bangladesh (Table 12).

   Cropping intensity in the organic system was found to be higher than in the conventional system, and even higher than the national average cropping intensity of 1.76 (Rahman and Thapa, 1999).

Table 12: Cropping intensity, crop diversification and mixed cropping

	Index values	
	Ecological system	**Conventional system**
Cropping intensity [a]	2.0	1.8
Crop diversification [b]	14.2	19.8
Mixed cropping [c]	0.3	0.1

[a] The higher the index value, the higher the intensity, [b] The lower the index value, the higher the diversity, [c] The higher the index value, the higher the mixed cropping.

3. **Mulching:** Mulches contribute to weed management in organic crops by reducing weed seed germination, blocking weed growth, and favoring the crop by conserving soil moisture and sometimes by moderating soil temperature. Synthetic mulching is not affordable as our farmers are not rich enough to buy it. Further, synthetic mulching materials are also not available. Organic mulches like straw suppress annual weed seedlings, conserve moisture, and add organic matter as they break down, but they are more labor-intensive to apply but still popular and could handle easily by our farmer. Organic management systems restrict the use of non-bio-degradable coverings and mulches.

   Through mulching humus status can be increased and humas is the longest lasting component of soil organic matter. It can last for several thousand years. Humus is generally very resistant to microbial breakdown; however a combination of synthetic nitrogenous fertilisers and oxidation through poor tillage practices causes it to decline rapidly. Soil erosion is the other major cause of humus loss, due to the top layers of the soil having the highest percentages of humus.

4. **Water management:** Organic management ensures that water resources are used efficiently to meet farm production requirements with strategies established to optimize water use and prevent wastage. Water is the carrier of chemical and microbial contaminants. As industrialization is the realty to development of Bangladesh, therefore, industrial contaminants have to manage through efficient manner in the organic system.

   On the other side, under organic practices, the consistent piece of information coming from many studies is that organic agriculture performs better than conventional agriculture in adverse weather events, such as droughts and intense rains. Organic systems use water more efficiently. Organic systems use water more efficiently due to better soil structure and higher levels of organic matter particularly humus. The open structure allows rain water to quickly penetrate the soil, resulting in less water loss from runoff. Humus is one of the most important components of organic matter. It stores up to 30 times its weight in water so that rain and irrigation water is not lost through leaching or evaporation. It is stored in the soil for later use by the plants (Handreck and Black, 2002).

5. **Maintenance of buffer zone:** Organic management takes precautionary measures to avoid contamination that could affect the organic integrity of the supply chain. Precautionary measures may include barriers/ buffer zones in production, cleaning of farm equipment, use of dedicated facilities and equipment and cleaning in processing. Organic management actively addresses risks of contamination. Where there is reasonable suspicion of contamination, efforts shall be made to identify and address the source of contamination. Organic management systems do not use genetically modified organisms (GMO) or their derivatives, in all stages of organic production and processing. The buffer zone for reducing the contamination is being proposed 5-7 meters for single organic from the nearby conventional farmers. For the community farming the block has to be separated 10 meters.

6. **Split production and parallel production**: The integrity of an organic farm unit is not compromised by the activities and management of non- organic operations undertaken on the same farm. Organic management completely and clearly separates the non-organic and organic parts and products of holdings with split or parallel production, e.g. through physical barriers; management practices such as the production of different varieties or the timing of harvest; storage of inputs and products. Considering the economical conditions of the farmers/ group partial conversation is being advocating to under the benefit.

Natural safe products for control of pest, disease, weeds, growth management

1. **Prevention**: Successful organic farming requires a whole-farm approach. This means managing a crop or animal as an integral part of the farm system rather than in isolation. Good organic farming is not just a matter of substituting an

organically acceptable input for a synthetic chemical. Initially some farmers convert to organic farming by using allowable organic inputs to replace chemicals. This is called substitution farming and it is seen as the first steps in the process of developing high output low input organic systems. It is very useful for many conventional farmers to take this approach as it is not such a great paradigm shift from their current practices.

IFOAM defines this process as: “As an ecosystem based sustainable production system OA relies on the utilization of biodiversity and the optimal utilization of ecosystem services. The use of these services is the key to the success of OA. To maximize multi-functional benefits OA utilizes ecological rather than chemical intensification. Ecological intensification optimizes the performance of ecosystem services. These services include pest and disease regulation, water holding and drainage, soil building, soil biology and fertility, nutrient cycling, nitrogen fixation, photosynthesis and carbon sequestration, multiple agricultural crop and animal species, pollination and others”

Soil health is the key principle to successful sustainable farming. Correctly balanced soil ensures minimal disease and insect damage. Plants growing on fertile soils are more resistant to pests and diseases than plants that are deficient or stressed due to poor soils and or poor management. Healthy plants produce a range of compounds that prevent or reduce damage from pests and diseases, particularly the phenolic and flavonoid anti-oxidants. A well balanced soil with high levels of calcium, humus and a neutral pH encourages a range of beneficial species and suppresses pests and diseases. These soils are rich in beneficial organisms. Examples are Trichodermasps that controls pathogens such as Rhizoctonia, Phytophthora pathogens such as Rhizoctonia, Phytophthora and Armillaria. Actinomycetes control many pests and diseases. Predatory nematodes control root burrowing nematodes and organisms such as Metarhizium and *Bacillus thuringiensis* kill range of insects.

The most efficient method dealing with pests and diseases is to be proactive and have a pest management plan. Generally the best results are obtained by developing a plan that uses a range of strategies taking a whole of farm approach. Unfortunately in most of agriculture, pest management is an ad hoc process. This means that the pests and diseases should be continuously controlled by the ecological systems the majority of the time. However no system, natural or manmade is infallible. Good famers will monitor and have a back-up strategy to deal with problems when they arise. Good organic farmers move beyond IPM by applying Eco Functional Intensification. One of the great advantages of Eco Functional Intensification is that once these systems are in place the ecology is doing the work to control the pests and disease with the help of the farmer. There is an old saying: “The footsteps of the farmer are the best fertilizer”.

2. **Biological control**: Biological methods of controlling pests are excellent examples of eco function intensification. A range of ecological solutions are used to replace the need for spraying to kill the pests and diseases. The ecology does the work. Insectaries are groups of plants that attract and host beneficial insects, arthropods and higher animal species. These are the species that remove arthropod (insect) pests from farms, orchards and gardens. They are known collectively as beneficials. Many beneficial insects have a range of host plants. Some useful species such as parasitic wasps, hoverflies and lacewings have carnivorous larvae that eat pests however the adult stages live mostly on nectar and pollen from flowers. Flowers provide beneficial insects with concentrated forms of food (pollen and nectar), to increase their chances of surviving, immigrating and staying in the area. Very importantly flowers also provide mating sites for beneficials, allowing them to increase in numbers. Trap crops are a variation of insectaries and are used to trap pest species. There are a range of methods and types of crops that are used.

   Examples:

   - Trap crops - Marigold as a trap crop
   - Repellent species
   - Barriers
   - Planting non pest host species and pest resistant varieties
   - Many beneficial insects can now be purchased. The following groups of arthropods are usually available.

     • Predatory nematodes, • Predatory mites, • Trichogramma and other parasitic wasps,

     • Lacewings (Chrysoperla sp.), • Lady beetles (Coccinella sp.)
   - Baits, lures, traps and pheromone disrupters

3. **Physical control:** (Allowable organic sprays and spray technology)

   Toxic sprays: Natural pyrethrum is very effective for every pest, as at this stage no insect has developed resistance to it. This is because it is a natural extraction of a mixture of different pyrethrums, with every batch having different combinations. This means if an insect pest begins to develop resistance against one batch, the following year's batch of natural pyrethrum will be different enough to ensure that the pests have no resistance to it.

List of organic insecticides, fungicides and biological controls

Below are lists of many of the natural compounds and biological controls that are allowed to be used in certified agriculture. This is by no means a complete list and there are many other natural compounds and biological controls that are available. It is always worth doing more research. Good farmers will always use a diverse range of these as part of their pest and disease management systems.

Botanical and simple natural chemicals

- Natural pyrethrum • Rotenone • Quassia • Ryania
- Emulsified vegetable oils • Mineral oils, • Essential oils
- Tea tree (*Melaleuca alternifolia*), eucalyptus, citronella (*Cymbopogon citratus*), lavender (*Lavandula sp*.), cypress pine (*Cupressus sp*.) etc.
- Potassium soap • Plain soap • Sodium silicate (waterglass) • Neem (*Azadirachta indica*)
- Copper sulphate • Lime • Sulphur • Potassium permanganate • Borax, • Baking soda
- Diatomaceous earth, • Stone meal, • Sea salts, • Kaolin, • Flour and water, • Chilli sprays,
- Garlic, • Vinegar and wood vinegar, • Pheromones, • Bordeaux mixture,
- Copper sulphate, Copper carbonate, Neem leaves and seeds, Diatomaceaous earth
- Sodium bicarbonate, • Vinegar and wood vinegar, • Yogurt and other natural lactic acid, fermented milk products, • Milk, whey and milk solids
- Synthetic chemical lures and baits are allowed if they are enclosed so that they do not leach into the environment.

Biopesticides

Various bacteria, fungi, viruses and their naturally produced metabolites are allowed. Many of these are very susceptible to insecticides, fungicides and particularly many herbicides.

- Bacillus thuringiensis – var. kurstaki for caterpillars
- Bacillus thuringiensis – var. enebrionis for beetles
- Bacillus thuringiensis – var. israeliensis form
- Trichoderma species for controlling diseases
- Cliocladiun virens for controlling diseases
- Bacillus subtillus for controlling diseases
- Verticilium lecanii for scale insects, aphids and white flies
- Beauveria basiana for a wide range of insects

Fresh good quality compost should have high levels of actinomycetes, protozoa and beneficial fungi that will control a wide range of pests and diseases.

Beneficial insects and arthropods

Many beneficial insects can now be purchased. The most effective way to introduce these creatures into the farm is to provide insectaries. Insectaries provide the equivalent of many thousands of dollars' worth of beneficial species weekly at no cost.

• Predatory nematodes, • Predatory mites • Trichogramma, • Wasps, • Lacewings, • Lady beetles, • Spiders, • Praying mantis, • Dragon flies

Commercial pesticides in Bangladesh

Before amending the rule 2010, the pesticide regulation in Bangladesh was on synthetic pesticides. In 2010, bio-pesticide component has been incorporated to the rules. After that, a few of bio-pesticide has been registered (Table 13) and a good number of bio-pesticide are in pipeline. Some popular products are enlisted in Table 14.

Table 13: Registered Bio-pesticide in Bangladesh

Bio-pesticide product	**Target crops**	**Target disease and pest**	**Application and mode**	**Application rate**
Cuelure (Pheromone) 3 products	Cucurbits	Fruit fly (*Bractrocera cucurbitae*)	Set in water trap within one month of seed sowing	70 lure (trap) ha^{-1}
Methyl Euginol (Pheromone) (1 product)	Mango	Fruit fly (*Bractrocera dorsalis*)	Set in water trap before one ad half month of harvesting	80 lures (traps) ha^{-1}
Spodoptera Pheromone (1 product)	Cabbage , cauliflower, mustard, chilli, tomato etc.	Prodenia caterpillar, spodoptera litura	Set in water trap within three weeks of seed sawing	40 lures (traps) ha^{-1}
BSFB pheromone (2 products)	Brinjal	BSFB *Leucinodes orbanalis*	Set in water trap within two weeks of transplanting	100 lures (traps), lure should change after 2 months
Abamectin 1.8 EC (natural fermentation product) (39 products)	Rice brinjal tea, cotton, litchi)	Redmite, spider, aphids, jassid	Foliar application	1.25 ml $litre^{-1}$ water
Spinosad (natural fermentation product)	Rice, Brinjal cotton	BFSB, Aphids, jassids, bollworm, hairy catterpiller, leaf folder	Foliar application	0.4 ml $litre^{-1}$ water

Table 14: Some popular products in Bangladesh

Bio-pesticide product	Target crops	Target disease and pest	Application and mode	Application rate
Azadirachtrin (neem based formulation)	Vegetables	Jassids, aphids, mite, thrips	Foliar application	1-3 ml litre^{-1} water depending on formulation
SNPV (Single embedded Nuclear Polyhedrosis Virus) *Spodoptera litura*	Cabbage, cauliflower, mustard, chilli, tomato	Prodenia caterpillar, spodoptera litura	Foliar application	0.2 g litre^{-1} water
Bt formulation	Vegetables, Chilli	Lepidoptera pest	Foliar application	0.4 g litre^{-1} water
Trichoderma (in pit soil)	Vegetables spices	Soil borne diseases	Mixed with the top soil (12 cm) one week before planting	1kg/4 dec., 5 g kg^{-1} soil in nursery

Post harvest management

On farm post harvest management maintains the organic integrity of organic products. On-farm post harvest management takes measures to prevent contamination and co-mingling of organic products with non-organic products in processing, handling, packaging, storage and transport; for example in the threshing, peeling, hulling, cleaning, cooling, cutting, drying and packing of products.

Fresh fruits and vegetables are often thought of as healthful, nutritious foods having no risk of foodborne illness associated with their consumption. However, recent foodborne illness outbreaks worldwide have been traced to fresh fruits, vegetables and juices. These incidents have caused growers, shippers, distributors, retailers and importers to reevaluate fresh fruit and vegetable production and handling practices. The probability of getting sick from eating a raw fruit or vegetable is very low, but a small probability does exist. Reducing the risk of food-borne illness from consumption of fresh fruits and vegetables is the responsibility of everyone, including growers, shippers, processors and consumers. Many natural formulations are common to minimize such microbial contamination.

Processing and Handling

Processing and handling management systems maintain the organic integrity of organic products. Organic processing management takes measures to prevent contamination and co-mingling of organic products with non-organic products in processing, handling, packaging, storage and transport. For example – the transportation of organic and non-organic products can only occur if adequate measures are in place to prevent mixing or contamination such as the products having different labeling and separate handling practices.

Approved additives and processing / post-harvest handling aids are Calcium carbonate, Tannic acid, Sulfur dioxide, Potassium metabisulphite, Lactic acid Carbon dioxide, L-malic acid, Ascorbic acid, Tocopherols, mixed natural concentrates, Lecithin , Citric acid, Sodium citrates, Potassium citrates, Calcium citrates, Tartaric acid, Sodium tartrate, Potassium tartrate, Mono calcium phosphate, Ammonium phosphate, Alginic acid, Sodium alginate, Potassium alginate, Agar, Carrageenan, Locust bean gum, Guar gum, Tragacanth gum and Arabic gum , Xanthan gum, Gelatin, Pectin, Sodium carbonates, Potassium carbonates, Ammonium carbonates , Magnesium carbonates, Potassium chloride , Calcium chloride, Magnesium chloride, Sulfuric acid, Calcium sulfate, Ammonium sulfate, Sodium hydroxide, Calcium hydroxide, Silicon dioxide (amorphous), Talc, Bentonite, Beeswax, Carnauba wax, Argon, Nitrogen, Oxygen, Ethylene, Activated carbon, Casein, Cellulose, Diatomaceous earth, Ethanol, Isinglass, Kaolin, Perlite, Preparations of bark.

Flavouring Agents

- Organic flavouring extracts (including volatile oils), and, if not available,
- Natural flavouring preparations approved by the control body. Such approval shall include assessment that natural flavors shall meet the following criteria:
    - The sources are plant, animal or mineral;

- The process of production is in accordance with a recognized organic standard;
- They are produced by means of solvents such as vegetal oil, water, ethanol, carbon dioxide and mechanical and physical processes.

Preparations of micro-organisms and enzymes for use in food processing

These may be used as ingredient or processing aids with approval from the control body:

- Organic certified micro-organisms
- Preparations of micro-organisms
- Enzymes and enzyme preparations

Before using these substances, stakeholders have to standardize the dose case by case

1. **Quality of food and crop productivity under natural ecological systems:** Present food production based on the philosophy is use of high input and harvest high output. It does not consider sufficiently the sustainability of the production. As result global organic matter which is the key source of crop nutrition, depleted alarmingly. Organic crop production standards prohibit the use of synthetic chemical crop protection products and certain mineral fertilizers to reduce environmental impacts leaching and pesticide contamination of groundwater) and the risk of pesticide residues being present in crop plants. Instead, they prescribe regular inputs of organic fertilisers (e.g. manure and composts), use of legume crops in rotation (to increase soil N levels), and application of preventative and non-chemical crop protection methods (e.g. the use of crop rotation, more resistant/ tolerant varieties, mechanical and flame weeding, and biological disease and pest control products). However, organic standards permit the use of certain plant or microbial extract and/or mineral (e.g. Cu- and S-based) crop protection products. Recent meta-analyses based on 343 peer-reviewed publications that indicate statistically significant and meaningful differences in composition between organic and non-organic crops/ crop-based foods. Most importantly, the concentrations of a range of antioxidants such as polyphenolics were found to be substantially higher in organic crops/ crop-based foods, with those

of phenolic acids, flavanones, stilbenes, flavones, flavonols and anthocyanins being an estimated 19 (95% CI 5, 33) %, 69 (95% CI 13, 125) %, 28 (95% CI 12, 44) %, 26 (95% CI 3, 48) %, 50 (95% CI 28, 72)% and 51 (95% CI 17, 86)% higher, respectively. Many of these compounds have previously been linked to a reduced risk of chronic diseases, including CVD and neurodegenerative diseases and certain cancers, in dietary intervention and epidemiological studies. Significant differences were also detected for some other (like minerals and vitamins) compounds. There is evidence that higher antioxidant concentrations and lower Cd concentrations are linked to specific agronomic practices prescribed in organic farming systems. In a conclusion, organic crops, on average, have higher concentrations of antioxidants, lower concentrations of Cd and a lower incidence of pesticide residues than the non-organic comparators across regions and production seasons and increased the microbial activities in the soil. There is scope for increased production on organic farms, since most agricultural research of the past 50 years has focused on conventional methods. Arguably, comparable efforts focused on organic practices would lead to further improvements in yields as well as in soil fertility and pest management. Production per unit area is greater on small farms than on large farms in both developed and developing countries; thus, an increase in the number of small farms would also enhance food production.

2. **South Asian Organic farming and trade/ market analysis:** Among the SAC member countries India is the leading terms of acreages and global trade. FIBL (2015) documented around 0.7 million producer in Asia and they are mostly from India. Bhutan has declared whole country as an Organic by 2020. Nepal and Sri Lanka also have product and producer as well. Bangladesh having 68660 hectares of certified organic lands (FIBL 2015).

   Since Bangladesh is a developing country and purchasing capacity of peoples is low, as a result people living in rural and urban areas mostly cannot afford organic foods. Situation is different among the well off conscious elite persons living in urban areas. This awareness compels to initiate organic food shops like Probortana, PROSHIKA, Meena Bazar and others to sell these commodities at a higher price, which is beyond the capacity of general people. Recent days, there are developments of marketing organic food like Prakritik Krishi Biponon Kendro at Mohammadpur and Dhaka Locoz at Jhenaidah. As there have authentication, opposite situation is found in rural areas. Recently, BARI initiated PGS system and Locoz applied for PGS Certification. Farmers in general grow vegetable and other consumable foods without pesticide and fertilizer for their own household consumption and these are not sold in the markets. Recently different private companies/ chain shops (like Agora, Meena Bazar, Nandan etc.) are selling organic fruits, vegetables and spices – these are for higher income people. Production and marketing system of organic agricultural products mainly are done by contract farming for private organizations/ companies/ chain shops and does not ensure fair price for the producing farmers.

Sustainability of the farming is depending on effective marketing system and value addition. At present, there is no separate marketing channel for organic goods. Certification processes have not yet developed even for internal market. Growers usually consume their own products and excess amount sell with other conventional product. Only UBINIG have two outlets namely *Shassy prabattana* in Dhaka sell branding as natural product which was grown by their member farmers. UBINIG also add value by processing the in the traditional processing instruments (Dhaki, Jata etc.) and send to outlet. Meena Bazer also has an organic corner and sells its own grown products. Three years trade's data of different organic food in Meena Bazer are shown in Fig. 4. It revealed that most of the products trade volume becomes almost doubled within three years. This is indicated the local demand. Fig. 5 showed the export volume of tea in the global market showing the same trend.

Organization	**Product**
Shassy prabattana	Rice, onion, chili, chili powder, pup rice, pulses, beans, garlic, zinzer, fruits pickles etc
Meena Bazer	Rice, onion, chilli, chilli powder, pup rice, pulses, beans, garlic, zinzer, mustard oil etc

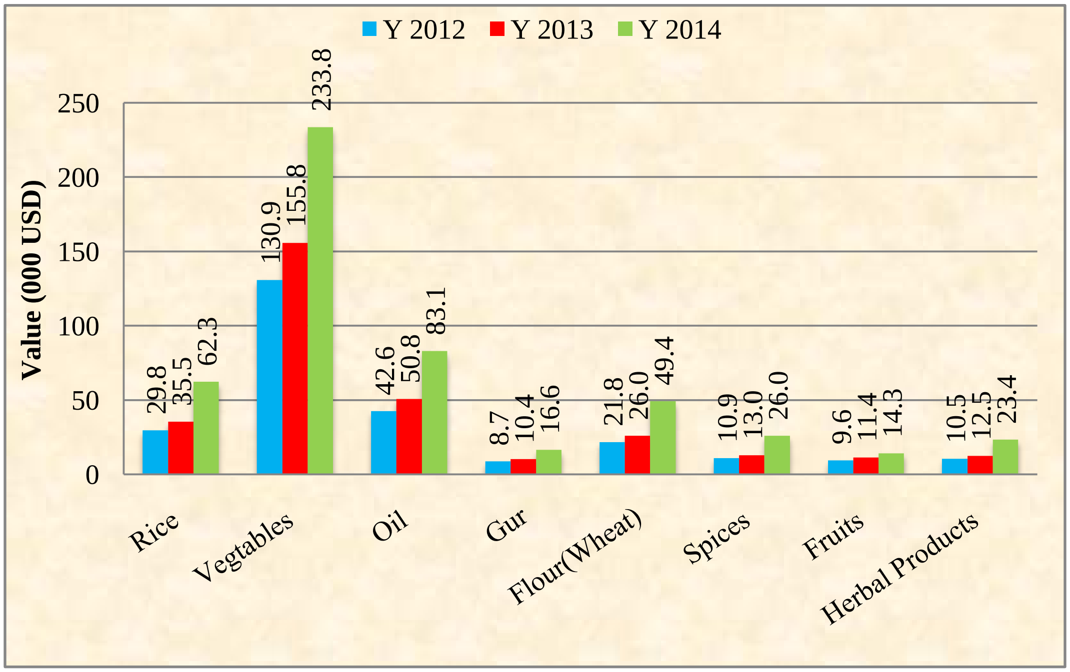


Fig. 4: Local market scenario of Mena Bazar during 2012 to 2014

FIBL 2014 documented the key commodity from Bangladesh for export.

- Tea, Rice
- Fruits (Banana, Mango, Pineapple Coconut, Jackfruit)
- Vegetables (Tomato, Brinjal, Taro, Cucumber, Pumpkin)
- Spices (Chilli Ginger, Turmeric, Garlic Onion, pepper, bay leaves)
- Fish (Sweet water -Ruhit, Katala),
- Meat (Goat, Chicken, beef, Shrimp)
- Honey (Wild collection)
- Different herbal products and medicinal plants

According to KKTE, the local markets have more demand of organic food but they are not able to fulfill the demand of the consumers. For the export market, EU (50%), USA (20%) and Japan (3%) are the main importers of organic tea from Bangladesh. Recently, organic shrimp have also been exported while USA, EU, Japan, New Zealand, Malaysia, India and Dubai are main recipients.

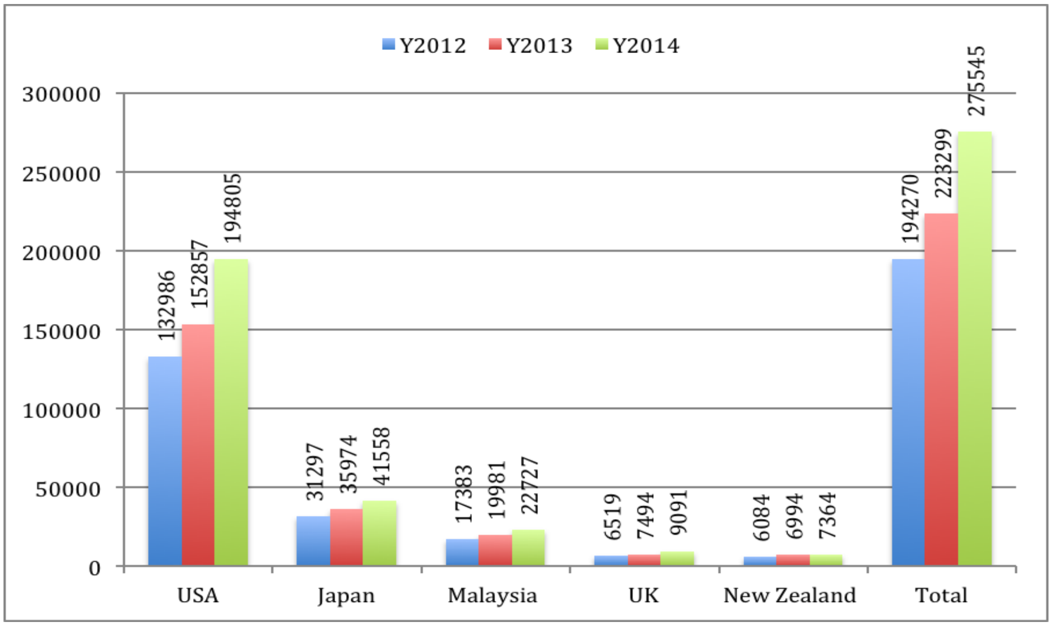
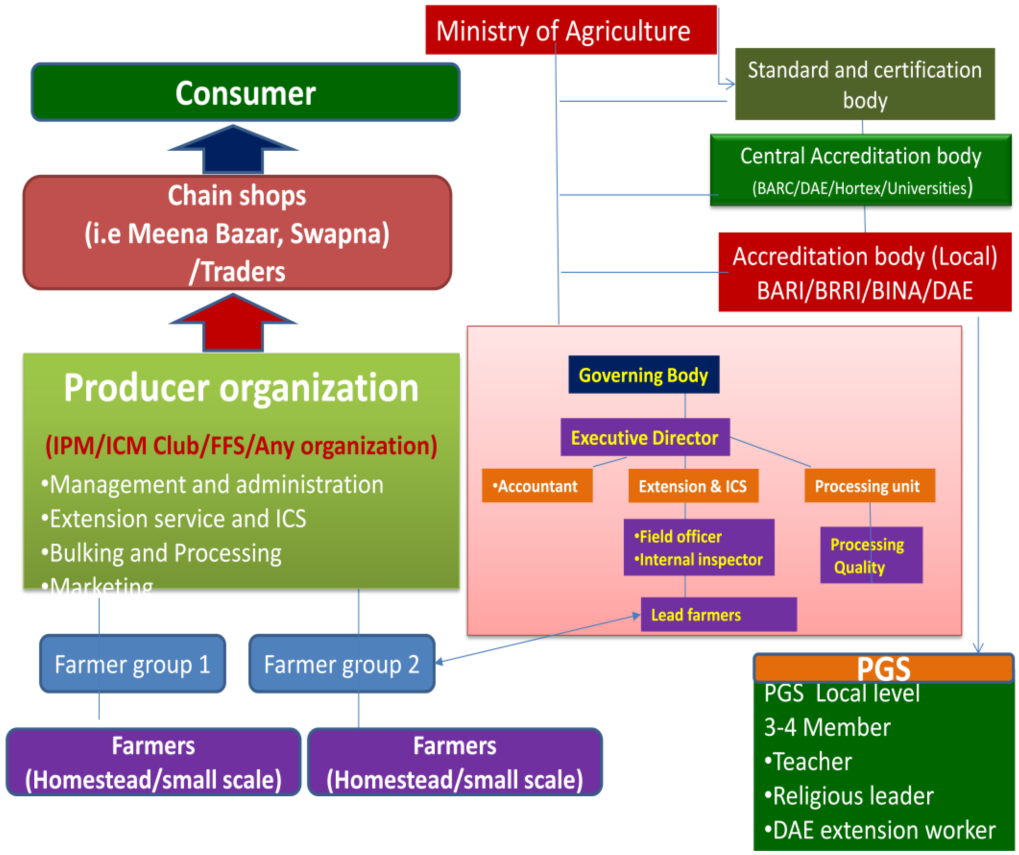


Fig. 5: Export Market of organic tea during 2012-2014

Issues and scope of marketing organic produce

As the consumers interests is increasing on safe food and organic production, by virtue of its production and handling procedure is safe enough. Business people also exploiting the organic brand but unfortunately, nobody could assure it is organic. There is also misperception on among the stakeholders. Grower's common perception is only chemical fertilizers and pesticide frees production is organic. They do not bother for conversion and maintenance of organic field. Traders do not worry for mixing the organic and conventional product. Therefore, organized production and product authentications are the key issues for marketing of organic production. During recent days, BARI initiated the PGS systems for authentications and only 85 farmers with this and one organic Unnyan Dhara applied to BARI for introduced PGS to their organic farmer groups and their production. BARI designed a program of organic certification which is mentioned in the following diagram.



Government support and South Asian/ International cooperation on organic agriculture

There have no national program for promoting organic farming directly but recently country's agriculture policy is reforming to have quality and safe food. As BARI has started research and DAE also taking some steps to promote organic through training to the farmers. AFACI, a Korea-based, construct a network namely Asian Network for Sustainable Organic Farming Technology (ANSOFT) with 10 Asian nations like; Bangladesh, Cambodia, Indonesia, Korea, Laos, Mongolia, Nepal, Philippines, Sri Lanka, Thailand and Viet Nam. Some other sporadic cooperation is available but not visible.

1. **Research and development institute (Research, Development and Promotion):** GO and NGO are involved in organic farming in Bangladesh by

their own capability. Research organization and universities are from the GO sites. Bangladesh Agricultural Research Institute (BARI) is only government organization is carrying out organized field research at Olericulture Division, Horticulture Research Center in Bangladesh following conversion time and others norms as per IFOAM basic standard. Moreover, BARI has a good IPM program by adopting the organic compliance technology stakeholder get benefit some extend.

Among others NARS organization namely, Bangladesh Rice Research Institute (BRRI), Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh Jute Research Institute (BJRI), Bangladesh Sugarcane Research Institute (BSRI), Soil Resources and Development Institute (SRDI), Bangladesh Tea Research Institute (BTRI), Bangladesh Fisheries Research Institute (BFRI) and Bangladesh Livestock Research Institute (BLRI) are involved in Agricultural Research have no organized research and development activities on organic farming. But have some research output which may used by organic stakeholders. Laboratory facilities SRDI may support organic growers to maintain the soil and plant health for sustainable production.

Universities are mostly engaged in basic research and conduct course. Among nine agricultural universities, only two universities have one full credit course in master's level, which is very meager to learn organic farming by the young professional.

2. **Legal framework and policy of organic agriculture:** There is no separate policy for supporting organic farming in Bangladesh. The Agriculture Policy (1999) has no specific clause or agenda on organic farming (Table 15). The government in its New Agricultural Extension Policy (NEAP) 1996 defined strategies to attain the prime objective of integrated environmental support. It defines that it would integrate environment into the overall agricultural policy to ensure a policy of sustainable agricultural development.

Table 15: Important features of National Agricultural policy (NAP) indirectly support to promote organic agriculture in Bangladesh

Issues	NAP 1996
Objective	Take necessary steps to ensure environmental protection as well as environment friendly sustainable agriculture through increased use of organic manure and strengthening of the Integrated Pest Management (IPM) programme
Fertilizers policy	The use of organic manure, bio-fertilizers and compost will be encouraged. Measures will be taken to update agricultural extension, training and motivational work at the farmers' level so that the farmers can follow suitable cropping patterns to maintain the natural balance of soil nutrients. Production, importation, sales and distribution of any fertilizer harmful to soil environment will be banned. Besides, the use of existing 'Soil Health Card' will be further extended for improving soil quality.
Pest Management Policy	Farmers will be motivated to use more pest resistant varieties of crops. Use of mechanical control measures such as light trap, hand net, etc. will be increased and popularized. Biological control measures will be used to destroy harmful insects and preserve the useful ones. Regular training and discussion programmes on IPM will be conducted among the farmers under the supervision of Union Agricultural Development Committee with a view to successful introduction and popularisation of the method at the farmers' level. Pest surveillance and monitoring system will be strengthened. Production, import, distribution or use of any chemical pesticide will be banned which is directly or indirectly harmful for human, animal and aquatic health. Use of any chemical pesticide harmful for natural environment will be discouraged and eventually banned.
Agriculture Research Policy	Research relating to the development and application of fertilisers which are harmless for soil quality, environment and health. Farm management research with a view to minimizing production cost and maximizing farmers' income. Research relating to IPM and development and application of pesticides from indigenous plants.
Agriculture Marketing policy	Export of agricultural commodities will be increased through grading and standardization. Also, to increase local consumption of such crops, necessary measures will be taken for grading, standardization, labeling and quality development according to consumers' taste and preference and food value.
Food-based Nutrition policy	Protecting consumers through improved food quality and food safety

IPM practices got popularity last couple years across the country but increased use of organic manure yet not draw the attention. Other issues like, marketing, quality of food and food based nutrition policy implementation did not catch the light. Moreover, government did focus this agenda properly.

3. **Food policy**: The National Food Policy of 2006 is Bangladesh's main policy document on food security. It represents an important departure from the past by applying a comprehensive and integrated approach to food security, including the availability, access and utilization dimension of food security. While previous efforts focused almost exclusively on increasing national food production, the 2006 policy broadens the Government's approach to food security by outlining three main objectives:

   Objective 1: Adequate and stable supply of safe and nutritious food

   Objective 2: Increased purchasing power and access to food of the people

   Objective 3: Adequate nutrition for all individuals, especially women and children

   Recently, cabinet approved the Safe Food Law 2013 to save the people from adulterated and contaminated food. Unfortunately, organic food production, distribution and marketing imposed restriction in this law.

4. **Public perception and attitude on organic farming:** Consumption of safe food is a global demand. Bangladesh being a developing country, awareness regarding safe food is getting momentum. Most of the consumers of kitchen market as well as organic shops are aware about safe food. Consumers believe that the food stuff they are consuming is not safe for health but they are bound to consume these food stuffs due to inadequate and unmarked supply of safe food in the market. Therefore, supply of safe food needs to be ensured to the markets. Two small studies (Hasan, M.K. and Nazimuddin, M., 2013; Rahman M.K. and Nazimuddin M., 2015) were conducted on the perception of the consumers concerning the safe food and available organic foods in Dhaka city. A three point rating scale such as 'agree', 'partially agree' and 'disagree' was used to rank responses by consumers. Two groups of consumers i.e. one purchasing food items (fish, fruit and vegetables) from traditional kitchen markets and another group of consumers purchasing organic food from chain shops who have at least organic corners for selling

organic food were selected. Different consumers' perceptions exist about organic food. Organic farming is better for the environment; since the organic farming avoids pesticides, chemical fertilizers and other toxins. So, it is healthy, safe and tasty. On the other hand, many consumers think that organic foods are expensive and not available. Since, consumers want to purchase genuine and trust worthy organic products, a realistic and easy certification system should be introduced. Labeling on the packaged organic food should be made mandatory to help making informed choice of the consumers in the organic food market. A collaborative effort from all stakeholders is important to eradicate the identified barriers of popularization of organic food Social and economic factors, contribution to rural livelihood development, food and nutrient security.

5. **Existing programs/ approaches to promote organic agriculture:** BARI through AFACI project organized farmers club under Model Organic Agriculture Village Program in Bangladesh under ANSOFT program. Some NGO namely, Hunger Free World, Unnyan Dhara, Action in Development, FIVDB, ALRD, CARTITAS, Action Aid, UBINIG, Community Development Association (CDA), BARCIK, Concern International, B-Safe, Fukuoka Foundation, VOCTA etc. are promoting organic Farming through training , demonstrations and awareness building.

   BARI has organized three national workshops on 2011, 2013 and 2015 which already created momentum among the policy makers, growers, extension personnel and business people. BARI also initiated Participatory Guarantee System (PGS) which will add more value to the consumer and organic promotion as well. PROSHIKA and Unnyan Dhara created organic consumers group and selling their products directly to the farmers. Unnyan Dhara is being applied for BARI PGS.

SUCCESSFUL STORIES

Farmers group or union (If only): Sporadically various farmer groups are working under the supervision of different NGOs. For example, Unnyan Dhara a local NGO are patronizing local farmers to established their right through Shadin Krishok Shangaton (Independent Farmers Organization) that localized in the Jhinaidah district of Bangladesh. Action Aid an international NGO formed farmers group focusing sustainable farming. PROSHIKA, UBINIG doing same thing from the inception of their activities. PROSHIKA, with its “Ecological Agriculture Program” (EAP), is the largest organic body in the country. “Since 1978 PROSHIKA began to spread ecological practices among its group members by growing varieties of seasonal vegetables (PROSHIKA 2004). PROSHIKA's EAP has involved around 0.8 million farmers in organic cultivation across 0.22 million acres of land. Out of these, 0.22 million farmers started to practice ecological agriculture on 0.08 million acres of land in the last five years (Sarkar and Itohara 2008). UBINIG promote “New Farmers’ movement (*Naya krishi andlon*)”. UBINIG started its activity in 1981. UBINIG’s New Farmers’ movement aims at independence from modern input which caused the environmental degradation and exploitation of farmers. UBINIG recognizes the importance of local knowledge for the promotion of organic farming. For example, seeds are purchased from commercial firms now, but UBINIG thinks that seeds are local resources, and they collect local seeds to conserve species diversity, establishing an exchange network among member -farmers. As regards food security, Sarkar and Itohara (2009) also reported that among 150 small-scale organic farmers of UBINIG interviewed, 98% had attained the household level of food security. Tangail regional center is the largest center with 90000 *naya krishi* families from more than 700 villages. Wheel another NGO organizing local farmer under organic farming system.

Department of agriculture extension have the big group(CIG, FFS, IPM, ICM club) country wide although they are not organic farmer, but have opportunity of government organization to boast the organic program.

Case study 1: PGS Certified Organic Farmers 'Mohammad Ali'

Organic farmers Mohammad Ali started organic on 2012 converting 1 acre of land. Farming system approach is being followed i.e, have livestock, poultry, fruits, vegetables, ducks. Mr. Ali has the strong innovative knowledge and explores many of the local formulations for soil improvement, plant growth and plant protection. BARI recently identified him started to PGS with BARI and DAE and his stage PGS green. He created great awareness in the locality and established himself as organic farmer and selling the products to Dhaka (Prakritik Krishi Biponon Kendra) and locality.

Case study 2: Legendary Farmer couple Asadul from Jhenaidh

Asadul belong the Village Bolorampur of Kaligonj Upuzilla under Jhenadh District. Asadul and his wife left chemical farming 20 years back and started organic farming in his own lands. Many times he explain to the media that how organic is safe for human and nature. He is the innovators of many locally made products which good for soil improvement, plant growth and plant protection. In his locality he is named Organic Asadul Family.

Case study 3: Organic Farmer Group *Nayantara nari Prochesta Dal,* at Dulla, Muktaghaca

Mymensingh leaded by women farmers. They are raising fund from *Mustir Chal* producing vermicompost and selling the local farmers. Moreover, they are doing organic cultivation at the homestead and rent land. BARI is also giving PGS certificate to them.

Case study 4: Organic Mango production by Rajshahi Krishi Pathagar which major petron is Jahangir Shah.

Production of Organic Mango is a challenging job for the growers as farmers have to face 4 major pests which could not be able to solve by botanicals or other common biocontrol agent. Prothom alo (4 July 2015) reported and author also personally communicate with the grower about the success story. According to Jahangir, the area of the farm is one hectare and Langra, Khirshapat Fazle is his major variety. However, owner did not apply any pesticide last two years. First year he did not get expected yield as most of the fruits was affected by fruit borer. But 2nd year, that is this year he harvested expected yield. He used pheromone and botanical pesticides for controlling the pest. The yield was 15 tonnes from one hectare of land. He did not sell the mango separately as organic because there is organized market for organic commodity. Jahangir expresses his satisfaction as he finally succeeded to grow organic mango.

Organic agriculture and safe food security for the small holders

Capital and chemical input-intensive approaches of farming have already created unintended but deleterious consequences. In varying combinations such approaches impact negatively on the well being of farming communities, the environment and on the quality and safety of food. Organic agriculture should not be seen as an isolated technology but as a systemic approach that embodies the principles of human ecology and sustainable development.

The following reasons are considered for safe food security of small holders.

- Organic agriculture can increase productivity, especially in situations where farmers are vulnerable to food shortages.
- Increase income and/or returns to labour which can be achieved through higher yields, higher (premium) prices, lower costs (for inputs) or combinations of these three.
- As diversity of production inherent in organic agriculture, therefore, reduces the risk of crop failure and attendant economic and food security problems.
- Produces safe food and a more varied and nutritious diet.
- Eliminates the very real risks associated with exposure to pesticides and other toxic chemicals.
- Has a major role to play in assisting with resource management, such as reducing water demand and run-off, soil erosion and in maintaining and enhancing biodiversity.

- Makes farmers and consumers more aware of the need for sustainable production and consumption, of the importance of clean and safe food and of the need to protect the environment.
- Organic agriculture brings clear benefits to women in agricultural communities, to other marginalized groups, as well as offering new employment opportunities for the landless poor.
- Acknowledges the value of traditional and indigenous knowledge and integrates this in its production methods, thereby increasing social capacity and self value.
- Has a clear role to play to address the global warming issues

SWOT analysis of Organic Farming in Bangladesh context

a. Strength

i. Favorable agro-climate

ii. Increasing domestic and global demand of organic product

iii. Long tradition of organic production

iv. Innovative farmers

v. Bio diversity in foods crops

vi. Prevalent various promoting agencies

vii. 2.2 million household

b. Weakness

i. Absence of accreditation, standard and certification

ii. Government policy

iii. Disorganized marketing channel

iv. Inadequate scientific evidence and slow active pest management method

c. Opportunities

i. Increased awareness against adulterated food

ii. Plenty organic waste for composting

iii. Effective network of stakeholders
iv. Govt. One household one farm
v. IPM /ICM club may act as PGS

d. Threats

i. Environmental vulnerabilities due to climate change
ii. Declining soil health
iii. Price of the organic food
iv. Excessive processing formalities

Conclusion

Organic farming is not new for Bangladesh. It is our tradition from the ancient like other SAARC countries**.** As the conventional farming fails to provide sustainable food, it has also created many problems of soil and environmental health. The traditional and local knowledge systems enhance agricultural soil quality and biodiversity as well as nutrient, pest, and water management, and the capacity to respond to environmental stresses such as climate. The development of sustainable agriculture through organic farming will require significant structural changes, in addition to technological innovation, farmer-to-farmer networks, and farmer-to-consumer solidarity. The required change is impossible without social movements that create political will among decision-makers to dismantle and transform the institutions and regulations that presently hold back sustainable agricultural development. A more radical transformation of agriculture is needed, one guided by the notion that ecological change in agriculture cannot be promoted without comparable changes in the social, political, cultural, and economic arenas that help determine agriculture. SAARC countries have glorious history and through organic farming an economic break through may come up by selling the product to the global market.

Recommendations

1. Most of the SAC countries have no organic standards and certification system, therefore, a common standards and certification system is recommended. The name of the standards could be Common Organic Standards for the SAARC

Countries (COSSAC).

2. Conversion time is the common problem for the smallholder, therefore, conversion time could be 2 cropping cycle instead of 2 years.
3. As the marketing is the common problem due to authentication, therefore, a common vision should be set for the SAARC countries.
4. For piloting the program A model SAARC organic village may be developed
5. A special taskforce might be formed with expert of the each country for exploring opportunities and mutual benefits.
6. SAARC countries has long experience in agriculture and majority of the farming community are small holders, therefore, A network might be created comprising researcher, academician, policy makers, legend farmers, extension personnel to find the traditional knowledge to share with the member countries through web circulation.
7. Opportunities have to create free exchange of organic product among the member countries under a common brand 'SAARC Organic'.

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Status and Future Prospect of Organic Agriculture for Safe Food Security in Bhutan

Kesang Tshomo

Program Coordinator, National Organic Programme, Department of Agriculture
Ministry of Agriculture and Forests, Thimphu, Bhutan

Email: ktshomo@moaf.gov.bt

Summary

Bhutan has become globally well known as a country with goals to be 100% organic by 2020. However, it needs to be understood that it is a vision, an aspiration and not a deadline to be met. In this paper realistic actions that can be taken and has been taken so far towards closing on the aspiration of becoming organic are discussed with the technical difficulties that exist in the process, the interventions and actions that need to be taken in order to make progress towards the desired goal.

The country's natural potential, natural resources and traditional farming systems that favour the development of organic agriculture with issues that need research, development and investment or technical break through are put forth and possible plans, strategies and actions points that could help make the journey possible are laid out and presented to share the experiences and lessons in hope that similar information and experiences are shared among the member countries so the region can develop together to make the South Asian region greener, cleaner and a more sustainable place to grow food.

Possible collaborative areas are proposed for joint research and development and capacity building to help us as a whole to share our knowledge and form a collective wealth of Asian organic knowledge bank.

Country profile

Bhutan is a small landlocked country located in the Himalayas with China to the North and India to the South. The country covers an area of 38,394 km^2 and shares boarders with China on the North and India on the East, West and South

(Fig. 6). The country is located on the lower, mid and greater Himalayas. It has six big river systems running from North to South into the Bay of Bengal through India and Bangladesh. 80% of the land is under forest area and 51.44% is under national parks and protected areas. Only 2.93% of the land is used for human settlement and farming.

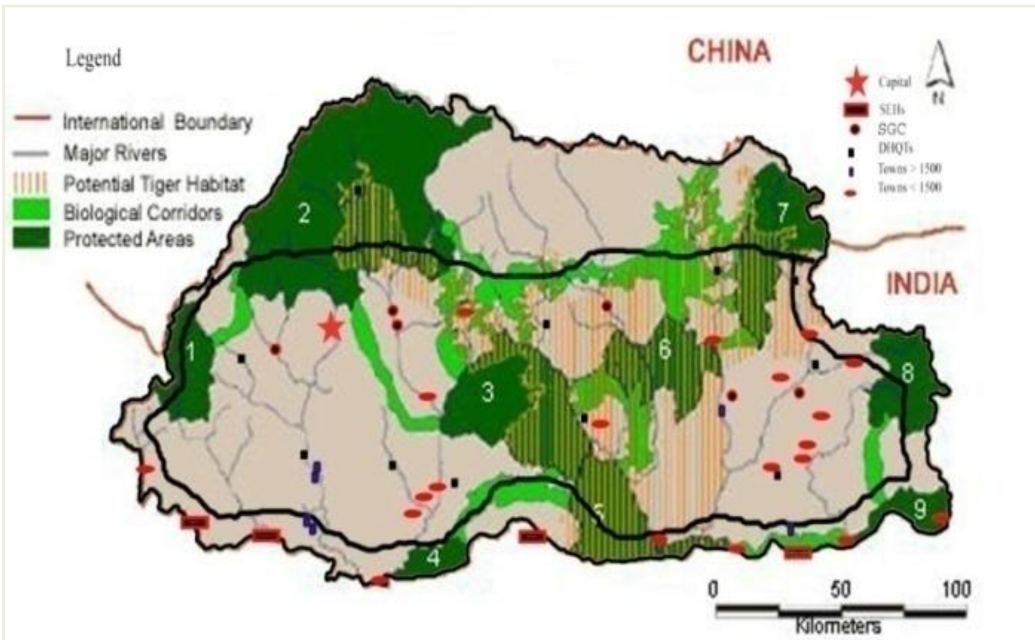

Fig. 6: Map of Bhutan

i. Climate

Alpine to temperate and to subtropical with monsoon season from June to September, there are four seasons and five agro-ecological zones that enable production of many different crops from subtropical to temperate and alpine crops. They are: wet subtropical, humid subtropical, dry subtropical, warm temperate, cool temperate and alpine zones.

ii. People

Nationality: The Bhutanese refer to themselves as Drukpa people. The total population is 745,153 (est. 2014). The GDP per capita in 2013 was Nu. 0.143 million. There were 56.2% of the population engaged in farming in 2013 and 53.3% of the women are engaged in farming (Bhutan RNR Stats, 2015).

iii. Ethnic groups, religion and language :

Bhutan has three main ethnic groups, Sharchops, Ngalongs (50%) and Lhotsampas, one of several Nepalese ethnic groups (35%), indigenous or migrant tribes 15%. The tantric form of Mahayana Buddhism (Drukpa Kagyupa) is the state religion, Indian- and Nepalese-influenced Hinduism 25%. The national language is dzongkha (official language), English (medium of instruction), Tshanglakha, Lhotsamkha (Nepali) and Khenkha, Sharchop.

Literacy: 54% (estimated), Women's literacy: 20% (estimated).

iv. Natural resources:

Hydroelectric power, timber, gypsum, calcium carbide

v. Agriculture products:

Rice, corn, root crops, citrus, apples, food grains; dairy products, eggs

vi. Industries:

Cement, wood products, processed fruits, alcoholic beverages, calcium carbide, Ferro alloy

vii. Exports and Import partners:

Exports: India, Bangladesh, USA, Malaysia, and Japan are some export destination countries with a value of Nu. 2,542.43 million (Bhutan RNR Stats, 2015).

Imports: Some of the important imports come from India, Japan, Sweden, China, Thailand, Bangladesh, Germany, Italy etc. with a value of Nu. 677.81 millions.

viii. Currency:

Ngultrum (BTN) pegged to the Indian Rupee (INR)

Concept, brief history and strategic importance of organic farming organic and inorganic area, and types of organic and inorganic manure

Bhutan has mainly practiced traditional farming systems since time immemorial. With the introduction of agriculture development in the 1960s, fertilizers, crop varieties and pesticides were introduced and promoted for free but the usage was very low. By the mid eighties, concerns of the negative effects of agro-chemicals on the health and environment, especially the reluctance of the people to use the agro-chemicals and wastage on farm was noticed. The government gradually started withdrawing the support. By the 1990s, all the subsidies were withdrawn and services made available only on full payment based on demand. Then there was also a stage when compost pits on farms were promoted for soil fertility management. Bhutanese farms generally have always relied on farm yard manures and forest leaf litter and green manure as part of traditional crop rotations to maintain soil fertility. When soil needed reviving green biomass and charcoal were added to the cropland (traditional knowledge). The Government of Bhutan (RGOB) adopted sustainable development as a policy during the Seventh five-year plan (1992-1997), which laid the foundation for the development and implementation of Integrated Pest Management (IPM).

Bhutan possesses vast tracts of forest producing abundant biomass and other natural resources that are not fully utilized due to the country's conservation policy. The vision 2020 states that Bhutan will maintain 60% of the total area of the country under forest at all times to come.

It is interesting to note that Bhutan was safeguarded from use of agro chemicals through lack of subsidy, remoteness of majority of the farms and difficulty in transportation. Hence, the usage of external inputs could barely flourish.

Bhutan owes its very conservative policy to His Majesty the 4th King Jigme Singye Wangchuck for his wise guidance and direction of emphasizing on environmentally friendly and ecologically sustainable development in the country. Bhutan has always had very clean, pristine environment with a perfect condition, conducive to develop organic agriculture. IPM strategy was promoted as part of the Pesticide Act 2003 towards safe and efficient use of pesticides and safeguarding the environment from pollution due to indiscriminate use of pesticides. Since then, there has been a decline in use of pesticides with the removal of subsidies on pesticides and the banning of several hazardous chemicals from the market for environmental reasons. Emphasis on biodiversity, the environment, forest cover maintenance, integrated pest and nutrient management approaches in existing policies favour organic farming. The Nature Conservation Act and Biodiversity Act, also supports the principles of organic farming. This gives the Ministry of Agriculture a very sound base from which to go from IPM to organic farming.

Principles of organic agriculture, Scope and Objectives

The definition of "*Organic Farming in Bhutan*" refers to *organic farming practices*, in Bhutan. Organic farming is an approach to agriculture where the aim is to create integrated, humane, environmentally and economically sustainable agricultural production systems, which maximize reliance on farm derived renewable resources and the management of ecological and biological processes and interactions, so as to provide acceptable levels of crop, livestock and human nutrition, protection from pests and diseases, and an appropriate return to the human and other resources applied. This closely fits the national development philosophy of Gross National Happiness (GNH) the concept propounded by the 4th King in the 1970s. The four pillars of the GNH are in a way almost exactly what the IFOAM has adopted as the four principles of organic agriculture.

Principles of Organic Farming IFOAM	GNH Pillars
Principle of Fairness	**Pillar 1**: Sustainable and Equitable Socioeconomic Development
Principle of Care	**Pillar 2**: Preservation and Promotion of Cultural Values
Principle of Ecology	**Pillar 3**: Preservation of Environment
Principle of Health	**Pillar 4**: Good Governance - Certification

Due to the natural setting, hugely traditional and natural farming, the potential for organic farming in Bhutan is immense and the scope covers all the sectors of the renewable natural resources, crops, livestock, forest products and wild harvests. Bhutan is a very pro conservation country with many policies that support organic sector growth such as the Economic Development Policy which stresses green economic development with development of organic brand with incentives to organic based businesses. With a clean green image the market power that could be built is positive. Over the last half decade, the awareness of people, growers and consumers have grown to understand our potential for organic production and the benefits of consuming organic foods. In Bhutan while the opportunity of market premium is very important, it is equally important in having enough quantities of food and the safety of food available to the people. Thus the objective of organic farming is not subject to safe food alone but to having clean ecological production systems and green products that can contribute towards reducing the use of hazardous materials to eventually phase out harmful materials used in farming systems.

Country status of agriculture today, including pesticide and fertilizer used (organic, inorganic, cultivation system, adoption of their environmental conditions)

The exact areas of land under organic management are not clearly known since registration or a regulation has not been initiated in Bhutan. The only product that is certified is essential oil of wild crafted lemon grass exported to Europe. 38558 acres of forest area are under organic management of Non wood forest products category and certified (NWFPs). As a start, the Department of Agriculture focuses on promoting organic production for local needs. Only two commodities, asparagus and buckwheat are cultivated at commercial scale production for income generation. Other organic crops are vegetables, herbs, spices and dry land cereals.

While organic production is practiced in all the districts, two districts namely Gasa and Samdrup Jongkhar have chosen to be organic where people have decided to not use any agrochemicals in their crops. Organic initiatives are supported and collaborated with non governmental agencies, farmer cooperatives and private business firms, but the biggest support is provided by the ministry of agriculture and forests (MOAF) through the National Organic Programme (NOP), through the research and development centres, extension systems by way of pilots and demonstrations and trainings. There is a school agriculture programme that is run jointly by the MOAF and the Ministry of Education which involves over 250 schools which are managed organically. Many of the farmer groups are also linked to schools for marketing their produce.

Soil fertility and fertilization

A survey (DOA, Stats. 2013) shows that a majority of cultivated land under cereal, vegetables and root crops in the country is managed with traditional or organic land management (95%). Only 5.5% synthetic chemical fertilizers are used in crops and only 2% in fruit trees (Fig. 8). Farm yard manures (FYM) and crop rotations and intercropping with legumes in crops like maize is common to improve soil fertility. NOP has been promoting composting, vermi-composting and bio-digesters to improve soil management among the farmers (Fig. 7).

Fig. 7: Compost and Manures

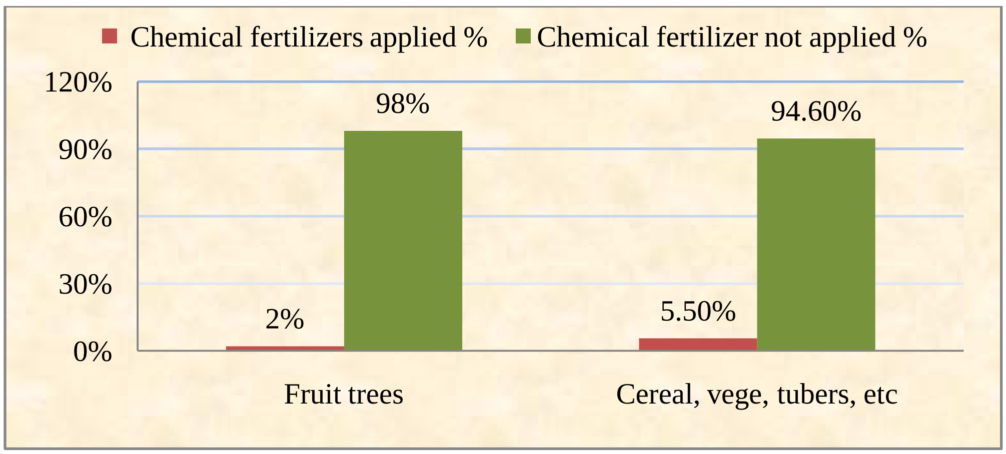

Fig. 8: Usage of chemical fertilizers in cultivated crops

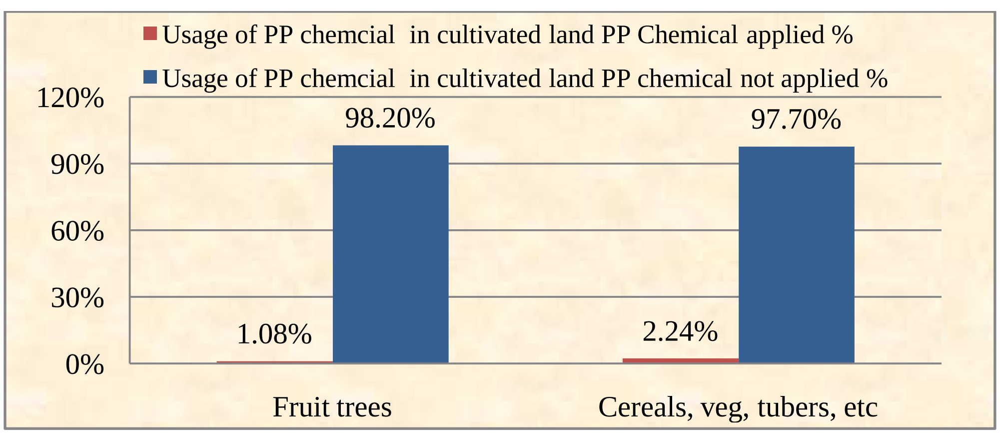

Fig. 9: Usage of Chemical PP in cultivated crops

The use of pesticides is even lower with only about 2% of the total number of trees being sprayed with synthetic chemical pesticides (Fig. 9). While the use of pesticides has not changed much over the years, there has been a growth in the usage of herbicides in rice fields, potato and maize fields (Fig. 10). This is mainly due to the acute shortage of labour for weed management in the country. The major challenge in going organic in Bhutan is until an alternative for weed management can be found that is economically and practically efficient reducing the usage of herbicide is going to be difficult as about 90% of the plant protection material used is herbicides as shown in below in the chart.

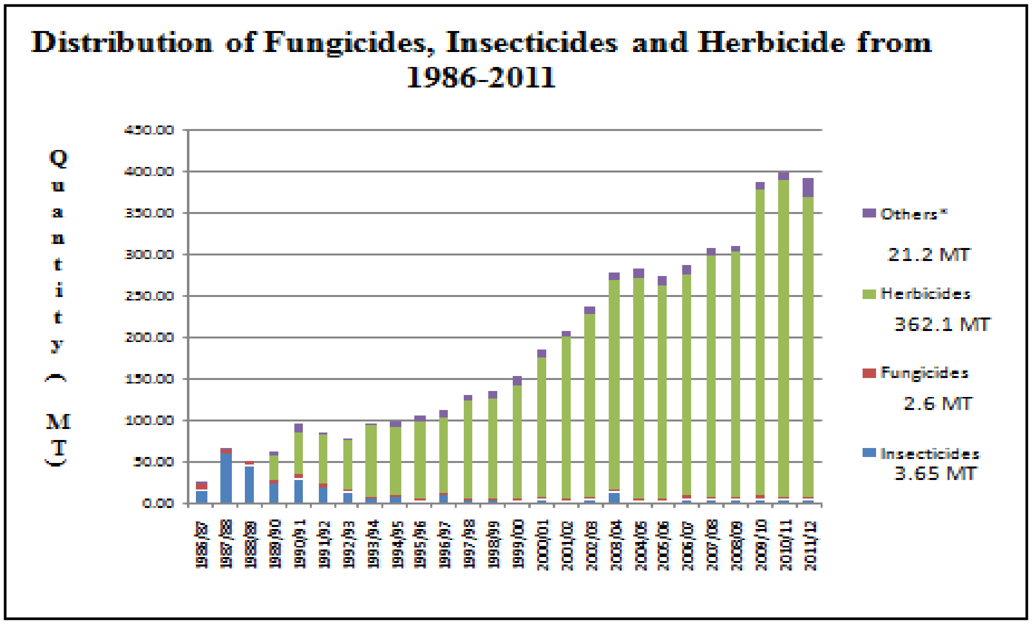

Fig. 10: Distribution of fungicides, insecticides and herbicides during 1986-2011

Components of farming

In Bhutan, the status and conditions of farming in some of the different components are given below.

S. No.	Components of farming	Country status of farming today
1	Fertilizers and manures	Wide use of farm yard manures and some use of fertilizers in main staple food crops and cash crops. No factories in the country.
2	Pesticides	Very low use, no factories in country. traditional knowledge and botanicals commonly used
3	Conversions of conventional to organic farming	Annuals -1 year, perennials- 1.5 years of conversion. Land use history valid for fast tracking if previously records available for endorsement. Conversion to organic initiated in phase wise manner for the country.
4	Hazards of in-organic farming	Very low risks from quantities of agrochemicals, misuse & awareness may be risk from mis-information. Risk of production and income loss from increased cost and lack of information in initial years.
5	Positive and negative effects on agriculture	Good sustainable system providing safe clean food and building good soil. Some poor learning lessons during initial adjustment time to convert to organic farming
6	Farm waste recycling/ organic mulches	Traditional system of FYM and green mulches are used. Traditionally all farm wastes were recycled into compost.
7	Scope for organic agriculture including manure production	Good opportunity, low capacity and technology appropriate for farmers that are easily adopted. Bio-digesters are very convenient for us at the farm level. Scope for bigger scale bio-fertilizer production exists as there is demand for more bio-fertilizers, compost etc. Farmers do not have time to produce them at adequate levels.
8	Soil and crop management	Lack of research focus on soil management in organic management with a systems approach. Low technology in existence for adoption, low Human resources and scientific know-how to support the needs of the field.

9	Humus, sewage sludge, organic compost etc	Humus and organic compost are used in the field widely, however sewage cannot be used on crop.
10	Buffer Zone	Maintain safe and practical buffer and boundary. Mostly steep mountainous terrain provides challenges of maintaining buffer zones due to local micro systems and wind drifts and water drainage from farm to farm.
11	Split and parallel production	Split and parallel production of in-organic and organic crops are not to be encouraged as traceability will be a risk.
12	Choice of crops and varieties	Choice of crop is left to the farmers to choose, but priority is biodiversity for food basket and potential in the domestic and then export market
13	Natural safe products for control of pest, disease, weeds, diseases and growth management	At the farmers level mainly botanical extract preparations using local weeds and plants are taught to farmers. Supply system for supply of bio-pesticide is planned to facilitate easy access of safe, natural and bio-pesticides for farmers who choose to manage their crops naturally. Weed management is an area that poses the high risk and challenge and a good alternative is not seen for the herbicide used as there is acute shortage of labour in the country.
14	Post harvest management	Local knowledge for preservation and storage are used widely and improved storage techniques are promoted at community level to manage the post harvest issues through trainings. IFOAM norms and Bhutan organic standard will be followed
15	Quality of food and crop productivity under natural ecological systems	The quality of the fruits and vegetables suffer to some extent if alternative management tools are not available. Productivity has not been an issue except in cash crops like potato where more fertilizers are used in some of the districts. The eating quality of the food from natural systems is preferred by most locals and willing

		to pay a good price for the flavor. However, for the lower income families the cheaper imported in-organic food is the best bargain for the family.
16	Processing, Handling, Packaging	Processing and handling is basic in the country with low technology and poor packaging. This is not specific to organic but applies to all crops. So interventions in this area will benefit the agriculture sector across the board. A lot of value and crops are lost due to poor capacity to value add to the available products. For organic products primary production and processing can be done one farm and for secondary processing will need to be monitored and inspected by BAFRA and certified if sold as organic.

South Asian organic farming and trade/ market analysis

The organic market in South Asia is growing fast as the consumers are becoming more health conscious and with increasing rates of health issues with changing food systems. India perhaps has the fastest growing organic consumers among the South Asian countries. However, the bulk of the organic food produced in South Asia may be still targeted for export to developed countries like the EU, US and Japan where the returns are bigger. The focus for developing organic farming in some countries started solely for exports and to earn hard currency. This is why South Asia still does not have a significant organic trade and there is no common organic certification or mutual recognition of standards in the region. Therefore, we still depend on a third country organic certification from Europe or US to certify our products if we want o sell it to our neighbor even within the SAARC countries.

In the smaller countries with difficult terrains and underdeveloped markets, subsistence is still the norm since the surplus production cannot be fully and efficiently marketed. This leads farmers to produce just enough to feed the family and the local market potentials. There is a lot of investment required to improve and develop efficient markets with benefits flowing to the growers. In Bhutan with the geography of land, difficult roads, high cost of inputs, acute shortage of labour, and poor services in trading results in high cost of production of any product locally. With the limited land under cultivation the challenges of competing in the market are very stiff. Therefore Bhutan has to focus on selecting carefully what can be grown and marketed profitably such as high value, low volume products such as medicinal, herbs, spices, condiments and niche products such as *Cordyceps Sinences*, Masutake mushroom, etc. for the global market and focus on growing what can be sold domestically for food products.

Issues and scope of marketing organic produce

Although organic farming is recognized and accepted as a better way to farm and produce food, there is generally poor support for developing organic farming in most of the SAARC countries. The potential is huge for regional trade development and overall health improvement with a better educated consumer. Besides support to the primary producers of organic products, there is need for the regional countries to come together to develop a regional organic standard with common system of assessment and conformity system to have a regional certificate that will enable organic products to flow from one country to another without barriers.

The SAARC countries have not been able to build a common image for market power supported by the standards and qualities that can be respected. The SAARC countries as a group have no market power harnessed. With the start of the SAFTA looking into cooperation on equivalence of conformity assessment among the SAARC countries, extending this services and cooperation into organic standards to develop or harmonize a common standard since many of the smaller countries standards are not internationally recognized is a good place to start. This would enable much easier a free flow of organic products among the SAARC countries and also help the international presence and identity development in the global market.

In Bhutan, there is no premium price for organic produce so the attraction for adopting organic for high returns is not true here. However, there is a good premium for local produce over the imported food products up to even 300-500% in peak season. The high cost of production, inputs and lack of subsidies for organic farming poses a challenge competing with cheaper imports from neighbouring countries. Acute shortage of labour for farming is the biggest constraints faced in general farming but for organic farming without the use of herbicide the competition gets even harder.

The situation of value addition, branding and labeling of organic produce is still very weak and marketing strategies and programmes are not very strong (Fig. 11). Plans are in the pipeline for labeling the organic produce from Bhutan under the "*Bhutan Organic"* brand for domestic market and "*Brand Bhutan"* for exports in the future.

Currently lemon grass essential oil is the only organic product that is certified and exported from Bhutan. Due to the production difficulties and logistics building bulk for export is another challenge.

Fig. 11: Vegetables sold by the roadside, and organic products sold in the local market

Government support and South Asian/ International cooperation on organic agriculture

The potential to build an Asian common standards and regulation or common certification system at least among the SAARC countries would be very valuable. For many smaller countries the South Asian and South East Asian market may be all that is required to boost the industry. With the Asian production capacity and the Asian market potentials is big enough to create an Asian market section that can have a common certification system like the EU regulations. The opportunity can be seized here to start a SAFTA organic certification system and a common mark and even explore linking it to the ASEAN group in the future. The benefit would be that with a simpler and common system and regulation the smaller holder growers will find it easier to market their produce and benefit from better market prices.

An Asian Regional Organic Standard has already been developed with the support of UNCTAD, IFOAM and FAO and with the participation of 12 Asian countries including India, Nepal, Sri Lanka and Bhutan from the SAARC countries. This standard is already approved by the IFOAM and ready for adoption or use. The SAARC countries could use this as the starting basic standards to add or change and through the cooperation adopt a common organic standard for organic trading among the SAARC countries.

For developing such a system technical services of the United Nations Forum for Sustainable Standards (UNFSS) could be explored for technical support. UNFSS provides such services globally to enhance more efficient trading with harmonized standards.

Research and Development Institutes

Research and development in the country is mostly adaptive and applied and specific research to organic farming does not exist in Bhutan but most research is based on farmer needs and targeted to address the problems of the farmer. With the development guidelines of the country being very conservative most research in crops are based on integrated pest management or sustainable farming concepts. While there is no dedicated research institute and organic research is not instituted for organic farming, one research and development centre, RNRRDC, Yusipang has been managed organically since 2004 and all cropping on this centre are organic. However, with limited technical human resources and capability research is very weak in the organic sector.

Creating cooperation with the SAARC countries to share knowledge and skills and information in organic research would be highly beneficial to Bhutan. Although Bhutan does not have the capacity now, it does have the right environment provide for a location of regional organic research and development centre where all the SAARC countries could collaborate and conduct research from this centre. It could serve as a hub for the SAARC countries to provide a site and location for training, experience, demonstrations and trials for the future.

Legal framework and policy of organic agriculture

Bhutan has an economic development policy (EDP, 2010) that targets to promote Bhutan with the organic image and brand Bhutan to be organic. The need to phase out hazardous agrochemicals and incentivize organic farming through tax holidays are listed for policy support. The Ministry of Agriculture and Forests have a *"National Framework for Organic Farming in Bhutan"* that provides policy guidelines for organic sector development within the agriculture sector. The approach for Bhutan's development has been to develop organic for selected products in selected areas based on potentials and interests and conserved areas where they are already clean. It is a vision for Bhutan to be all organic by 2020. However, the conditions created and investments made will determine if the vision is achieved.

While domestic food, nutrition security and safety are the priorities, all efforts will be made to develop areas and products where there is commercial value and potential. Products easiest done organically such as herbs, medicines, spices and vegetables are to be developed first while research and development to support other crops is initiated.

There has been a statement made by the former Prime Minster, Jigme Y. Thinley that the government would aim to achieve 100% organic in food production in 2012. A lot of progress has been made since the National Framework for Organic Farming in Bhutan was initiated in 2007 but a lot remains to be done. Bhutan has also committed to remain carbon neutral, currently it is carbon negative.

Organic regulation, national certification system or a certification body is not in place yet but there is an interim condition for exports of organic products. Currently, there is no regulation for domestic trade. Bhutan has a National Standard that has been approved in principle, and is in the process of assessing it for Common Requirements of Organic Standards (COROS) with IFOAM for international equivalence. A local assurance system based on registration with the NOP is in the process of development, which is a modified form of PGS that is run and managed by the Ministry of Agriculture and Forests to enable domestic trading and link to exports for third party certification through registration with Bhutan Food and Agriculture Regulatory Authority (BAFRA) when required. Certification is voluntary for domestic trade by mandatory for exports. Certification for local assurance is planned to be free to growers and operators.

Public perception and attitude on organic farming

The public perception on organic farming are mixed as many do not have a clear idea of what it means and how different it is from the conventional farming and traditional farming. Some are worried about the perceived loss of yields in crops although the amount of agrochemicals they have used in the past are minimal, others are optimistic and want to adopt organic farming as they appreciate the health and environmental benefits and the idea of not using chemical pesticides appeal to the majority of the farmers. However, since the decision of food production is more a food security matter than an ideological matter the farmers chose to be practical and use the most practical and least harmful method of farming. Thus, the technological interventions to address the pest and disease issue more than anything is important to Bhutanese farmers. Since majority of the farmers already use farm yard manure as the main source of farm input for soil fertility management, this area is a lesser concern.

The growing concern of weed management in crops using herbicide is the biggest challenge that needs technological intervention to find a comparatively good alternative to herbicides. While attitude towards organic farming is positive and supportive, practical issues in the field cause difficulties in some areas where food production is done on larger scale for market orientation.

Social and economic factors, contribution to rural livelihood development, food and nutrient security

In Bhutan, close to 65% of the population are dependent on agriculture for livelihood and agriculture and allied activities are the major source of food, income and employment. Close to 95% of the farmlands are managed organically or naturally so organic farming is socially acceptable in Bhutan. There has been little difference in economic factors since farming productivity in the country has not been enhanced or optimized with conventional means that much to cause such huge differences in production. In almost all the crops observed under organic practices the productivity has been similar in yield; however the cost of management has increased due to weed management in crops like rice. Since potato is an important food and cash crop for the farmers this crop was not promoted as organic and this is the crop that uses the most chemical fertilizers in Bhutan although below international levels. Important food and cash crops are not promoted or suggested for organic production in new area so as not to disturb the farmers’ income and livelihood and only supported for conversion when the farmers choose to grow them organically by their own choice.

The National Organic Programme supports voluntary conversion and provides information and technology through trainings and advocacy to all farmers to choose good sustainable and ecological farming systems and transition to organic according to their comfort and ease. Emphasis is given to grow their own food requirements for a nutritionally balanced food basket first and practice in their kitchen garden before they go forth to produce for the market.

Existing programmes/ approaches to promote organic agriculture

The National Organic Programme has programmes and activities that are targeted to promote organic farming and collection and increase the area under organic management and products that are traded in the country to generate income. The approaches taken are to capture natural potentials and build upon the existing strengths and encourage area where market and/ or production opportunities and promising. Below are the broad approaches for focus for organic development in the country.

i. Organic programme approach for focus

Category 1	Naturally organic, remote areas, areas within National Parks, high altitude areas	For conservation of area/ watershed, household nutritional needs and food basket security. Developing integrated self reliant farming systems. Many NWFPs and highland products may be covered within this category
Category 2	Selected areas selected products linked to potential markets in local proximity	Production for local markets and building towards surplus production for market orientation. Farmer groups organized to produce for mainly local markets e.g. hotels, resorts. PGS organic with Bhutan Organic logo for domestic market.
Category 3	Any area suitable for production, any products identified as suitable for production for assured market	Contract growing, FDI or commercial scale production targeting export markets, may be certified

ii. Programmes to implement the development strategies and approaches

1	Awareness , education and capacity building
2	Demonstrate and promote the use of quality organic seeds
3	Demonstration and promotion of organic products (e.g. Bio-pesticides)
4	Promote sustainable plant nutrient management
5	Organic pest & disease management
6	Research and development of organic practices
7	Market development and marketing, farmer groups and cooperatives
8	Quality assurance of organic products
9	Standards, regulation and certification
10	Non-wood forest products-certification and value addition
11	Livestock production-alternative to veterinary medicines and feeds

iii. A-C: Specific actions required to address main concern the pose difficulties in going organic in different sectors

<u>**Action Plan for Soil Fertility and Nutrient management Issues**</u>

Commodity/Product	Constraint/ problem in going organic	Action / Intervention required to find the solution
Irrigated Rice	Low fertility for improved varieties	Improve fertility, varieties, funds
Maize	Mono-cropping, poor soils management	cropping systems (crop rotation
Vegetables	Alternatives for agrochemicals	Research and trials
Fruits- apples and citrus and potato	Pest and disease, and fertility management.	Research and trials

Action Plan for Plant Protection Issues and management practices

Commodity/ Product	Constraint/ problem in going organic	Action / Intervention required to find the solution
Rice	Pests and diseases, weeds	Research to find solutions
Maize	GLS/TLB, ear infection by various fungi	Research and trails
Other cereals, oils and vegetables	Alternatives for agrochemicals	Research and trails
Fruits- apples and citrus	Pest and disease	Research and trails

Action Plan for Common Crosscutting Issues

Commodity/ Product	Constraint/ problem in going organic	Action / Intervention required to find the solution
Education, Awareness and Advocacy,	Poor awareness	Advocacy campaign, funds
Standards, Regulation and Certification	Lack of system	Professional T.A. To set up system
Farmer groups /Cooperatives & Marketing: *through organic farmers groups and cooperatives*	Poor capacity	Trainings, support, incentives, funds
Human Resource Development:	Poor capacity, limited Nos.	Trainings
Information and data management system for organic sector	Efficient information documentation and sharing	System set up, HR, training
Monitoring and Evaluation	Delivery and impact	HR,

Other relevant information - Issues that need attention or development

- Urgent need to find a safer alternative to the herbicides
- Limited capacity and resources (HR and facilities) for organic program – mobility for support coverage
- Lack of pesticides residue testing facilities and bio-control laboratories
- Bio-pesticides development programme with labs
- Lack of microbiology lab to promote bio-fertilizers
- Lack of research mandate for organic alternatives at RDCs.

SUCCESSFUL STORIES

Even though there may not be significant impact on a global scale, within Bhutan a lot of progress has been made and within a short duration the preparations have been made for future developments and ground has been prepared for a better coordinated progress in the future. There are growing number of farmers and groups choosing to embrace organic farming. There has been an increase in educated young people who chose to venture into organic farming as an option to create their own employment and in the process employ others on the farm. One of the first farms that was piloted as organic won the best farmer award in 2006. The wild crafted lemon grass oil which is certified is exported to Europe and is very popular in the domestic market too.

The following supporting programmes have been development by the Department of Agriculture to ensure more successes to materialize.

1. The National Framework for Organic Farming in Bhutan
2. A Guide to Organic Farming in Bhutan
3. National Organic Standard of Bhutan – Draft
4. Bhutan Organic Certification Systems- BAFRA
5. Strategic Action Plan for Organic Agriculture Development in Bhutan
6. Training Manual- Organic technologies
7. Master Plan for Organic Sector Development- Draft
8. Participatory Guarantee System for local assurance- Draft

9. Bhutan Organic Labelling programme- draft
10. Brochures and Posters for trainings- Extension and farmers
11. Posters of agro biodiversity and ecological land and crop management

Way Forward and Recommendations

- Development and Research Funds for organic sector support
- HR strength and capacity with resources at NOP
- Organic mandate given to Departments and all RDCS
- Incentives/ support for conversion for farms
- SAARC Regional collaboration for R&D
- SAARC collaboration to develop and establish a common regional standards and recognition of equal systems – Asian Regional Organic Standard (AROS)
- SAARC regional trainings and capacity building

Conclusion

While Bhutan has a vision to be organic in the future, there still remains a lot of work, investment and capacity building to be done. Unless interventions and investments follow the many plans and strategies the visions cannot be achieved. However, there are lots of areas where Bhutan can collaborate with the other SAARC countries and start working towards the vision. Work in the area of research and development in areas of production to generate practical usable information and technology, human capacity building, marketing, and market development are essential. To pull along the sector setting up enabling environment where the sector can take shape and grow systems for supporting production, trading, assurance systems for trading to happen are very important.

When developing, looking at broad need based on the whole value chain is very important especially in the organic sector. Positive government policies and supporting programmes can help such growth take place faster. However, matching investment and support to the sector in the form of incentives, positive acknowledgement could make much bigger impact on the growth of the organic sector.

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Status and Future Prospect of Organic Agriculture for Safe Food Security in India

N. Ravisankar[1], Subash Chand[2] and Kamta Prasad[3]

[1] Principal Scientist, ICAR-Indian Institute of Farming Systems Research
Uttar Pradesh, India
Email: agrosankar2002@yahoo.com.in

[2] Principal Scientist, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, India

[3] Principal Scientist, ICAR-Indian Institute of Farming Systems Research,
Uttar Pradesh, India

Summary

Organic farming systems are very much native to Indian Agriculture. Traditionally, precisely before dawn of the green revolution, crops and livestock have been reared together in all the farm households. And, as of now also, in more than 85% of the farm-households field crops + livestock farming system is prevailing. Nevertheless, during pre-green revolution period (up to 1960s) the rate of national agricultural growth was not able to keep pace with population growth and virtually 'ship to mouth' situation prevailed. This was the major factor for introduction and large-scale popularization of the high yielding varieties (HYVs) of crops, which were highly responsive to the chemical fertilizers and water use. As a result, the total food grain production increased phenomenally – from mere 50.82 million tonnes in 1950-51 to 264.00 million tonnes in 2013-14 – indicating a 5 times increase. This increase can be primarily attributed to large-scale adoption of HYVs, combined with other green revolution technologies (GRTs) in cereal crops, expansion of gross irrigated area (22.56 million ha in 1950-51 to 89.36 million ha in 2010-11) and increase in fertilizer consumption (0.07 million tonnes in 1950-51 to 25.54 million tonnes in 2012-13). All of them put together have led to substantial increase in the productivity of crops, especially food grains (from 522 kg ha^{-1} in 1950-51 to 2125 kg ha^{-1} in 2012-13) culminating into the change in the status of India from a food importer to net food exporter (presently contribution of agriculture in total export value is 14.1%).

However, total factor productivity (TFP) growth score prepared by National Institute of Agricultural Economics and Policy Research has revealed that technology-driven growth has been highest in Punjab and lowest in Himachal Pradesh. It implies that some of the states like Himachal Pradesh, Uttarakhand, Madhya Pradesh, Rajasthan, Jharkhand and north-eastern region of India have not been influenced much by the modern inputs of agriculture like chemical fertilizers and pesticides. India's average fertilizer and pesticide consumption stands at 128.3 kg ha^{-1} and 0.31 kg a.i. ha^{-1}), respectively. Moreover, despite all technological advancements, the nutrient use efficiency is on lower side (33% for N, 15% for P and 20% for K and micronutrients). On the other hand it has been proved scientifically and convincingly that integrated use of organic manures with chemical fertilizers improves the use efficiencies of the latter owing to concurrent improvement of soil physical, chemical and biological properties. The water holding capacity of the soil also gets improved on account of regular use of organic manures. It is estimated that various organic resources having the total nutrient potential of 32.41 million tonnes will be available for use in 2025. Out of these organic resources, considerable tapable potential of nutrients ($N + P_2O_5 + K_2O$) from human excreta, livestock dung and crop residues have been worked out to be only 7.75 million tonnes.

As we know, organic is more of a description of the agricultural methods used on a farm, rather than food itself and those methods combine tradition, innovation and science. Organic agriculture, in simple terms, requires a shift from intensive use of synthetic chemical fertilizers, insecticides, fungicides, herbicides, PGRs, genetically engineered plants to extensive use of animal manures, beneficial soil microbes, bio-pesticides, bio-agents and indigenous technological knowledge, based on scientific principles of agricultural systems. Scientific evidences clearly establish that conversion of high intensive agriculture areas to organic systems lead to reduction in crop yields considerably (up to 25-30%), especially during initial 3-4 years; before soil system regains and crop yields come to comparable level. In this scenario, if all the cultivated areas are brought into organic production systems, the national food production system may get jeopardized; hence a phased approach may be desirable. Considering this fact on one hand and looking into global scenario of organic agriculture Working Group on Horticulture, Plantation Crops and Organic Farming for the XI-Five-Year Plan (Planning Commission, GOI 2007) suggested a spread of organic farming on 1-5 per cent area in the high productive zones and larger spread in the less exploited areas, such as, rainfed and hill areas. Nevertheless, integrated approach of crop management – including integrated nutrient management and inter/ mixed cropping – is also considered as **"towards organic"** approach; and at the same time has been found to increase the use efficiency of all costly inputs especially fertilizers and water, it would be appropriate to adopt it in the resource-rich states contributing major share to the food basket. This approach will also contribute to 'more crops per drop and less land, less resource/ time and more production' strategies of the government.

India has a sizable cropped area in different states, which is more prone to weather vagaries; especially those located in rainfed, dryland and hilly areas. Increasing the agricultural productivity and income of the farmers as well as sustaining soil resource in these agricultural systems has always been a challenging task for researchers and policy planners. Presently, in these areas use of fertilizers and pesticides is minimal and much below the national average. At first instance, these are the areas which need to be targeted for organic production by devising proper strategies and identifying niche crops (crops which yield higher under organic production systems and have adequate market demand). The domestic and export markets must be exploited for increasing the income of these farmers, as it is important to note that 78% of Indian organic consumers prefer Indian brand of organic and many other countries also require diversified organic foods of tropical fruits, vegetables, essential oils, flowers, herbs, spices and organic cotton from India. In addition, large-scale adoption of organic agriculture in such areas will not only help in conserving the environmentally fragile ecosystems but also help in supplementing overall food production of the country. This can be clearly brought out by the example of Sikkim – an agriculturally weak state located in north-eastern hills region of the country. During 2002-03 (before Sikkim Organic Mission) fertilizer consumption was the highest (21.5 kg ha^{-1}), the productivity of rice was 1.43 t ha^{-1} but 11 years later, i.e., during 2013-14, it increased to 1.81 t ha^{-1}, and more interestingly, no yield reduction was observed during conversion period. Productivity increase in other crops was also noted to the tune of 11%, 17% and 24% in maize, finger millet and buckwheat, respectively. It can be concluded that organic farming technologies need to be fine-tuned and updated, based on scientific principles to further enhance the yields. Further, accelerated adoption of **"towards organic"** (integrated crop management) approach for intensive agricultural areas (food hubs) and **"certified organic farming"** with combination of tradition, innovation and science in the de-facto organic areas (hills) and rainfed/ dryland regions will contribute towards safe food security and climate resilience, besides increased income of farm households. This approach will also positively contribute to the cause of human, livestock and ecosystem health, the basic objective of organic agriculture.

Country Profile

India is the largest democracy and second most populous country (1.267 billion in 2014) having 17.5 % of world population. With many languages, cultures and religions, India is highly diverse. This is also reflected in federal political system, whereby power is shared between the central government and 29 states and 7 union territories. Geographically, India is divided in to 4 physical divisions (The great mountain walls, Indo-gangetic plains, Deccan plateau and Coastal ghats). Indian agriculture began by 9000 Before the Common Era (BCE) as a result of early cultivation of plants, and domestication of crops and animals. Settled life soon followed with implements and techniques being developed for agriculture. Double monsoons (South-west and North-east) led to two harvests being reaped in one year and products soon reached the world via existing trading networks and many new crops were introduced to India. The middle ages saw irrigation channels reach a new level of sophistication in India and Indian crops affecting the economies of other regions of the world. As per the land use statistics 2011-12, the total geographical area of the country is 328.7 m ha of which 140.8 m ha is the reported net sown area with 195.2 m ha as gross cropped area. Cropping intensity is 138.7 % with net irrigated area of 65.3 m ha. The agriculture sector contributes 13.9 % of India's Gross Domestic Product (GDP), but 53.2 % of the population is still dependent on it. Rainfall is the important element of Indian economy as 75.5 m ha of net sown area is not irrigated. Although, the monsoons affect most part of India, the amount of rainfall varies from heavy to scanty on different parts. There is great regional and temporal variation in the distribution of rainfall. Over 80% of the annual rainfall is received in the four rainy months of June to September. The average annual rainfall is about 125 cm, but it has great spatial variations. The highest rainfall occurs in west coasts, on the Western Ghats as well as the sub-himalayan areas in North East and Meghalaya Hills (A&N Islands, Assam, West Bengal, West Coast and Southern slopes of eastern Himalayas) which receives more than 200 cm of annual rainfall. Southern Parts of Gujarat, East Tamil Nadu, North-eastern Peninsular, Western Ghats, eastern Maharashtra, Madhya Pradesh, Odisha, the middle Ganga valley receives rainfall ranging from 100 to 200 cm while Upper Ganga valley, eastern Rajasthan, Punjab, Southern Plateau of Karnataka, Andhra Pradesh, Telangana and Tamil Nadu gets less rainfall of 50-100 cm. Northern part of Kashmir, western Rajasthan, Punjab and Deccan Plateau gets scanty rainfall of <50 cm. The country is divided in to 15 agro-climatic zones and 131 NARP (National Agricultural Research Project) zones. Based on the crop growing period, the country is also divided in to 20 agro-ecological regions in which 8 regions (gross cropped area of 104.36 m ha) have less than 150 days of growing period.

Backed by continued science led technological innovations in the agriculture sector, India's food grain production has more than doubled over the decades to a record 264 mt in 2014. The country has 11.3 % of world arable land and one-fourth of the population depending on agriculture is living in India. Ranks second in rice, wheat, groundnut, vegetables and fruits production with larger share of livestock especially buffaloes (57.3 %). Productivity of major crops in India against the world is given in Table 16. Inspite of technological advancements, the lower productivity prevails in paddy, maize, pulses and soybean to the extent of 18 to 53 % compared to world average productivity which is mainly attributed to large dependency on rainfall and other climatic conditions for good yield.

The irrigated area produces about 56% of total food requirement of India. The remaining 44% of the total food production is supported by rainfed agriculture. Most of the essential commodities such as coarse cereals (90%), pulses (87%), and oil seeds (74%) are produced from the rainfed agriculture. These statistics emphasise that rainfed regions play a major role in ensuring food for the ever-growing population. The rainfed regions are predominantly marked by low cropping intensity, relatively low organic matter status, poor soil physical health and low fertility. Further, moisture stress accompanied by other soil related constraints also results in low productivity of crops (Sharma *et al*., 1997).

Table 16: Productivity (kg ha^{-1}) of major crops in India and World (2011)

Crops	India	World	% difference
Paddy	3591	4429	18.9
Wheat	2989	3175	05.8
Maize	2496	5154	51.5
Total cereals	2864	3661	21.8
Total pulses	616	859	28.2
Potato	22724	19455	-
Soybean	1200	2529	52.50

Source: Agricultural data book, 2014

As per FAO definition, food security is not only the ability to produce but also to access food. According to the data put out by international agencies, 70 % of world's food is produced by small holders and 30 % by the agri-business sector. A report by United Nations Conference on Trade and Development (UNCTAD) and United Nations Environment Programme (UNEP), found that organic agriculture is more conducive to food security and is more sustainable in the long term. There are two significant areas where organic systems have higher yields than conventional systems. These are under conditions of climate extremes and in small holder systems. Both these areas are critical to achieving safe food security for future in India. Organic farmers grow a variety of crops and livestock in order to optimize competition for nutrients. This results in less chance of low production, improved availability and positively impact local food security. Studies by national and international agencies have proved the following aspect of organic agriculture systems.

- Organic systems may decrease yields depending on intensity of inorganic inputs used before conversion.
- In irrigated lands, conversion to organic agriculture may lead to almost identical yields over a period of time.

- In low input traditional/ rainfed agriculture, conversion to organic agriculture has potential to increase yields.

Hence, having 53.6 % area under rainfed and rainfall extremes in various parts of the country, promotion of organic agriculture in niche areas and crops is essential for having safe food security in future.

Concept, brief history and strategic importance of organic farming

Organic farming is very much native to this land. India and China have the long history of organic farming. The farmers of these two countries are farmers of 40 centuries and it is organic farming that sustained them (Yadav, 2008). This concept of organic farming is based on following principles.

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

In today's terminology, it is a method of farming system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (bio-fertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment. Organic farming system relies on crop rotations, crop residues, animal manures, legumes, green manures, safe off-farm organic wastes and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and to control insects, weeds and other pests. In its simplistic form, organic agriculture may be defined as “a kind of diversified agriculture wherein crops and livestock are managed through use of integrated technologies with preference to depend on resources available either at farm or locally". According to Scialabba (2007), the strongest benefits of organic agriculture are its reliance on fossil fuel independent, locally available resources that incur minimal agro-ecological stresses and are cost-effective. She describes organic agriculture as 'neo-traditional food system', which combines modern science as well as indigenous knowledge.

Available records on grain yield of paddy under traditional farming practices indicates yield up to 2.95 t ha^{-1} (2605 lbs $acre^{-1}$) in the first crop (Kuruvai) and 2.81 t ha^{-1} (2484 lbs $acre^{-1}$) in the second crop (Thaladi) [1925-26] has been recorded by Lalgudi Sivagnanam Co-operative Agricultural Society in the Madras Presidency [Royal Commission on Agriculture in India report volume III, 1927]. Similarly in case of wheat, yield of 2.41 t ha^{-1} has been reported from West Bengal during 1970-71 [Report of National Commission on Agriculture, 1976]. The historical perspective and key mile stones of organic farming in world and India are given in Table 17a and 17b.

Table 17a: Historical perspective of organic farming

Oldest practice	10000 years old, dating back to Neolithic age, practiced by ancient civilization like Mesopotamia, Hwang-Ho basin etc.
Ramayana	All dead things - rotting corpse or stinking garbage returned to earth are transformed into wholesome things that nourish life. Such is the alchemy of mother earth (interpreted by C. Rajagopalachari)
Mahabharata (5500 BC)	Mention of Kamadhenu, the celestial cow and its role on human life and soil fertility
Kautilya Arthashastra (300 BC)	Mentioned several manures like oil cake, excreta of animals.
Brihad-Sanhita (by Varahmihir)	Described how to choose manures for different crops and the methods of manuring.
Rig Veda (2500-1500 BC)	Mention of organic manure in Ria Veda 1, 161, 10, 2500-1500 BC, is green manure in Atharva Veda II 8.3, (1000 BC). In Sukra (IV, V, 94, 107-112) it is stated that to cause healthy growth the plant should be nourished by dungs of goat, sheep, cow, water as well as meat. A

	reference of manure is also made in Vrksayurveda by Surpala (manuscript, oxford, No 324 B, Six, 107-164)
Holy Quran (590 AD)	At least one third of what you take out from soils must be returned to it implying recycling or post-harvest residue

Source: Bhattacharya and Chakraborty, 2005

Table 17b: Key milestones of organic farming in World and India

World		India	
1909	American agronomist F.H. King tours China, Korea, and Japan, studying traditional fertilization, tillage, and general farming practices. Findings published in "Permanent Agriculture: Farmers of Forty Centuries"	1905-1924	British botanist Sir Albert Howard, often referred to as the father of modern organic agriculture, works as an agricultural adviser in Pusa & Bengal, where he documented traditional Indian farming practices, and came to regard them as superior to his conventional agriculture science.
1924	Rudolf Steiner's publishes "Spiritual Foundations for the Renewal of Agriculture" which leads to the development of "biodynamic agriculture"	1984	First conference of NGOs on organic farming in India by the Association for Propagation of Indigenous Genetic Resources (APIGR) at Wardha
1939	The first use of the term "organic farming" is by Lord Northbourne. The term derives from his concept of "the farm as organism", which he expounds in his book, "Look to the Land"	1994	Sevagram declaration for promotion of organic farming in India
1940	In Japan, Masanobu Fukuoka, develops "Fukuoka farming"	2001	• National Programme for organic production • National Standards for organic products and processes & Accreditation of Certification Agencies
1943	Lady Eve Balfour published "The Living Soil", which led to	2004	• National Project on Organic Farming

	the formation of a key international organic advocacy group, the Soil Association.		• National Centre of Organic Farming with 6 regional centres • Formulation of policy on Organic farming by Karnataka state • Network Project on Organic Farming was started by Indian Council of Agricultural Research in India with 13 centres in 12 states • The Mizorum Organic Farming Act (First state in India to enact act)
1962	Rachel Louise Carson, (1907 - 1964) a prominent scientist and naturalist, publishes "Silent Spring", chronicling the effects of DDT and other pesticides on the environment. A key factor for the federal government of the United States to ban the use of DDT in 1972	2007	Nagaland state declared intention to go organic and defined organic pathway and policy
1970	One Global goal of the organic movement is to encourage consumption of locally grown food. There is the promotion of this concept with slogans such as "Know Your Farmer, Know Your Food".	2010	Launching of Sikkim Organic Mission with the intention to covert entire state as organic by December 2015
1972	In Versailles, France, creation of The International Federation of Organic Agriculture Movements (IFOAM)	2013	Network Project on Organic Farming in Horticulture crops started with 9 centres under ICAR
1991	The European Union provides a legal framework for the organic agriculture designation	2014	Network Project on Organic Farming of ICAR was strengthened with addition of 7 new centres to cover niche areas

			and crops
2008	IFOAM suggested the definition for Organic Agriculture: "Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved."	2015	• Paramparaghat Krishi Vikas Yojana (PKVY) to promote traditional practices of agriculture including organic farming • Special scheme to promote organic farming in North Eastern states of India • Gujarat state joins as 9th Indian state to promote organic farming in default areas

India’s first internationally certified organic product emerged in the mid 70’s, supported by UK’s Soil Association. India's organic farmers have been at the forefront of developing field based technologies ranging from vermicomposting to integrated livestock practices that facilitate their ability to improve soil fertility even in semi-arid or barren areas. Different parts of India have developed their own local or regional systems for ecological agriculture such as agnihotra and panchakavya that are now gathered in one umbrella term ‘*Jaivic Krishi’ or ‘Jaivik Kheti’*.

Inherited tradition of organic farming in the country is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic and export market. Organic produces are increasingly preferred by developed countries and major urban centres in India. Huge demand for Indian organic products especially tea, coffee, cotton etc. exists in the international market. A special class of consumers is also emerging in the domestic market that requires quality food. The global trade during 2013-14 was USD 60 billion (Rs. 3,60,000 crores) and may touch USD 100 billion (Rs.

6,00,000 crores) within the next five years. Trade in India may reach Rs. 5000-6000 crore, which is about 1% of the global trade. The International Competence Centre for Organic Agriculture (ICCOA) estimated that the domestic market for organic products in the year 2011-12 was Rs. 300 crore and grew to Rs. 600 crore in 2012-13 i.e. a growth rate of 100%. India being a country with different agro-climatic zones, each state produces its own specialty products. Organic products for which production in India has a comparative advantage were documented by Salvodor and Katke (2003), and is given in Table 18.

Table 18: Products for which Indian production has a comparative advantage

Product	Season	States	Major Locations
Tea	Throughout the year	Assam, West Bengal, Uttranchal	Darjeeling, Guwahati, Dehradun
Spices	Throughout the year	Kerala, Tamil Nadu, Karnataka	Cochin, Coimbatore, Idduki, Coorg
Coffee	Throughout the year	Kerala, Tamil Nadu, Karnataka	Coimbatore, Coorg, Wayanadu, Peeremade
Rice	Kharif and Rabi	Punjab, Haryana, Assam, Maharashtra, Tamil Nadu	Amritsar, Jalandhar, Darrang, Ratnagiri, Kanchipuram, Thiruvallur
Wheat	Kharif and Rabi	Punjab, Haryana, Uttar Pradesh	Ambala, Patiala, Bhatinda, Faridkot
Vegetables	Throughout the year	All India	Various locations
Fruits	Throughout the year	All India	Various location
Cotton	Kharif	Maharashtra, Gujarat Madhya Pradesh,	Akola, Amravati, Amreli, Kheda, Indore

Source: Salvador and Katke, 2003

Besides the broad range of products and the seasonal advantages mentioned above, India has other comparative advantages for organic production which are given below.

- India is strong in high quality production of certain crops like tea, some spices, rice specialties, ayurvedic herbs etc.

- India has a rich heritage of agricultural traditions that are suitable for designing organic production systems. Botanical preparations, some of which originate from the ancient Veda scripts, provide a rich source for locally adapted pest and disease management techniques. The widespread cultivation of legume crops facilitates the supply of biological fixation of nitrogen.
- In several regions of India agriculture is not very intensive as regards to use of agro-chemicals. Especially in mountain areas and tribal areas, use of agro-chemicals is rather low, which easily facilitates conversion to organic production. On these marginal soils, organic production techniques have proved to achieve comparable or in some cases (especially in the humid tropics) even higher yields than conventional farming.
- The Non-Governmental Organizations (NGOs) sector in India is very strong and has established close linkages to a large numbers of marginal farmers. Many NGOs are engaged in promotion of organic farming and provide training, extension services information and marketing services to farming communities.
- The Indian Government has realized the potential and significance of organic agriculture for the country and has recently started to support organic agriculture on a large scale and on various levels. A national regulatory framework (standards, accreditation regulations) has already been passed in 2000 and as a result National Standards for Organic Production (NSOP) was notified in 2001 under National Programme of Organic Production. Ministry of Agriculture launched National Project on Organic Farming. Special schemes to support organic agriculture in North-Eastern states and Paramparaghat Krishi Vikas Yojana also formulated to give impetus to organic systems. Indian Council of Agricultural Research provides research and technological back up in the country.

Organic Area, Production and Export

Emerging from 42,000 hectares under certified organic farming in 2003-04, the organic agriculture has grown many folds and by March 2014 India has brought more than 4.71 m ha area under organic certification process. Out of this, cultivated area accounts for 0.72 m ha (15.2 %), while remaining 3.99 m ha (84.8 %) is wild forest harvest collection area (Fig 12 and Table 19).

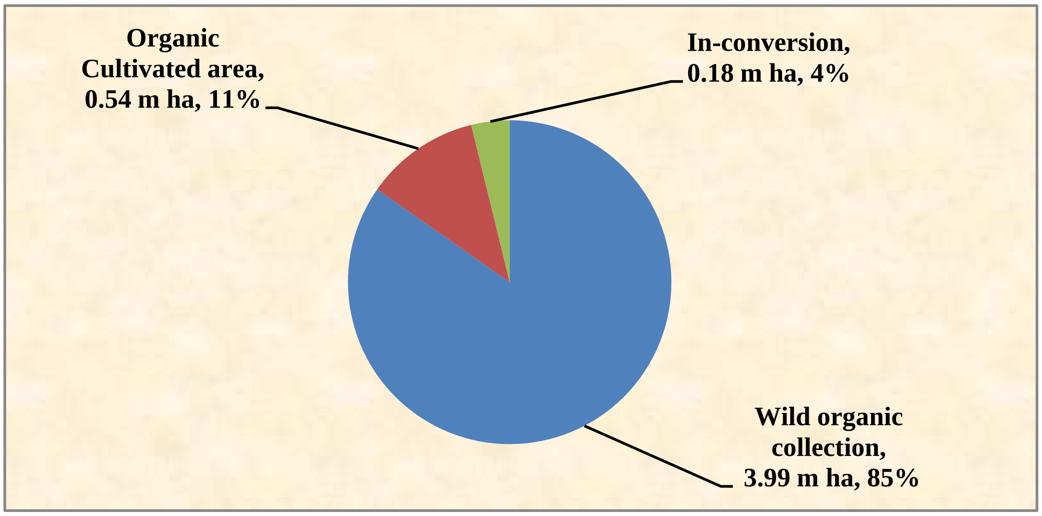


Fig. 12: Share of area under organic production (Source: APEDA, 2014)

Table 19: India organic: An overview (2013-14)

Area under certified	4.72 million ha
Total Certified Production	1.24 million tonnes
Accredited inspection and certifying agencies	25
Major countries for export	U.S.A., European Union, Canada, Switzerland, Australia, New Zealand, South East Asian countries, Middle East, South Africa

Currently, India ranks 10th among top ten countries having the cultivable land under organic certification. Growth of area under organic farming during different years is presented in Fig. 13. In terms of wild collection, India ranks 3rd next to Finland and Zambia. Around 6.50 lakhs producers are engaged in the country in various forms. Presently only 0.51% of area (including wild collection) is under the process of certification. Sikkim has the highest 79% of net sown area under organic certification while Madhya Pradesh is having largest area (232887 ha) under organic production system (Table 20). As per the statistics, 99.5% of area is still under conventional system. However, it is important to note that the data of organic farming area is collected from certification agencies, producers and processors. The actual area under organic production system must be and should be higher as many of the hilly states and rainfed districts are having very low use of external inputs for managing the soil fertility and pests.

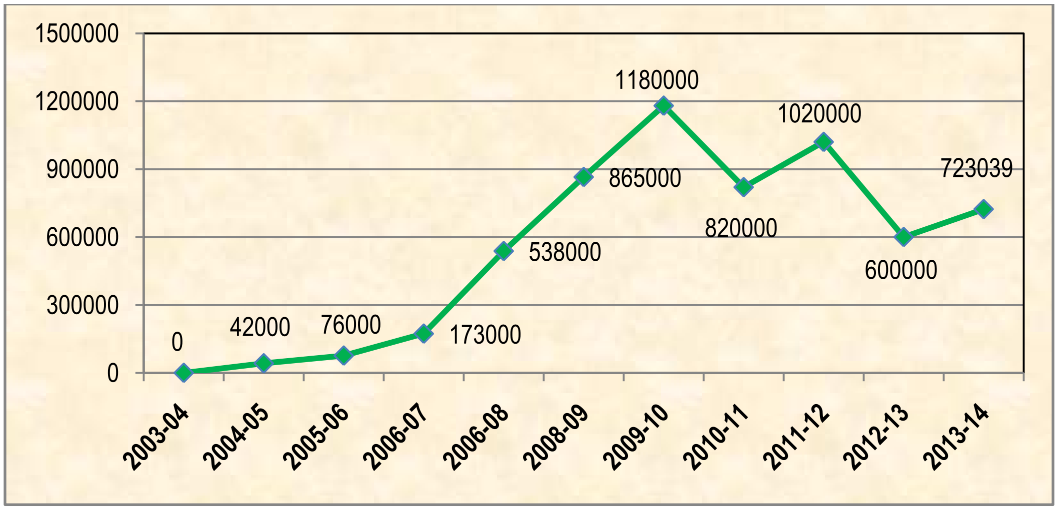


Fig. 13: Trend of area (ha) under organic certification (Source: APEDA, 2014**)**

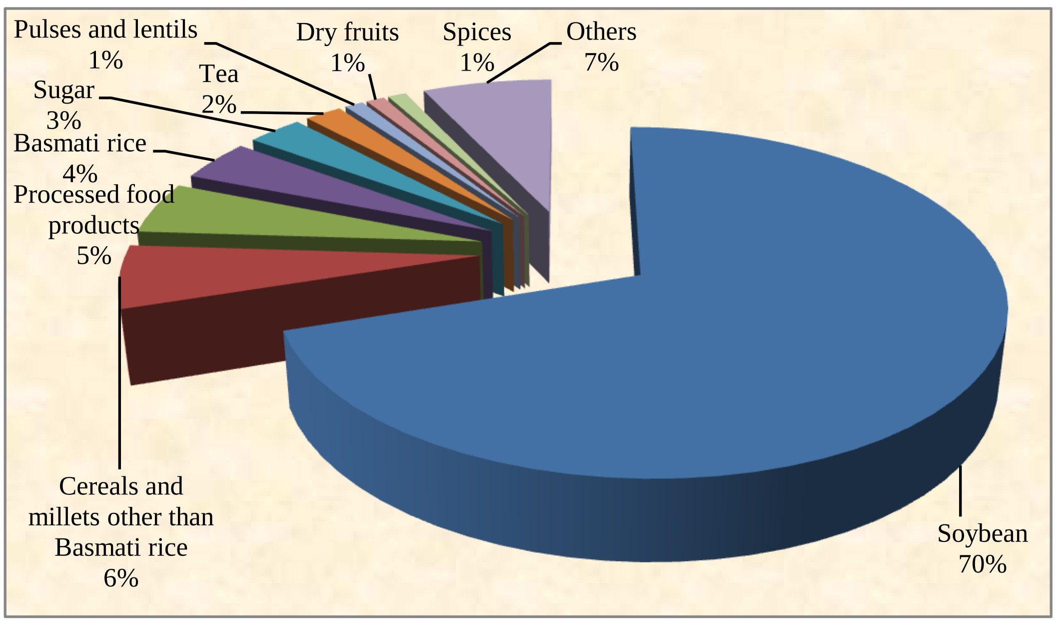
Table 20: Top 10 states of India in terms of actual area (ha) and % of net sown area under organic farming

Actual area			**% of net sown area**			
State	**Net sown area (000 ha)**	**Area under organic certification in 2013-14 (ha)**	**State**	**Net sown area**	**Area under organic certification in 2013-14 (ha)**	**Net sown area**
Madhya Pradesh	15119	232887	Sikkim	77	60843	79.0
Maharashtra	17406	85536	Goa	131	12853	9.8
Rajasthan	18349	66020	Uttarakhand	723	24739	3.4
Sikkim	77	60843	A&N Islands	15	321	2.1
Odisha	4682	49813	Madhya Pradesh	15119	232887	1.5
Gujarat	10302	46863	Nagaland	362	5168	1.4
Uttar Pradesh	16593	44670	Jammu and Kashmir	732	10035	1.3
Karnataka	10523	30716	Odisha	4682	49813	1.0

Uttarakhand	723	24739	Himachal Pradesh	539	4686	0.8
Kerala	2072	15020	Kerala	2072	15020	0.7
All India*	**141515**	**723039**	**All India***	**141515**	**723039**	**0.5**

*All India includes other states data also (**Source**: Anonymous, 2015)

India exported 135 products during 2013-14 with the total volume of 1, 77,766 t, with total value of 1328.61 crores. Export volume and value from the country during last 3 years (Table 21) indicates highest volume of export to USA and in terms of value to European Union during 2013-14 and over the years it has grown drastically. Among the various commodities exported, soybean shares 70% (Fig. 14).



Source: APEDA, 2014

Fig. 14: Share of commodities in organic export during 2013-14

Table 21: Export volume and value from country in last three year

Countries	2011-12		2012-13		2013-14	
	Export volume (t)	Value (□ crores)	Export volume (t)	Value (□ crores)	Export volume (t)	Value (□ crores)
European Union	51138	505	82835	678	56946	553
U. S. A.	37630	197	34292	228	74942	498
Canada	19848	66	33645	146	38545	182
Switzerland	2161	21	3455	27	4306	33
Japan	232	8	199	11	309	16
Australia	349	5	468	6	749	14
Rest	4055	34	5380	57	1964	28
Total	**115417**	**839.3**	**160276**	**1155.8**	**177765**	**1328**

Source: Ministry of Commerce and Industries, GOI, 2014

Inorganic and organic sources of nutrients

A: Inorganic sources: Chemical fertilizers such as urea, DAP, complex fertilizers, Murate of potash and single super phosphate forms major source of inorganic source of nutrients for crop production in the country. Among the various sources, highly soluble nitrogenous source is urea and shares 49.5 % of total consumption in the country followed by DAP (Table 22).

Table 22: Inorganic source of fertilizers consumed for crop production during 2010-11

Source of Fertilizers	Consumption (mt)	% share of total
Urea (46 % N)	28.11	49.5
Di Ammonium Phosphate (16% N, 42% P_2O_5)	10.87	19.1
Complex fertilizers (NP/ NPK)	9.86	17.3
Murate of Potash	3.93	7.0
Single Super Phosphate	3.82	6.8
Mono Ammonium Phosphate	0.10	0.2
Triple Super Phosphate	0.09	0.1
Sulphate of Potash	0.02	<0.1
Total	**56.80**	**100.0**

B: Organic sources: Bhattacharya and Chakraborty (2005) estimated the current status of organic farming in India and other countries. They noticed various problems in the conventional farming in India and opined that the integration of organic and inorganic farming would be an ideal model. Based on their results, the industrial nitrogen fixation (INF) is 40 mt per year which accounts for only 15.3% of total nitrogen fixation. On the other hand, the quantity of biological nitrogen fixation (BNF) is 175 mt per year contributes for 67.3% of the total amount. Plant also uses nutrients from organic sources through mineralization and billions of microorganisms are available in soil for this job. India is endowed with various types of naturally available organic form of nutrients in different parts of the country and which will help for organic cultivation of crops substantially. Sources of nutrients from organic manures estimated by Bhattacharya (2006) are presented in Table 23. There is enough scope for production of sufficient organic inputs exists in India and it works out to 7 mt in terms of nutrients. Among different sources, livestock accounts for lion share (nearly 40%). It is followed by crop residues (30%) and other sources (15%). Other sources include the rural compost, vermi-compost and agricultural wastes. The other estimate by Tandon (1995) indicates potential of 39.9 mt (Table 24) which includes forest litter, urban and sewage sludge wastes.

Table 23: Sources of nutrients from organic manures in India

Source	Quantity (mt)
Livestock	2.47
Crop residues	2.00
Bio-gas slurry	0.12
Bio-fertilizer	0.20
Green manure	0.10
City refuse	0.68
Others (Rural, vermicompost and other agricultural wastes)	1.00
Total	**6.57**

Table 24: Potential of plant nutrients (mt) from various sources in India

Source	Plant Nutrients (mt)			
	N	P_2O_5	K_2O	Total
Cattle	2.997	0.793	1.332	5.102
Buffalo	0.745	0.276	0.487	1.508
Goat and sheep	0.214	0.063	0.020	0.297
Pig	0.044	0.027	0.029	0.100
Poultry	0.027	0.020	0.010	0.057
Other livestock	0.079	0.018	0.069	0.166
Human beings	3.228	0.776	0.715	4.719
Farm crop wastes	5.600	2.300	10.700	18.600
Forest litter	0.075	0.030	0.075	0.180
Water hyacinth compost	0.060	0.033	0.075	0.168
Rural compost	1.130	0.678	1.130	2.938
Urban compost	0.024	0.015	0.030	0.069
Sewage sludge	0.012	0.009	0.003	0.024
Total	**14.215**	**5.038**	**14.675**	**39.928**

(**Source**: Tandon, 1995)

Principles of organic agriculture, Scope and Objectives

The organic community has adopted four basic principles (FAO 2001), and broadly speaking, any system using the methods of organic agriculture and being based on these principles, may be classified as organic agriculture:

- **The principle of health:** Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.
- **The principle of ecology:** Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.
- **The principle of fairness:** Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.

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

Organic farming is considered incomplete without livestock as livestock alone contributes 37.5 % of total organic manures in the country. Crop + dairy is the pre-dominant farming system practiced traditionally by Indian farmers over the centuries. Analysis of benchmark data of 732 marginal households across the 30 NARP zones indicates existence of 38 types of farming systems. Out of this, 47 % of households have the integration of crop + dairy, 11 % have crop + dairy + goat, 9 % households have crop + dairy + poultry systems and 6 % households have only crop component. Hence, natural strength exists in the country for promotion of organic farming. Further, over 85% of the farmers hold less than 2 ha land and about 53% of the area under agriculture is dependent on rainfall, whereby return on investment is not assured due to failure of rains and other calamities. Small and marginal farmers who spend most part of their income on food alone have no opportunity to make any savings. In the absence of cash reserves, the poor farmers are unable to procure necessary inputs for crop production. As against the world average of 172 kg ha^{-1} chemical fertilizers, Indian agriculture consumes only about 128 kg ha^{-1}. The average fertiliser consumption is even lower, if fertilisers applied for three important crops like paddy, wheat and sugarcane are not considered in the average. Infact, hilly and rainfed regions are more suitable for growing wide variety of crops under organic farming.

The organic agriculture is always compared with conventional yields which receives 100 % recommended quantity of major nutrients. The yield level of organic agriculture is lower in some of the crops in the initial years compared to 100% recommended chemical fertilizers. However, in the real sense, the organic agriculture yield should always be compared with the yield obtained under farmer’s package of nutrient management; then only, the real issue of food security can be discussed. The large number (904 no’s in various states) of on-farm data collected in AICRP-IFS indicates, except some states like Punjab, existence of nutrient application gap between farmers and recommended package with farmers package receiving 33, 37,77 and 62 % lesser quantity of N, P_2O5, K_2O and micro nutrient respectively for major food crops namely rice, wheat and maize. Organic inputs ensure balanced supply of nutrients to crops. Besides domestic market (Table 25), there is a huge demand for Indian organic products in the export market.

Table 25: Market potential for organic foods by study products in top 8 metros in India

Study Products	Accessible Potential		Market Potential	
	Million Rs.	**%**	**Million Rs.**	**%**
Vegetables	1030	18	3220	22
Fruits	710	13	2460	17
Milk	520	9	1660	11
Dairy Products	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	0.3	0
Total	**5620**	**100**	**14520**	**100**

Source: Rao *et al.*, 2006

Overall, what we need ideally is a high yielding, income generating, science-based, farmer-empowering and eco-friendly agriculture system that provides nutritional food security first to small-holder farmers and eventually to the nation. Organic farming principles have all these features with major objectives as follows.

- Production of high quality food in sufficient quantity in harmony with natural systems and cycles
- Enhancing biological cycles within the farming system involving microorganisms, soil flora and fauna, plants and animals
- Maintaining long-term soil fertility and genetic diversity of the production system and its surroundings including plant and wildlife
- Promoting healthy use with proper care of water resources and all life therein
- Creating harmonious balance between crop production and animal husbandry
- Minimizing all forms of pollution

Components of organic farming

Essential components of organic farming are keeping the soil alive through effective management natural resources. They are as follows.

- **Enrichment of soil:** Abandon use of chemicals, use crop residue as mulch, use organic and biological fertilizers, adopt crop rotation and multiple cropping, avoid excessive tilling and keep soil covered with green cover or biological mulch.
- **Management of temperature**: Keep soil covered, plant trees and bushes on bund
- **Conservation of soil and rain water:** Dig percolation tanks, maintain contour bunds in sloppy land and adopt contour row cultivation, dig farm ponds, maintain low height plantation on bunds.
- **Harvesting of sun energy:** Maintain green stand throughout the year through combination of different crops and plantation schedules.
- **Self-reliance in inputs:** Develop your own seed, on-farm production of compost, vermicompost, vermiwash, liquid manures and botanical extracts.
- **Maintenance of life forms**: Develop habitat for sustenance of life forms, never use pesticides and create enough diversity.
- **Integration of animals**: Animals are important components of organic management and not only provide animal products but also provide enough dung and urine for use in soil.

- **Use of renewable energy**: Use solar energy, bio-gas and other eco-friendly machines.

Country status of agriculture today, including pesticide and fertilizer used

India accounts for only about 2.4 % of the world's geographical area and 4 % of its water resources, but has to support about 17 % of the world's human population and 15 % of the livestock. As per 4th Advance Estimates for 2013- 14, total production of rice in the country is estimated at 106.54 mt which is a new record, higher by 1.30 mt than the production of rice during 2012-13. Production of wheat estimated at record level of 95.91 mt is also higher than production of 93.51 mt during 2012-13. The production of Coarse Cereals is estimated at 43.05 mt which is also higher than the production of Coarse Cereals during 2012-13. Total food grains production during 2013-14 estimated at 264.77 mt is also a record. It is higher by 7.64 mt than the production of 257.13 mt of food grains achieved during 2012-13. Total production of pulses and oilseeds estimated at record levels of 19.27 mt and 32.88 mt respectively are higher by 0.93 mt and 1.94 mt than their production levels during 2012-13. The horticulture sector has been a driving force in stimulating a healthy growth trend in Indian agriculture. India is currently producing 257.2 mt of horticulture produce from an area of 23 million ha. Over the last decade, the area under horticulture grew by about 3.8% per annum but production rose by 7.6% per annum. The higher growth rate in horticulture was brought about by improvement in productivity of horticulture crops, which increased by about 28% between 2001-02 and 2011-12 (GOI, 2013). The agriculture sector is predominantly part of a mixed crop-livestock farming system. The livestock sector supplements income of the farmers, provides employment, draught power and manure. India is the largest producer of milk in the world, estimated production of milk in 2011-12 is 127.9 mt and the second largest producer of fish in the world with estimated production of 8.85 mt during 2011-12. The ultimate irrigation potential in the country is estimated at about 140 million hectares. Of this, about 58.5 million hectare is from major and medium irrigation sources, and 81.5 million hectare is from minor irrigation sources (about 64.1 million hectare from groundwater irrigation and 17.4 million hectare from surface water). Groundwater provides about 70 percent of irrigation and 80 per cent of the drinking water supplies.

Consumption of nitrogenous (N), phosphatic (P), and potassic (K) fertilizers has increased from 1.1 mt in 1966-67, the year preceding the green revolution to 25.5 mt in 2012-13. The all-India average consumption of fertilizers has increased from 105.5 kg ha^{-1} in 2005-06 to 128 kg ha^{-1} in 2012-13 (Table 26). While per hectare consumption is 250.2 kg in Punjab and 219 kg in Andhra Pradesh, it is comparatively low in Madhya Pradesh (84.8 kg ha^{-1}), Odisha (90.3 kg ha^{-1}), Rajasthan (51.7 kg ha^{-1}) and Himachal Pradesh (50.2 kg ha^{-1}) and below 10 kg ha^{-1} in many of the North Eastern States. Among the different zones, western zone has got the lowest consumption (84.6 kg ha^{-1}). The fertilizer use efficiency on average is reported to be 33% for N, 15% for P, 20% for K and micronutrients. Even with the best management practices it has not been possible to achieve more than 50% for N, 30% for P and 50% for K. Rest of amount either get volatilized or get leached/ fixed in the soil in complex forms, hence resulting into to the economical loss.

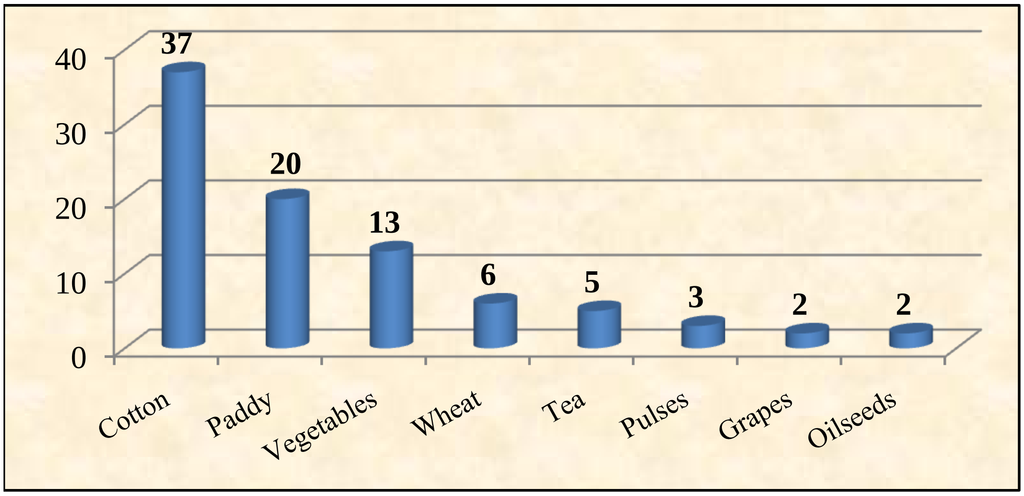
Table 26: Status of plant nutrient consumption (kg ha^{-1}) per unit of gross cropped area

Zone/ State	N	P_2O_5	K_2O	Total	Zone/ State	N	P_2O_5	K_2O	Total
West (2012-13)					**East (2012-13)**				
Gujarat	82.3	21.1	6.2	109.6	Arunachal Pradesh	1.6	0.1	0.3	2.1
Madhya Pradesh	49.1	32.5	3.2	84.8	Assam	36.3	11.8	18.2	66.3
Chhatisgarh	66.2	31.7	8.2	106.1	Bihar	154.5	45.3	12.5	212.2
Maharashtra	56.8	29.7	16.1	102.7	Jharkhand	89.5	60.9	7.8	158.2
Rajasthan	37.2	13.7	0.8	51.7	Manipur	26.1	3.7	1.4	31.1
Goa	17.3	10.2	6.1	33.6	Meghalaya	9.9	3.4	1.0	14.3
Daman and Diu	46.7	6.7	3.3	56.7	Mizorum	12.3	0.7	0.2	13.2
Dadra and Nagar Haveli	26.4	17.3	-	43.6	Nagaland	2.4	1.5	0.8	4.8
West	53.2	24.7	6.7	84.6	Odisha	58.0	22.9	9.4	90.3
South (2013-14)					Sikkim	-	-	-	-
Andhra Pradesh	139.7	56.7	22.6	219.0	Tripura	39.1	20.7	12.9	72.7

Karnataka	68.3	29.8	19.1	117.2	West Bengal	86.2	47.4	29.6	163.2
Kerala	46.5	23.8	34.4	104.7	East	85.8	35.0	17.4	138.2
Tamil Nadu	99.9	38.8	25.9	164.6	**North (2012-13)**				
Telangana	155.5	45.5	12.0	213.0	Haryana	157.3	47.7	2.6	207.6
Puducherry	365.5	91.3	52.6	509.4	Himachal Pradesh	35.5	7.2	7.5	50.2
A&N Islands	22.6	16.8	13.2	52.6	Jammu & Kashmir	66.5	21.1	8.6	96.2
South	93.9	38.7	20.7	153.2	Punjab	188.5	58.7	3.1	250.2
					Uttar Pradesh	132.0	46.0	5.2	183.2
					Uttarakhand	103.7	20.3	6.4	130.4
					Delhi	25.7	1.6	-	27.3
					North	141.4	46.3	4.6	192.3
					All- India (2012-13)	**84.5**	**33.4**	**10.4**	**128.3**

Source: Agricultural Research data book, 2014 & FAI, Southern zone report, 2014-15

It is noteworthy that use of chemical pesticides in India is very low and estimated at only 381g ha^{-1} (technical grade pesticide) when compared to the global average of 500 grams of technical grade pesticide per hectare. Information provided by State Governments reveal that around 90 million hectares of cropped area is within the ambit of pesticides usage leaving out significant swathes of agricultural land in the country where pesticides are not being applied to crops. Different estimates show that more than 50% of consumption of pesticides is garnered by insecticides, whereas herbicides and fungicides together contribute about 30- 40% of total pesticide consumption (GOI, 2013). Bio-pesticides usage has shown a steady increase in the last two decades to reach a consumption level of more than 5734 t during 2013-2014. Among the crops, cotton, rice, vegetables and fruits account for the largest share of pesticide consumption in the country (Fig. 15).



(**Source:** Kodandaram *et al.*, 2013)

Fig. 15: Share of pesticide consumption in different crops during 2012-13

The tractor density in India is about 16 tractors for 1,000 hectares, as against the world average of 19 tractors. The increasing threat to natural resources, notably land and water, has further necessitated switching over to machine assisted resource conservation techniques such as zero-tillage, raised-bed planting, precision farming, etc. Even though farm mechanization is increasing in India, it is mostly region specific. The decreasing trend in operational land holdings is an impediment in the growth of agricultural mechanization. Small and marginal farmers who cultivate about 85 per cent of the holdings and account for nearly 44 per cent of the total cultivates area cannot afford high cost agricultural machines (GOI, 2013).

With the increasing awareness about the safety and quality of foods, long term sustainability of the system and accumulating evidences of being equally productive, the organic farming has emerged as an alternative system of farming which not only addresses the quality and sustainability concerns, but also ensures a profitable livelihood option. Cultivated area under certified organic farming has grown almost 17 fold in last one decade (42,000 ha in 2003-04 to 7.23 lakh ha in 2013-14). The Government of India has implemented the National Programme for Organic Production (NPOP) in the year 2001. The national programme involves the accreditation programme for certification agencies, norms for organic production, promotion of organic farming etc. States like Uttaranchal, Karnataka, Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, Tamil Nadu, Kerala, Nagaland, Mizoram, Sikkim have been promoting organic farming.

Soil fertility and fertilization

Maintaining the soil fertility is major concern in India. Yadav (2013) reported that 63, 42 and 13 % samples drawn from various locations were low in nitrogen, phosphorus and potassium respectively. Besides, 49 % samples were deficient in Zn and 41 % samples were deficient in sulphur. Some samples also gave the deficiency of copper, iron, manganes and molybedinum. In order to ensure sustainable food security and reduce the environmental cost of agriculture, soil health management is promoted in India with the following strategies.

1. **Integrated Nutrient Management:** In order to enhance the efficiency of chemical fertilizers and for improving crop response to the applied fertilizers, use of organic manures is required to concurrently improve the soil physical and biological properties. Therefore, for sustained agricultural production, the Integrated Nutrient Management, which envisages soil test based use of chemical fertilisers in conjunction with organic fertilisers (Compost, Farm Yard Manure etc) is accepted as a good practice. Approximate amount of subsidy given on chemical fertilizers required for crops viz. wheat, paddy and pulses as per the balanced nutrient management is given in Table 27.

Table 27: Conjoint application of nutrients to crops and approximate subsidy on chemical fertilizers

Name of Crop	Nutrient dose (Integrated Package) (kg ha^{-1})				Equivalent chemical fertilizer dose + FYM/ Compost (kg ha^{-1})				Approx. Subsidy on chemical fertilizers (Rs ha^{-1})
	N	P	K	FYM/ Compost	Urea	DAP	MOP	FYM/ Compost	
Rice	60	40	30	10000-12000	110	90	50	10000-12000	3300
Wheat	90	60	30	10000-12000	150	130	50	10000-12000	4400
Pulses	10	20	20	2500-3000	25	45	33	2500-3000	1200

(**Source**: Anonymous, 2015)

2. **Organic agriculture for sustainable production:** Government of India provides assistance for on-farm production of organic inputs, sustainable internal control system for certified organic farming, and has established a National Centre to promote capacity building, training and awareness programmes. The areas having very low levels of fertilizers consumption such as, rainfed and hilly areas are most suitable for conversion to organic farming. Rainfed agriculture which constitutes over 50% of net sown area are also targeted for expansion of organic farming as the fertilizer use per hectare in these areas is low compared to the national average. Agriculture in North East Region and Himalayan States is also by and large natural.

Conversion of conventional to organic farming

The time between the start of organic management and certification is called conversion period. It is necessary to maintain organic and non-organic fields separately. In the long run, the entire farm including livestock should be converted into organic. The conversion period is decided based on the past use of the land and ecological situation. Generally, the conversion period is two years for annual crops and three years for perennial crops. However, the conversion period can be relaxed based on the verification by third party certification agency if the requirements are fully met. During conversion, steps should be taken to maintain bio-diversity.

1. **Banning of chemicals:** It is widely known fact that some biological processes of plants involved in acquiring nutrients such as nitrogen e.g. N_2-fixation are generally inhibited through application of Nitrogen. Studies generally caution against non-judicious fertilizer use and encourage use of organic compost otherwise it may lead to deficiency of micronutrients. Therefore in organic farming systems there is no place for chemicals.
2. **Low input alternative:** In first year, sowing of three different types of legumes in strips, first of 60 days (like moong), second of 90-120 days (cow pea or soybean) and third of more than 120 days (red gram) in strips is recommended. Apply mixture of compost and vermicompost (2:1) @ 2.5 t acre^{-1} enriched with 4 kg *Azotobacter* and 4 kg PSB biofertilizers or 4 kg consortia of customized cultures as basal dose at the time of sowing preferably in furrows below the seeds. Seeds of legumes should be treated with crop specific strains of *Rhizobium* biofertilizer. Mulch the entire surface with a

thick layer of biological mulch and drench the biomass with Jivamrut @ 200 l acre^{-1}. The percent change in the yield of major crops during conversion (1-3 years) and afterwards is given in Table 28. Overall, the yield starts improving or on par with chemical management from 3rd year onwards except wheat.

Table 28: Mean yield of crops tested in cropping systems under organic input management and yield trend over the years

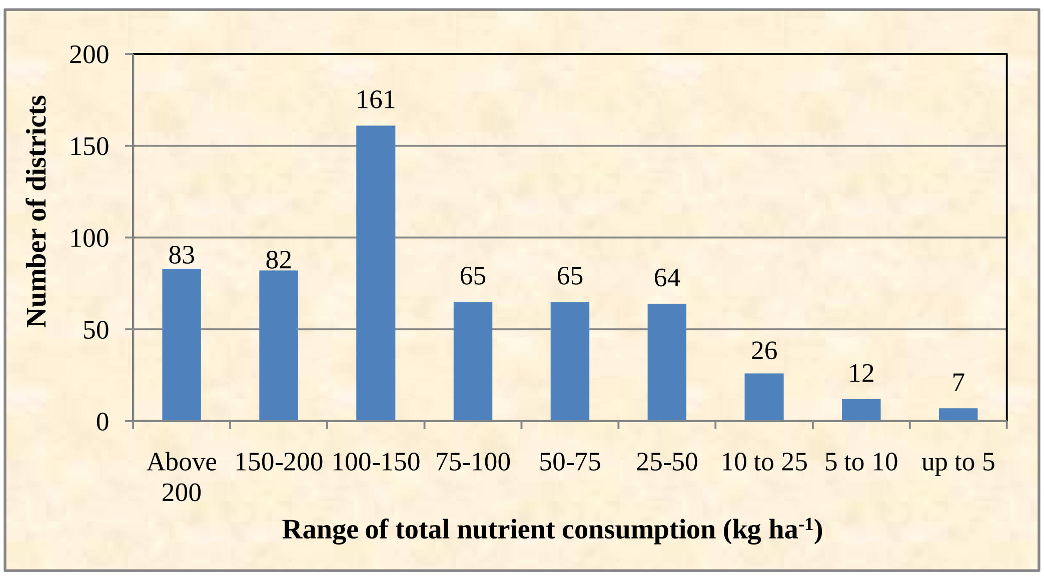
Crop	**N**	**Mean yield under organic input management (kg ha^{-1})**	**Yield trend under organic system over the years % increase (+) or decrease (-) over inorganic input management**						
			1st year	**2nd year**	**3rd year**	**4th year**	**5th year**	**6th year**	**7th year**
Basmati rice	67	3099	-13	-14	-3	2	2	8	7
Rice	56	3639	-12	-13	5	2	1	2	1
Wheat	56	2952	-15	-9	-7	-3	-7	-13	-4
Maize	55	4541	-5	9	4	0	3	10	16
Green gram	12	905	-	-4	-	-9	3	13	13
Chickpea	25	1269	-10	5	9	3	0	1	5
Soybean	58	1697	1	1	5	0	3	0	12
Cotton	29	1243	8	9	11	12	11	14	12
Garlic	9	7878	-10	-19	8	15	-	-	-
Cauliflower	12	10683	-8	-8	4	2	-	-	-
Tomato	11	20577	-13	-13	-30	-28	35	26	20
Mean			**-6.7**	**-4.8**	**0**	**1**	**8.4**	**5.6**	**9.0**

N = No. of observations **Source**: NPOF, 2014

Hazards of inorganic farming

Inorganic farming or so called green revolution has made the country proud by producing sufficient food for all. However, Charyulu and Biswas (2010) have documented the hazards of using inorganic sources of nutrients and pesticides in the country.

1. **Impact of green revolution:** The glory of green revolution was on the basis of the use of high yielding varieties (HYV), chemical fertilizers, pesticides, and farm mechanization that led to unprecedented pressure on our natural resource base including natural way of controlling pest and diseases. Green revolution has encouraged an increase in the production of mainly two crops, wheat and rice, but the cost paid was in terms of destruction of other crops (especially coarse cereals and pulses) and over exploitation of precious water resources and fertile soils. The high dosage application of fertilizers (Fig. 16) deteriorated the physical, chemical and biological properties of soil on one side, on the other, increased soil salinity and pollution of ground water resources. The use of pesticides has been posing serious environmental and health problems. The 59th round of survey conducted by National Sample Survey Organization during 2003 indicates over dependency of farmers for seeds, fertilizers and pesticides from outside farm makes farming costlier.



Source: FAI, 2014

Fig.16: Classification of districts according to range of total nutrient consumption during 2013-14

2. **Impact on soil health:** Total factor productivity and growth rate of productivity of crops are decreasing year after year and deterioration of soil health is the major contributor for the same. Inspite of 326 districts receiving more than 100 kg of nutrient ha^{-1}, it has been found that, soils in majority of the districts are low in nitrogen (228 districts), phosphorus (170 districts) and potassium (47 districts). Exhaustive cropping systems cause mining of soil nutrients far in excess of external supply. Nutrient uptake of major systems (Table 29) indicates continuous mining of soil nutrient resource in the intensively cultivated areas. Rice-wheat-cowpea fodder system removes around 800 kg ha^{-1}. Further, wider nutrient application gap between recommended and farmers practice also adds to the problem. Across the major systems, farmers are applying 33.3, 38.8, 57.1 and 93% less application of NPK and micro nutrients compared to recommended doses. Among the systems, rice-rice is having the minimum gap in application in terms of NPK (1.1, 12.6, and 36.4%, respectively). Continuous application of under doses of nutrients and wider NPK ratio (8.2:3.2:1 during 2012-13 reported by Ministry of Chemicals and fertilizers, 2013) to intensive systems like rice-rice, rice-wheat, and maize-wheat leads to decline in soil health.

Table 29: Nutrient uptake in high intensity cropping in India

Cropping systems	System yield (t ha^{-1})	Nutrient uptake (kg ha^{-1} year^{-1})		
		N	P_2O_5	K_2O
Rice-wheat	8.8	235	92	336
Pigeonpea-wheat	4.8	219	71	339
Maize-wheat-greengram	8.2	306	62	278
Rice-wheat-greengram	11.2	328	69	336
Maize-potato-wheat	8.6 + 11.9 (t)	268	96	358
Rice-wheat-cowpea	9.6 + 3.9 (f)	272	153	389

t, f represents tuber and fodder yield **Source**: Tandon and Sekhon, 1988

Temporal decline in response of nutrients has been observed in many systems. Across the systems, it has been observed that the response of 13.4 kg yield per kg of NPK in 1960 has come down to 2.7 kg per kg. Declining soil health also contributes for wider yield gap in many systems. The yield gap due to application of recommended nutrient doses and farmers nutrient dose was found to be more in maize-wheat (2996 kg ha^{-1}) system followed by rice-wheat (2215 kg ha^{-1}) (Fig. 17). Partitioning of yield between major (NPK) and micro nutrients indicates, in case of cereal – cereal system, contribution of major nutrients such as NPK in bridging the yield gap is higher (72 to 86%) while micronutrients contributes to about 14 to 28%. However, in rice-green gram system, the contribution is almost equal (52 and 48%, respectively). During the initial years of introduction of the HYVs, only macronutrient deficiencies were discovered as an obstacle to their high yields. With passes of time, the situation has worsened with increasing use of high analysis fertilisers free from secondary and micronutrients, decreasing use of organic manures and neglected recycling of crop residues. As a result, multi-nutrient deficiencies (macro + micro) are being observed in recent years. Among micronutrients, Zn deficiency is the most common soil disorder accounting for nearly 48% of the soil samples analyzed under ICAR's AICRP on Secondary and Micronutrients and Pollutant Elements. Next to Zn are B (38%) and Fe (12%) deficiencies (Gangwar *et al.*, 2013).

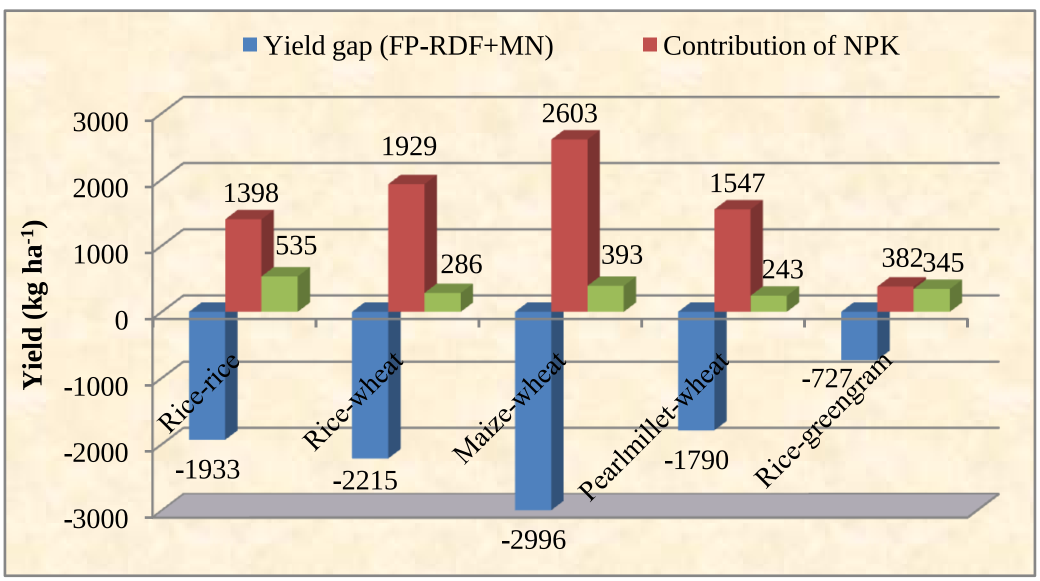
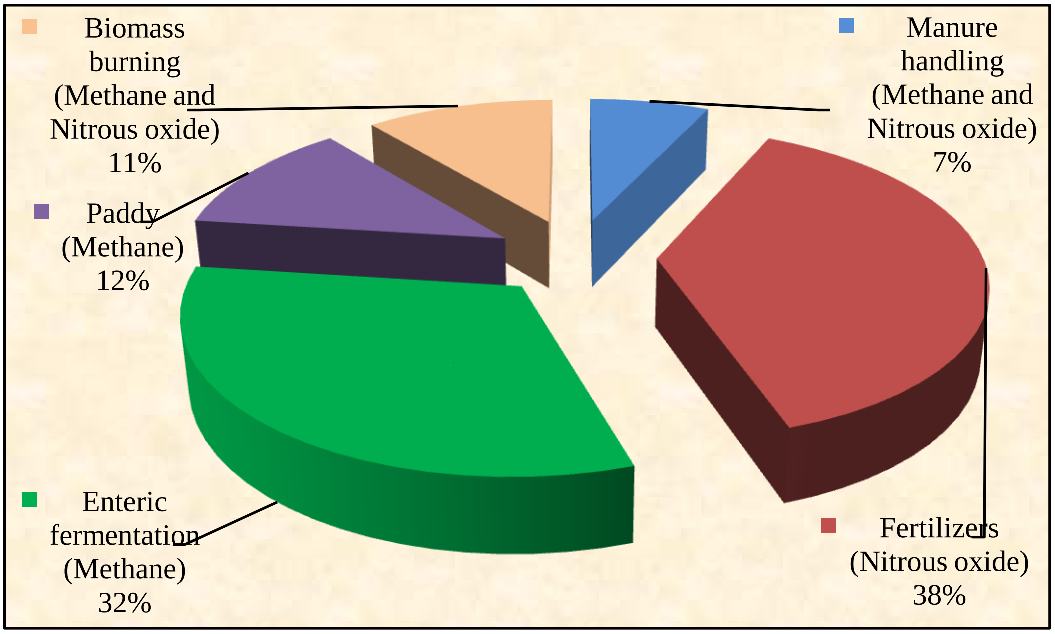


Fig. 17: Yield gap between farmers and recommended nutrient package and contribution of major and micro nutrients to yield gap

3. **Impact on climate:** With manufacturing of fertilizers and pesticides as the two major inputs of green revolution technologies, an important point of consideration was the need for fossil fuels and/or expensive energy which are associated with serious environmental and health problems. This fact further got the attention of the world when the Intergovernmental Panel on Climate Change (IPCC) found that agriculture as practised today (conventional agriculture, modern agriculture or GR agriculture) accounts for about one fifth of the anthropogenic greenhouse effect, producing about 50% and 70%, respectively of the overall anthropogenic methane and nitrogen oxides emissions (Charyulu and Biswas, 2010). Crop productivity has increased substantially through utilization of heavy inputs of soluble fertilizers – mainly nitrogen and synthetic pesticides. However, only very minimal was taken up by crops (approximately 17-22 %). The remainder was lost to the environment. Between 1960 and 2000, the efficiency of nitrogen use for cereal production decreased from 80 to 30 % (Erisman, et al., 2008). High levels of reactive nitrogen (NH_4, NO_3) in soils may contribute to the emission of nitrous oxides and are main drivers of agricultural emissions. The excess fertilizers (not taken up by the plants) are often emitted into the water bodies and the atmosphere. The emission of GHG in CO_2 equivalents from the production and application of nitrogen fertilizers from fossil fuel amounted to 750 to 1080 mt (1 to 2 % of total global GHG emissions) in 2007. In 1960, 47 years earlier, it was less than 100 mt. In summary, each year, agriculture emits 10 to 12 % of the total estimated GHG emissions. Smith *et al.*, (2007) documented that fertilizers alone contributes for 38 % of GHG emissions (Nitrous oxide) from agriculture sector (Fig. 18).



Source: Smith *et al.*, 2007

Fig. 18: GHG emissions of the agriculture sector

4. **Reduction in genetic diversity and natural enemies:** Diversity in crops was a key factor in agricultural systems in India during earlier years. It provided stability and resilience to the systems as well as economic security to the farmers. However, after the introduction of modern technology, more emphasize upon high yielding varieties focused on single species. This resulted in the erosion of genetic diversity base of agro-ecosystems. Many research studies have proved that reduction in genetic diversity lead to more susceptibility to pests and diseases. The reduction in natural enemies due to chemical management was found to be 63 to 74 % in various crops (Table 30).

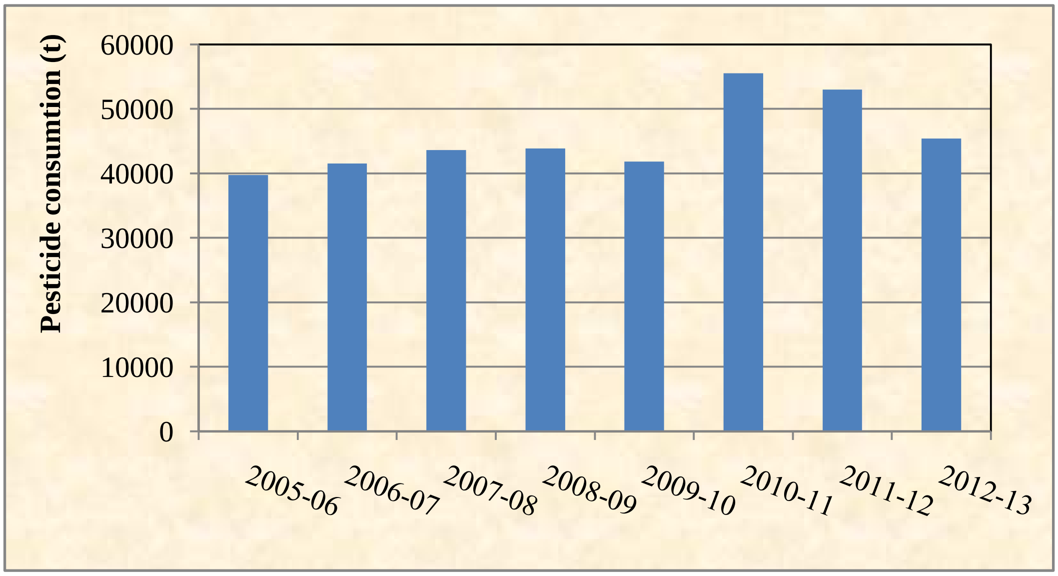
Table 30: Changes in *Coccinelids* and other natural enemy population in various crops under organic and chemical management practices

Crops	*Coccinelids*		Other natural enemies (*Syrphids, Micromus, Chrysopa, spiders*)		Cumulative % reduction of natural enemies/ year under chemical management
	Chemical	Organic	Chemical	Organic	
Maize (nos/m)	0.80	2.65	0.50	1.53	68
Groundnut(nos/m)	0.69	2.58	0.76	2.15	69
Soybean (nos/m)	0.35	1.35	-	-	74
Cotton (nos/plant)	1.60	4.15	0.88	2.67	63
Potato (nos/m)	0.30	1.25	0.09	0.30	74

Source: Annual Report, 2010-11

5. **Contamination of food and decline in nutritive values:** The incessant application of chemicals not only polluting the grains but also the food consumed (Rup Lal *et al.*, 1989; ICMR Bulletin, 2001). The wide spread application of chemicals lead to genetic mutation of pests and develop resistance to these chemicals. According to Pimentel (1995), only 0.1% of pesticide actually reaches the target pests and the rest go to non-target sectors. The details of consumption of pesticide (technical grade) in India from 2005 to 2013 are presented in Fig. 19.

   There was a significant decline (around 15 %) in the consumption of total pesticides in the country during 2012-13 compared to previous years. The reduction in the consumption may be due to the introduction of IPM technologies including bio-control and conduct of awareness programmes by the government. However, pesticide residue is major concern. According to study by CCS Haryana Agricultural University, Hisar, the pesticides in agricultural produce, food commodities (Table 31), animal feed, fodder, animal products and irrigation water (Table 32) are matter of serious concern as their presence is more than maximum residue limit (MRL) of Prevention of Food Adulteration Act, 1954 (Bhattacharyya and Chakraborthy, 2005). In general, cotton (37 %) and fruits (grapes, 2 %) and vegetables (13%) consume more quantity of pesticides. Modern/ conventional agriculture practices also adversely affected the quality of food supply. Growing foods with methods designed to increase production or to facilitate transportation and storage is often detrimental to their nutritional value. Organic foods have been shown to have a higher nutritional value than conventionally grown foods (Shiva *et al.*, 2004).



Source: Agricultural Data Book, 2014

Fig. 19: Pesticide consumption in India

Table 31: Pesticide residue persistence in agricultural produce and food commodities

Commodity	2001		2002	
	Samples (no.)	Contamination	Samples (no.)	Contamination
Vegetable* (17 crops)	712	61 12% above MRL	529	63.5 8.5% above MRL
Fruits** (12 crops)	378	53 (Less than MRL)	329	47 (approaches MRL)

Source: CCSHAU, 2003

* At Hisar all contaminated- 46% above MRL, Heptachior and Cypermethrin; ** Fields in Faridabad – Vegetables, fruits, flowers highly contaminated, MRL= Maximum residue limit

Table 32: Pesticides residue persistence in animal feed, fodder, animal products and irrigation water

Commodity	Samples (no.)	Contamination (%)	Major residue recorded	Year of testing
Feed and fodder	125	81.0	HCH, DDT, Chloropyri-phos, Endosulphan	2001
Milk	537	52.0	94% HCH, 9% Endo-Sulphan, DDT residue	2001
Butter	184	67.4	94% HCH, 9% Endo-Sulphan, DDT residue	2002
Irrigation Water				
a. General water	258	60.0	HCH, DDT	2001
b. Surface water	251	73.0	Endo-Sulphan Chloropyriphos, 4 above all	2001
c. Canal	10	All		2001
d. Pond	10	All		2001

Source: CCSHAU, 2003

Table 33: Adverse effects of nitrogenous fertilizers on human health and environment

Effect	**Causative agents**
Human health	Excess NO_3 and NO_2 in water and food
Methemoglobinemia cancer	Nitrosamine illness from NO_2, secondary amines, peroxyacyl nitrate
Environmental health Environment	Excess NO_3 in water and food
Eutrophication	Inorganic and organic N in surface water
Materials and ecosystem damage	HNO_3, aerosols in rainfall

Source: Bhattacharyya, 2004

6. **Impact on human health:** Crop produced with chemicals especially pesticides above MRL not good for health, contains heavy metals and causes several diseases due to excess nitrate and nitrite contents and pollutes the environment. Bhattacharya (2004) documented the adverse effects of nitrogenous fertilizers on human health and environment (Table 33).

Farm waste recycling and organic mulches

According to Ministry of New and Renewable Energy (MNRE, 2009), Govt. of India approximately 500 mt of crop residues are generated every year. Depending on the crops grown, cropping intensity and productivity in different regions of India, there is a large variability in generation and end use of these crop residues. The crop residues generation is the highest in Uttar Pradesh (60 mt) followed by Punjab (51 mt) and Maharashtra (46 mt). Among different crops, cereal crops generate 352 mt residues followed by fibre crops (66 mt), oilseeds (29 mt), pulses (13 mt) and sugarcane (12 mt). The cereal crops (rice, wheat, maize, millets) contribute 70% (rice 34% and wheat 22%) of crop residues. Among fibre crops, cotton generates maximum (53 mt) with 11% of crop residues. Coconut ranks second among fibre crops with 12 mt of residues generation. Sugarcane generates 12 mt i.e., 2% of crop residues (comprising of tops and leaves) in India. A large amount of residues are, in addition, generated from fruit, vegetable and fodder production (NAAS, 2010). The unutilized crop residues i.e., total residues generated minus residues typically used for various purposes are burnt on-farm. Estimated total crop residues unutilized in India is 84-141 mt year^{-1} where cereals and fibre crops contribute 58% and 23%, respectively. Sugarcane, pulses, oilseeds and other crops contribute to the remaining 19%. Out of 82 mt surplus crop residues from the cereal crops, 44 mt is from rice crop followed by 24.5 mt from wheat crop, which is mostly burnt on-farm. In case of fibre crops (33 mt of unutilized residues) approximately 80% is cotton residues and are subjected to on-farm burning. There are large uncertainties in the data on generation of crop residues, their uses, the remaining surplus and on-farm burning. Pathak *et al.* (2010) estimated that about 90 mt of crop residues are burnt on-farm and this figure is close to 85 mt when the coefficients developed by the Inter-Governmental Panel on Climate Change (IPCC) are used. Annual production of different kinds of farm wastes and by-products estimated by NAAS, 2010 is given in Table 34.

Table 34: Annual production of different kinds of farm wastes and by-products

Type of waste	Annual production in mt
Crop residues from field crops	679
Crop residue from horticultural crops	268
Road side/forestry and social forestry waste	204
Animal dung/excreta on dry matter basis	9.50
Slaughter house waste	10.00 + 24.25 million hide and skins
Wastes from fallen carcasses of animals	7.17 + 24.25 million hide and skins
Fisheries waste	8.00
Total	**1566 + 48.50 million of hide and skins**

Source: NAAS, 2010

Composting of wastes and recycling

A good quality compost free from weeds, pathogens and rich in nutrients is a prerequisite for adopting organic farming practice. Different methods have been developed for the preparation of quality compost from farm wastes. Several methods of composting of farm wastes exist in India (Krishan Chandra, 2005). Depending upon the nature and quantity of raw material available with the farmer, any one or combination of following methods suggested by Manna and Asha Sahu, 2013 can be adopted for the production of compost. Production and nutrient content of various composts in India is given in Table 35. Government has established 19 fruit vegetable waste compost units in various states from 2004 to 2014 with production capacity of 63150 t and 50 bio-fertilizer units with production capacity of 12563 t under National Project on Organic Farming.

1. **Indore method:** This is an old method of compost preparation in the pit having size of 9'x5'x3'. A portion of pit is filled with farm wastes layer by layer. Each layer is around 3" thick and over it a layer 2" of cow dung slurry mixed with urine is spread. Pit is filled with farm wastes and plastered with 2"-4" thick layer of soil and dung. This prevents moisture loss and allows the temperature to rise up to 60-65ºC within 3-4 days. Material inside the pit is turned after 15-30 days and moisture is maintained by adding water. Another turning is given after an interval of 30 days. Good quality compost becomes ready within 3-4 months.

2. **NADEP compost:** This compost method was developed by Naryan Devrao Pandri Pandey. A brick structure measuring 10'x6'x3' is prepared with holes in the side walls to ensure adequate supply of air during composting. The brick tank is filled with farm wastes, soil and cow dung and water is added to maintain moisture between 60-75%. A tank is filled with soil, 16-18 qtls, farm wastes 14-16 qtls, dung 1-1.2 qtls. Water is added to moisture the material and upper layer is plastered with soil and dung mixture. After 75-90 days of composting, microbial culture of Azotobacter, Rhizobium and phosphate solubilizing bacteria are added into the mixture. Compost becomes ready for use within 110-120 days. One tank provides about 2.5-2.7 t of compost sufficient for one hectare land. Another kind of nadep is known as BHU-NADEP. In this construction of tank by bricks are not required. Method of filling is same as above.
3. **NADEP Phospho compost:** This is a method to prepare phosphorus enriched compost using farm wastes, rock phosphate and phosphate solubilizing bacteria. Insoluble phosphorus present in rock phosphate is transformed into soluble form through the action of certain specific microorganisms during the process of composting. Compost is prepared using farm wastes, cow dung and soil as the quantity given for preparation of NADEP compost .Rock phosphate is added to this mixture @ 12.5% w/w. This mixture is filled either in pit, NADEP tank or BHU-NADEP. This material is plastered with a mixture of dung and soil after adding sufficient water to moisten the decomposing mixture. The material is turned after 15 days and thereafter at an interval of 30 days. At each turning, water is added to maintain sufficient moisture. Compost becomes ready within 3-4 months and contains N 1%, P_2O_5 2-4% and K_2O 1-2%. One equal P_2O_5 basis, this compost can substitute the use of phosphatic fertilizers in crops.
4. **Institute of Biological Sciences (IBS) Rapid Composting Technology:** This technology involves inoculating the plant substrates with cultures of a cellulose decomposing fungus (*Trichoderma harzianum*), for composting. Sawdust mixed with the leaves of subabul (*Leucaena leucocephala*), a leguminous tree, is used as the medium of growth for compost fungus activator. The composting time, using this procedure, ranges from 21 to 45 days, depending on the plant substrates used. The procedure consists of two parts: the production of the compost fungus activator and the composting

process. Substrates such as rice straw, weeds and grasses should be chopped as this helps speed up decomposition by increasing the surface area available for microbial action, and providing better aeration. If large quantities of substrates are to be used (several tonnes), a forage cutter/ chopper is needed. Substrates should be moistened with water. If a large volume of substrates are to be composted, a sprinkler is more convenient. Carbonaceous substrates should be mixed with nitrogenous ones at a ratio of 4:1 or less, but never lower than 1:1 (on a dry weight basis). Some possible combinations are: • 3 parts rice straw :1 part subabul • 4 parts rice straw:1 part chicken manure • 4 parts grasses:1 part legume materials + 1 part manure • 4 parts grasses: 1 part Chromolaena odorata or Mikania cordata (weeds) + 1 part animal manure The substrates should be piled loosely to provide better aeration within the heap. Compost heaps should be located in shady areas such as under big trees. The platform should be raised about 30 cm from the ground, to provide adequate aeration at the bottom. Alternatively, aeration can be provided by placing perforated bamboo trunks horizontally and vertically at regular intervals, to carry air through the compost heap. The compost fungus activator is broadcasted onto the substrates during piling. Once decomposition is complete, the compost should be sun dried again until its moisture content is 10- 20%. If mature compost is needed at once, it should be sun dried for one day, or as soon as its temperature drops to 30°C.

5. **Coir pith compost:** Large quantity of coir waste of about 7.5 mt is available annually from coir industries of India. Coir fibre is usually used in rope making industries which generates bulk amount of dusty materials called coir dust/ coir pith. Composting of coir pith reduces its bulkiness, C:N ratio, lignin and cellulose contents and increases its manurial value. Coir pith composting is an aerobic composting. Thus, a heap of 4' x 3' x 4' (LxWxH) is made. Initially coir pith should be put upto 3" height and thoroughly moistened. Then nitrogenous source may be added in the form of fresh poultry litter @ 200 kg t^{-1}. Microbial inoculum namely Pleurotus spps. was added. For maintaining aerobic condition, turning (once in 10 days) is done. Sixty per cent moisture is to be maintained at the time of composting. The matured compost is ready to use within 60 days.

6. **Sugarcane trash compost:** Sugarcane produces about 10 to 12 tonnes of dry leaves ha^{-1}. Its trash contains 28.6% organic carbon, 0.35 to 0.42% nitrogen,

0.04 to 0.15% phosphorus and 0.50 to 0.42% potassium. Sugarcane trash can be easily composted by using the fungi like *Trichurus, Aspergillus, Penicillium* and *Trichoderma*. For one tonne of sugarcane trash 50 kg fresh dung is recommended. The dung can be mixed with 100 litres of water and thoroughly mixed with sugarcane trash. Rock phosphate @ 5 kg t^{-1} of waste and inoculums @ 2kg t^{-1} can be added. After mixing all the inputs with sugarcane trash, heap should be formed with a minimum height of 4'. This height is required to generate more heat in the composting process, and the generated heat will be retained long time inside the material. The composted material should be turned periodically once in 15 days for better aeration.

7. **Pressmud compost:** Pressmud is a by-product obtained from sugar industry. About 3% of pressmud is obtained for the total quantity of cane crushed. Pressmud is spread in the compost yard to form a heap of 9' x10.5' x4.5' (LxWxH). Distillery effluent is sprayed on the heaps to a moisture level of 60% and the pressmud heap is allowed overnight to absorb the effluent. Bacterial culture was diluted with water (1:10) and added @ 10 l t^{-1} after 3 days. Depending on the moisture content of heap, the effluent should be sprayed once or twice in a week. This should be repeated for 8 weeks so that the pressmud and effluent proportion reaches an optimum ratio of 1:3. The heaps are then allowed for one month curing. The bioinoculants such as Azotobacter can be added to enrich the compost for nitrogen and the introduction of phosphorus solubilizing microorganisms like Aspergillus awamori or Bacillus polymyxa will improve the available phosphorus content in the manure.

8. **Poultry waste compost using paddy straw:** Fresh poultry droppings are mixed thoroughly with chopped paddy straw (< 2 cm size) @ 1:1.25 ratio. Pleurotus sajor-caju is inoculated @ 5 packets (250 g each) t^{-1} of substrate. Periodical watering should be done once in 15 days and turning should be given on 21, 35 and 42 day of composting (avoid turning during first 3 weeks of composting). Materials are converted to matured compost within a period of 50 days.

9. **Vermicompost:** Earthworms are used to prepare compost from farm and livestock wastes. Earthworms continuously feed upon the organic residues and produce casts. This casts is generally termed as vermi compost, Casts of earthworms are usually rich in nutrients and organic matter and therefore

serves as a good source of manure for growing crops. Certain earthworms like *Eisenia foetida*, *Perionyx excavatus* and *Eudrilus eugeniae* are specifically suited for the preparation of vermicompost. Vermicompost contains N 1.0-1.5%, P_2O_5 0.2-1.0% and K_2O 1-2% depending upon the raw materials used.

10. **Pitcher Khad:** This is a fermented preparation made from cow dung 15kg, cow urine 15 litres, water 15 litres and gud 250 grams. Mixture is mixed in a container and covered with a cloth or gunny begs. The material is fermented for 4-5 days. The fermented mixture is mixed with water 200 litres and sprayed over the crop in one acre area. 2-3 sprays are sufficient for short duration crops.

11. **Bio-gas slurry:** Bio-gas slurry prepared from livestock wastes is a good manure. Slurry is dried in solar drier. Dried slurry is directly applied in fields.

Table 35: Nutrient content of various composts in India

Compost	Production potential (t)	N (%)	P_2O_5 (%)	K_2O (%)	C:N ratio
Coirpith compost	4.0	1.24	0.06	1.21	24:1
Pressmud compost	2.0	2.70	3.00	3.00	10:1
Poultry waste compost	2.5	1.89	1.83	1.34	12:1

Scope in niche areas

1. **Niche areas:** A study by Panneerselvam *et al* (2013) indicates conversion to organic improved the economic situation of farmers although food production was reduced by 3–5% in the organic situation. Thus, the estimated economic values were higher in the organic system (5–40% in fertilizer subsidy scenario and 22–132% in no fertilizer subsidy scenario) than in the conventional system, whereas the total state-level food productions were lowered by 3–5% in the organic compared to the conventional system. Food production was higher when rainfed, and lower in the irrigated situation in the large-scale organic scenario. Niche areas for promotion of organic farming in the country

based on nutrient and pesticide usage are given in Fig. 20. Arunachal Pradesh, Nagaland, Meghalaya, Mizorum, Assam, Rajasthan, Madhya Pradesh, Odisha, Bihar, Jharkhand, Gujarat, Karnataka, Himachal Pradesh, Jammu & Kashmir and Uttarakhand are very much suitable for promotion of organic farming based on its usage of inputs. Further, towards organic approach having non-pesticide but with chemical fertilizers can be promoted in Tamil Nadu, Kerala, Andhra Pradesh, West Bengal, Uttar Pradesh, Punjab and Haryana states. This approach will help to improve the food security of country. There is a great potential for organic farming to flourish in this country and given an appropriate institutional and policy framework, it will not be very difficult to promote the existing *'de-facto organic'* farms in N E region and Western India to the category of certified organic farms (Shetty *et al.*, 2013).

2. This would enable the small farmers to take advantage of the lucrative market for certified organic products in the developed world, which could directly contribute towards the improvement of their economic well-being. In India, some regions like as N E Region, Western Rajasthan Himalayan region and chota Nagpur plateau are naturally growing crops without fertilizer and pesticides. Government should concentrate these areas and try to give them organic certificate. Statewise consumption of fertilizers in NEH (Table 36) indicates all the states are having much lesser consumption of nutrients through chemical fertilizers. Eastern Hill states also called 7 sister states offers wider opportunity for organic agriculture. Among the states, 75 % area of Sikkim and 14 % of Nagaland are under certification process (Fig. 21). In other states, it is also constantly increasing.

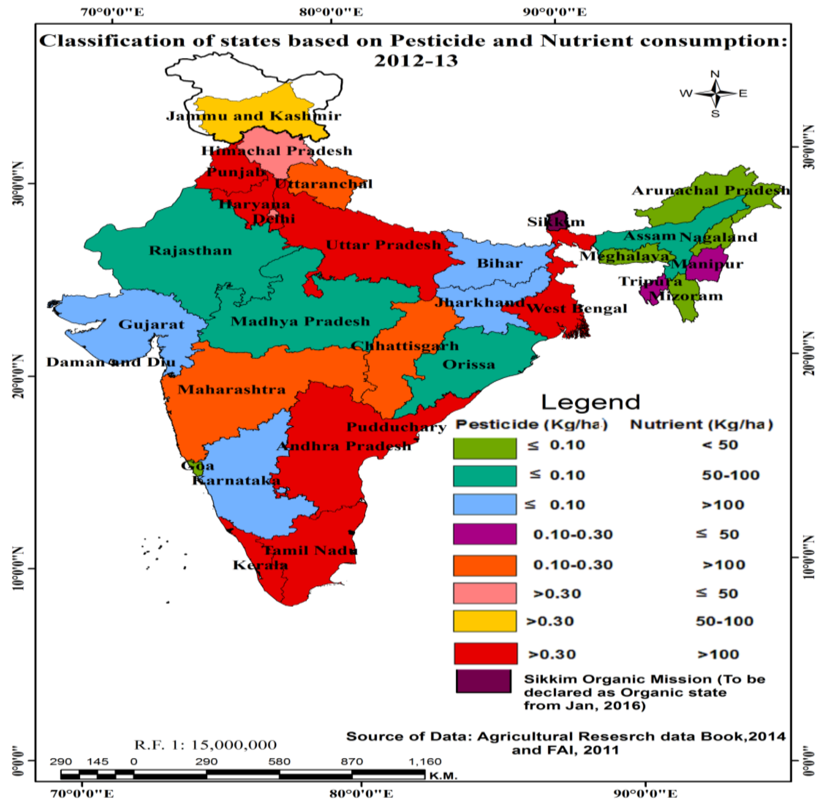
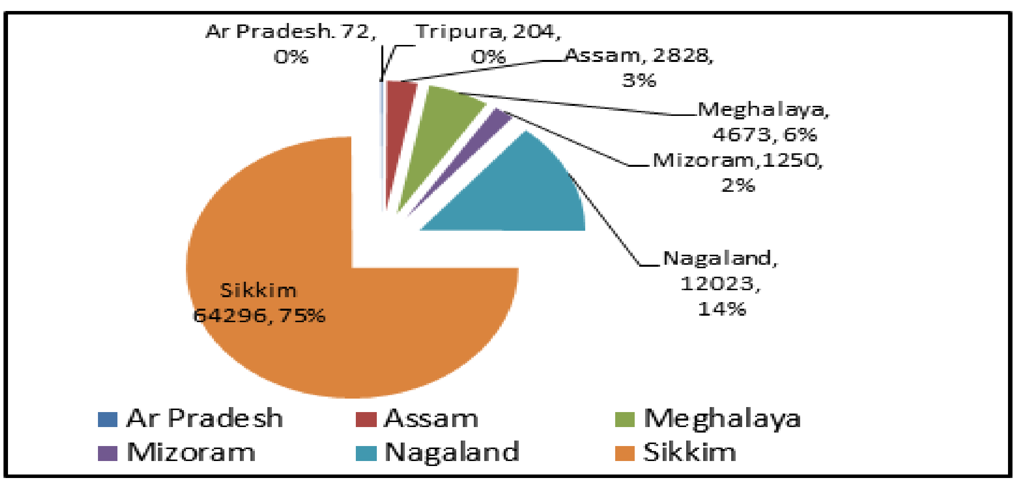


Fig 20: Niche areas suitable for promotion of organic farming based on pesticide and nutrient use



Source: MOF, 2015

Fig. 21: Area under certification process in North-Eastern hill states of India

Table 36: State wise consumption of plant nutrients per unit of gross cropped area in N E State as compared to national average

	Consumption			
	N	**P_2O_5**	**K_2O**	**Total**
Arunachal Pradesh	01.9	00.8	00.3	03.0
Assam	34.8	14.5	18.2	67.6
Manipur	21.9	4.7	01.3	27.9
Meghalaya	09.0	4.5	01.4	15.0
Mizoram	16.7	19.8	09.1	45.5
Nagaland	01.6	01.0	00.3	02.9
Tripura	26.0	14.4	11.2	51.6
All-India	84.5	33.4	10.4	128.3

Source: FAI, 2011-12 and Agricultural Data Book, 2014

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) and Participatory Guarantee (PGS) system, per farmer costs have come down drastically. The costs which were ranging from Rs. 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 to 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. Eight states have their own certification agency accredited by APEDA and issuing the certificates at subsidized rates.

3. **Economic viability:** The studies conducted under Network project on Organic Farming NPOF) revealed that across the locations, net return was 17 % higher (at 20-25 % premium price) under organic production system compared to inorganic production system. Benefit: Cost ratio of important cropping systems experimented under NPOF is given in Table 37.

Table 37: Benefit:Cost ratio of different cropping systems experimented under organic production

Cropping System (s)	B:C ratio*	Cropping System (s)	B:C ratio*
Babycorn -Potato-Greengram	2.38	Rice -Lentil-Sesbania (GM)	0.97
Brinjal-Sunflower	1.41	Rice -Mustard-Sesbania (GM)	1.19
Cabbage-Radish-Capsicum	0.81	Rice -Pea(veg.)-Sesbania(GM)	2.16
Cauliflower-Radish-Tomato	1.42	Rice-Dolichos bean	0.94
Frenchbean-Cauliflower-French bean	0.86	Rice-G.Nut	1.35
Ginger	1.97	Rice-Maize	1.12
Groundnut -Sorghum	3.52	Rice-Mustard	0.75
Maize-Cotton	2.60	Rice-Pea-Sorghum F	2.99
Maize-Garlic	1.83	Rice-Potato-Radish	1.91
Maize-Mustard-Radish-Green gram	1.87	Rice-Wheat-Sesbania (GM)	1.35
Maize-Potato-Okra	1.73	Sorghum (F)-Pea-Okra	2.69
Potato-Chickpea	3.06	Soybean- Wheat	3.00
Rice – Berseem	3.46	Soybean-Berseem	1.58
Rice - Carrot	4.34	Soybean-Chickpea	2.11
Rice – French bean	3.18	Soybean-Isabgol	2.44
Rice -Mustard	1.04	Soybean-Mustard	1.94
Rice - Potato	2.06	Turmeric	1.91
Rice – Potato -Okra	3.34	Turmeric+ Onion	1.26

* Benefit cost ratio worked out by taking 20 to 25 % premium price for organic products and it is mean of over the years and across the locations

The cost of organic source of nutrients under organic cultivation varied between 28 to 85 % of the operational cost across different crops, whereas, under non-organic cultivation, the cost of nutrient sources predominantly constituted by inorganic sources ranged between 16 to 68 %. Srikrishna sudheer (2013) compared the economics of organic farmers (N=350) and chemical farmers (N=200) for three crops, paddy, redgram, and groundnuts, in the state of Andhra Pradesh during 2010-11. It was found that organic farmers are earning a gross income of 5%, 10% and 7% more compared to the chemical farmers of paddy, redgram and groundnut, respectively, and with lower input costs, the profits earned by the organic farmers are higher by 37%, 33% and 59% for the selected crops respectively. Organic farming is generally more profitable in terms of financial costs and returns than chemical farming, irrespective of the crop or the size of farm (the exceptions being small redgram farms and large goundnut farms). An analysis of the farmers' perception of organic farming reveals that electronic media (television) is the prime motivator for farmers to adopt organic practices.

4. **Environment saviour:** Assessment of soil C sequestration potential was made after 10 years of continuous organic cultivation of different crops at HAREC, CSK HPKVV, Bajaura (Himachal Pradesh) under Network Project on Organic Farming. Averaged across different cropping systems, Walkley-Black C stock at 0 – 60 cm soil depth was found 66.3, 51.7 and 40.7 t ha^{-1} under organic, integrated and chemical management of soil nutrients, respectively. Under the organic system, this build up of Walkley-Black C stock was higher by 28.2 and 63.1% than to integrated and chemical application of nutrients, respectively. Further, Walkley – Black soil C sequestration rate in 0 – 60 cm soil depth under organic cultivation of crops was 1.46 and 2.57 t ha^{-1} $year^{-1}$ as compared to integrated and chemical application of soil nutrients, respectively. This study explicitly shows that continuous practice of raising the crops organically has good potential to sequester the C in the soil to offset the C emissions in the atmosphere (IIFSR, 2015).

Various forms of organic agriculture

1. ***Biodynamic Agriculture:*** Biodynamic agriculture is a method of farming that aims to treat the farm as a living system which interacts the environment to build healthy, living soil and to produce food that nourishes and vitalizes and helps to develop man kind. The underlying principle of biodynamics is making life-giving compost out of dead material. The methods are derived from the teachings of Rudolf Stainer and subsequent practitioners. The important components of biodynamic farming are as follows.

   - Turning in plant materials such as green crops and straw

- Not using chemical fertilizers and pesticides
- Avoiding soil compaction by machinery or animals, particularly in wet weather
- Keeping soil covered by pasture, crops or mulch not destroying the soil structure by poor farming practices such as excessive use of rotary hoe or cultivation in unsuitable weather (too wet or too dry)
- Fallowing the land by planting deep-rooting permanent pasture species or using green crops
- Use of preparations BD-500 and BD-501
- Compost made with preparations BD-502 – BD-507
- Liquid manure made with preparations BD-502 – BD-507
- Cowpat pit manure made with preparations BD-502 – BD-507

These biodynamic preparations named BD-500 to BD-507 are not food for the plants, but they facilitate the effective functioning of etheric forces. They are also not the usual compost starters, but can stimulate compost organisms in various ways. In short they are biologically active dynamic preparations which help in harvesting the potential of astral and etheral powers for the benefit of the soil and various biological cycles in the soil. So far 9 biodynamic preparations have been developed, named as formulation 500 to 508. Out of these, formulation-500 (cow horn compost) and formulation- 501 (horn-silica) are very popular and are being used by large number of organic farmers. Formulations-502 to 507 are compost enrichers and promoters, while formulation 508 is of prophylactic in nature and helps in control of fungal diseases.

2. ***Rishi Krishi:*** Drawn from Vedas, the Rishi Krishi method of natural farming has been mastered by farmers of Maharashtra and Madhya Pradesh. In this method, all on-farm sources of nutrients including composts, cattle dung manure, green leaf manure and crop biomass for mulching are exploited to their best potential with continuous soil enrichment through the use of Rishi Krishi formulation known as "*Amritpani*" and virgin soil. 15 kg of virgin rhizosperic soil collected from beneath of Banyan tree (*Ficus bengalensis*) is spread over one acre and the soil is enriched with 200 lit Amritpani. It is prepared by mixing 250 g ghee into 10 kg of cow dung followed by 500 g honey and diluted with 200 lit of water. This formulation is utilized for seed treatment (*beej sanskar*), enrichment of soil (*bhumi sanskar*) and foliar spray on plants (*padap sanskar*). For soil treatment it needs to be applied through irrigation water as fertigation. The system has been demonstrated on a wide range of crops i.e. fruits, vegetables, cereals, pulses, oilseeds, sugarcane and cotton.

3. ***Panchgavya Krishi:*** Panchgavya is a special bioenhencer prepared from five products obtained from cow; dung, uine, milk, curd and ghee. Dr Natrajan, a Medical practitioner and scientist from Tamilnadu Agricultural University, has further refined the formulation suiting to the requirement of various horticultural and agricultural crops. Ingredients and methods of preparation of Panchgavya and enriched. Panchgavya (Dashgavya) has already been described in preceding pages. The cost of production of panchgavya is about Rs. 25-35 per lit. Panchgavya contains many useful microorganisms such as fungi, bacteria, actinomycetes and various micronutrients. The formulation act as tonic to enrich the soil, induce plant vigour with quality production. Time schedule of application of panchagavya in various crops is given in Table 38.

Table 38: Time of application of Panchagavya for different crops

Crops	**Time schedule**
Rice	10, 15, 30 and 50 DAT
Sunflower	30, 45 and 60 DAS
Black gram	**Rainfed**: 1st flowering and 15 DAF, **Irrigated**: 15, 25 and 40 DAS
Green gram	15, 25, 30, 40 and 50 DAS
Castor	30 and 45 DAS
Groundnut	25 and 30 DAS
Bhendi	30, 45, 60 and 75 DAS
Moringa	Before flowering and during pod formation
Tomato	Nursery and 40 DAT: seed treatment with 1 % for 12 hours
Onion	0, 45 and 60 DAT
Rose	At the time of pruning and budding
Jasmine	Bud initiation and setting

DAT- Days after transplanting, **DAS-** Days after sowing, **DAF-** Days after flowering

4. ***Natural farming:*** Natural farming emphasizes on efficient use of on-farm biological resources and enrichment of soil with the use of Jivamruta to ensure high soil biological activity. Use of Bijamruta for seed/ planting material treatment and Jivamruta for soil treatment and foliar spray are important components. The use of both these ingredients has been incorporated in the package described above. Jivamruta has been found to be rich in various beneficial microorganisms. 200 lits of jivamruta is needed for one application in one acre. It can be applied through irrigation water by flow, by drip or sprinkler or even by drenching of mulches spread over the field or under the tree basin.

5. ***Natueco Farming:*** The Natueco farming system follows the principles of eco-system networking of nature. It is beyond the broader concepts of organic or natural farming in both philosophy and practice. It offers an alternative to the commercial and heavily chemical techniques of modern farming. Instead, the emphasis is on the simple harvest of sunlight through the critical application of scientific examination, experiments, and methods that are rooted in the neighborhood resources. It depends on developing a thorough understanding of plant physiology, geometry of growth, fertility, and biochemistry.

   Natueco Farming emphasizes 'Neighborhood Resource Enrichment' by 'Additive Regeneration' rather than through dependence on external, commercial inputs. The three relevant aspects of Natueco Farming are:

   - **Soil -** Enrichment of soil by recycling of the biomass by establishing a proper energy chain.
   - **Roots -** Development and maintenance of white feeder root zones for efficient absorption of nutrients.
   - **Canopy -** Harvesting the sun through proper canopy management for efficient photosynthesis.

   In all biological processes, energy input is required and solar energy is the only available resource. No time and no square foot of sun energy should be lost by not harvesting it biologically. Lost sun energy is lost opportunity. Photosynthesis is the main process by which Solar Energy is absorbed. It is of course the objective to obtain a higher degree of photosynthesis. Although genetically photosynthesis efficiency is around 1.5% to 2.5%, we can increase leaf index [area of leaf for every square meter of land] by caring for healthy canopies, use of multiple canopy utilizing direct and filtered sunrays.

6. ***Homa Farming:*** Homa farming has its origin from vedas and is based on the principle that “you heal the atmosphere and the healed atmosphere will heal you” The practitioners and propagators of homa farming call it a "revealed science". It is an entirely spiritual practice that dates from the Vedic period. The basic aspect of homa farming is the chanting of Sanskrit mantras (Agnihotra puja) at specific times in the day before a holy fire. The timing is extremely important. While there is no specific agricultural practice associated with homa farming, the farm and household it is practiced in, is energised and "awakened". The ash that results from the puja is used to energise composts, plants, animals, etc. Homa Organic Farming is holistic healing for agriculture and can be used in conjunction with any good organic farming system. It is obviously extremely inexpensive and simple to undertake but requires discipline and regularity. Agnihotra is the basic Homa fire technique, based on the bio-rhythm of sunrise and sunset, and can be found in the ancient sciences of the Vedas. Agnihotra has been simplified and adapted to modern times, so anybody can perform it. During Agnihotra, dried cow dung, ghee (clarified butter) and brown rice are burned in an inverted, pyramid-shaped copper vessel, along with which a special mantra (word-tone combination) is sung. It is widely believed that through burning organic substances in a pyramid-formed copper vessel, valuable purifying and harmonizing energies arise. These are directed into the atmosphere and are also contained in the remaining ash. This highly energized ash can successfully be used as organic fertilizer in organic farming.

7. ***Effective microorganisms (EM) technology:*** Effective Microorganisms is a consortium culture of different effective microbes commonly occurring in nature. Most important among them are : N_2-fixers, P-solubilizers, photosynthetic microorganisms, lactic acid bacteria, yeasts, plant growth promoting rhizobacteria and various fungi and actinomycetes. In this consortium, each microorganism has its own beneficial role in nutrient cycling, plant protection and soil health and fertility enrichment.

Soil and crop management

The natural resources (soil, rainfall, dust) provide several nutrients for crop plants. Soil Organic Carbon (SOC) is central to soil health due to its influence on soil structure, water retention, microbial activities, soil aeration, and nutrient retention. It is the organic forms of C and not the source of nutrient which is important for soil-plant continuum. Hence, Bio-organic fertilizer merits consideration. Indian soils are, in general, poor in organic C, which is further going down with every intensification of agriculture. Promotion of green manuring is essential and quick way to increase Farmers should take at least one green manuring crop once in every two years. In all rice fields, cultivation of green manuring plants as an intercrop is highly recommended (like one row of sesbania after every 10-15 rows of rice which can be incorporated into field after 30-35 days) to achieve the best productivity. Use of crop straw and weed biomass as mulch-wheat and rice straw can also be used with dung and cattle urine to increase Organic Carbon.

1. **Mixed farming:** Animal husbandry, poultry, fisheries should be practised in addition to agricultural farming. Shifting cultivation is not allowed under organic agriculture. Integrated organic farming system model is being developed at Meghalaya and Coimbatore centres under Network Project on Organic Farming (Fig. 22). The models could improve the net returns by 3 to 7 times compared to existing systems (Table 39).

Source: ICARNEH, Umiam

Fig. 22: Integrated Organic Farming System Model established at Umiam through Network Project on Organic Farming

Table 39: Performance of integrated organic farming system models

Components	**Area (ha)**	**Total cost (Rs/year)**	**Net returns (Rs/year)**				
			Crop	**Live-stock**	**Others**	**Total**	**Existing system**
Coimbatore (Tamil Nadu)							
Crops (Okra, cotton, desmanthus) + **Dairy** (1 milch animal, 1 heifer & 1 bull calf) + **Vermicompost** + **Boundary Plantation**	0.40	1,10,109	64,500 (87 %)	8,216 (11 %)	1,600 (2 %)	74,316	27,200 *
Umiam (Meghalaya)							
Crops (Cereals + pulses + vegetables + fruits + fodder) + **Dairy** (1 cow + 1 calf) + **Fishery** + **Vermicompost**	0.43	68,255	33,531 (57 %)	13,252 (22 %)	11,538 (21 %)	58,321	8,618 **

* Finger millet-cotton-sorghum, ** rice-fallow

2. **Manurial Policy:** Soil fertility should be maintained/ enhanced through raising green manure crops, leguminous crops etc. The residues of plants after harvest should be incorporated into the soil as far as possible. Bio-degradable materials of microbial, plant or animal origin shall be applied as manures. (eq. compost, vermicompost, farm yard manure, sheep penning etc.) Use of synthetic/ chemical fertilisers is not permitted. The mineral based materials like rock phosphate, gypsum, lime, etc. can be applied in limited quantities when there is absolute necessity.

   The following products are permitted for use in manuring/ soil conditioning in organic fields.

   - Farm yard manure, slurry, green manures, crop residues, straw and other mulches from own farm
   - Saw dust, wood shaving from untreated wood

- Calcium chloride, lime stone, gypsum and chalk
- Magnesium rock
- Sodium chloride
- Bacterial preparations (Bio-fertilisers), eg. *Azospirillum*, *rhizobium*
- Bio-dynamic preparations
- Plant preparation and extracts, eg. neem cake
- Vermicompost

If proposing for certification, the certification agency may be consulted before using inputs such as FYM, slurry, urine, straw etc from other farms, blood meal, bone meal, sulphate of potash without preservatives, minerals like basic slag, sulphate of potash, wood ash from untreated wood, and vermicompost from other farms. Identified nutrient management package for various cropping systems through network project on organic farming are given in Table 40.

Table 40: Identified nutrient packages for various cropping systems at different locations

Location	Cropping System (s)	Sources
Jabalpur (Madhya Pradesh)	Basmati rice-wheat-berseem (seed)	Vermicompost (VC) + Farm Yard Manure (FYM) + Non Edible Oil Cakes (NEOC) @ 1/3 N
Coimbatore (Tamil Nadu)	Cotton-maize-GM Chillies-sunflower-GM	FYM + NEOC @ ½ N each + Panchagavya (PG)
Raipur (Chhatisgarh)	Rice-chickpea	Enriched compost (EC) + FYM + NEOC @ 1/3 N each + Bio dynamic (BD) + PG
Calicut (Kerala)	Ginger-fallow	FYM + Neem Cake (NC) + 2VC + PG + biodynamic + Rock phosphate(RP)
Dharwad (Karnataka)	Groundnut-sorghum Maize-chickpea Chilli +onion	EC + VC + Green leaf manure (GLM) + biodynamic spray @ 12 g ha^{-1} with PG spray

Karjat (Maharashtra)	Rice-red pumpkin Rice-cucumber	FYM + rice straw + gliricidia @ 1/3 rd each of N during *kharif* and FYM + NC + VC @ 1/3 each of N during *rabi* along with spray of PG
Ludhiana (Punjab)	Maize-wheat-summer moong	FYM + PG + BD in maize, FYM +PG in wheat and FYM alone in moong
Bhopal (Madhya Pradesh)	Soybean-wheat Soybean-chickpea Soybean-maize	FYM+PG + BD
Pantnagar (Uttarakhand)	Basmati rice-wheat Basmati rice-chickpea Basmati rice-vegetable pea	FYM + VC + NC + EC @ ¼ N each + BD + PG
Ranchi (Jharkhand)	Rice-wheat Rice-potato	VC+ Karanj cake (KC) + BD+ PG
Umiam (Meghalaya)	Rice-maize Rice-toria	FYM + VC + PG

3. **Soil and water conservation:** Measures like stone pitching/ contour wall construction are to be taken up to prevent soil erosion. In case of saline soils, saline resistant varieties may be grown. Judicious irrigation is to be practised. Mulching is required. Pollution of surface and ground water shall be prevented. Clearing of primary forest is prohibited.

Developing organic farm

For optimization of productivity, all the essential components need to be developed in a systematic manner. These steps include:

a. Habitat development
b. On-farm facilities for input production
c. Cropping sequence and combination planning
d. 3-4 year rotation plan
e. Growing of crops suiting to the region, soil and climate (Yadav, 2008)

1. **Development of farm facilities (Infrastructure):** Reserve 3-5% of farm space for utilities, such as space for cattle, vermicompost bed, compost tank, Vermiwash/ compost tea unit etc. 5-7 trees should be planted only on this space, as all utility infrastructure need shade. Irrigation well, water pumping infrastructure etc can also be in this utility area. Dig some percolation tanks (7x3x3mt or of any other size depending upon the rainfall and run-off pattern) for rain water conservation (1 pit per ha) at appropriate places depending upon slope and water flow. If possible develop a farm pond of preferably 20x10 mt size. Keep few 200 lit tanks (1 per acre) for liquid manure preparation and few containers for botanicals. For 5 acre farm, develop 1-2 vermicompost beds, 1 NADEP tank, 2 biodynamic compost beds, 2-3 compost tea/ vermiwash units, 5 liquid manure tanks, five cowpat pits and one underground cattle-urine collection tank. Efforts should also be made to produce sufficient quantities of BD-500 (cow horn manure) and BD-501(cow horn silica). 10-12 horn products are sufficient for 5 acre farm. Use of biodynamic compost prepared with the use of BD-502-507 has also been found to be very effective.

2. **Habitat and biodiversity**: Management of an appropriate habitat for sustenance of different life forms is an essential component of organic farming. This can be achieved by ensuring crop diversity and by maintaining a wide variety of trees and bushes as per climatic suitability. These trees and bushes will not only ensure the nutrients from air and deep soil layers to surface layer but also attract the birds and predators, friendly insects and also provide the food and shelter. There may be some loss of productivity due to shading effect but that loss can be compensated with reduced pest problems and natural biological pest control system. In the plains, for a 10-acre farm, plant at least five to six neem trees (*Azadirachta indica*), one to two tamarinds (*Tamarindus indica*), two gular (*Ficus glumerata*), eight to ten ber (*Zizyphus* Sp) bushes, one to two aonla (*Emblica officinalis*), one to two drumstick and 10–15 wild bushes. More specifically, if we classify areas into wet and dry farms, then on the wet farms there should be five to six neem trees, one to two wood apples, one to two star fruit, eight to ten guava or sour soap, three to four drumstick, one to two fig and 10–15 bushes of mulberry, star gooseberry, curry leaf etc, and on the dry farms there must be at least five to six neem, one to two bael fruit, eight to ten ber or custard apple, one to two aonla , one to two drumstick and 10–15 bushes of sasaka , nirgundi (*Vitex negundo*), *Cassia auriculata*, *C. tora*, etc. In hilly areas, *Alnus nepalensis* is considered to be a

wonder tree as it fixes good amount of nitrogen. It is being promoted in a cropping system mode particularly in northeastern India. Bushes of Prunus, oak (*Quercus glauca*), Pinus species along the farm boundary and yarrow (*Achillea millifolium*), buck wheat (*Fagopyrum esculentum*), lupin (*Lupinus sativus*), Himalayan stinging nettle (*Urtica parviflora*), marigold, etc., in between the plots invite a lot of predators and also attract a large number of pests. Fruit orchards also need to maintain adequate diversity with at least 3-5 types of fruit plants and few non-fruit trees (as listed above).

3. **Multiple cropping and crop rotation:** Mix cropping is the outstanding feature of organic farming in which variety of crops are grown simultaneously or at different time on the same land. In every season care should be taken to maintain legume cropping at least 40%. Mix cropping promotes photosynthesis and avoids the competition for nutrients because different plants draw their nutrients from different depth of soil. The legume fixes atmospheric nitrogen and make available for companion or succeeding crops. In selecting crop combinations, it is also to be kept in mind that plants also have their feelings, likes and dislike e.g. maize gets along well with beans and cucumber, tomatoes go well with onions and marigold. On the other hand, beans and onions do not go well with each other. Entire farm should have at least 8-10 types of crops at all the times. Each field/ plot should have at least 2-4 types of crops out of which one should be legume. In case if only one crop is taken in one plot then adjacent plots should have different crops. For maintenance of diversity and pest control randomly plant 50-150 acre^{-1} vegetable seedling for home consumption and 100 plants acre^{-1} of marigold in all crop fields. Even high nutrient demanding crops such as sugarcane can also be grown with suitable combination of various legume and vegetable crops with optimum productivity.

4. **Crop rotation:** Crop rotation is the back bone of organic farming practices. To keep the soil healthy and to allow the natural microbial systems working, crop rotation is must. Crop rotation is the succession of different crops cultivated on same land (Fig. 23). Follow 3-4 years rotation plan. All high nutrient demanding crops should precede and follow legume dominated crop combination. Rotation of pest host and non-pest host crops helps in controlling soil borne diseases and pest. It also helps in controlling weeds. It is better for improving productivity and fertility of soil. Crop rotations help in

improving soil structure through different types of root system. Legumes should be used frequently in rotation with cereal and vegetable crops. Green manure crops should also find place in planning rotations.

Fig. 23: Crop rotation (Tomato-cauliflower-pea) at NPOF centre, Bajaura (HP) Source: NPOF centre, Bajaura

5. **Effective microorganisms (EM) technology:** Effective Microorganisms is a consortium culture of different effective microbes commonly occurring in nature. Most important among them are : N_2-fixers, P-solubilizers, photosynthetic microorganisms, lactic acid bacteria, yeasts, plant growth promoting *rhizobacteria* and various fungi and actinomycetes. In this consortium, each microorganism has its own beneficial role in nutrient cycling, plant protection and soil health and fertility enrichment.

Preparation of organic matter, humus, sewage sludge, organic compost

All organic residues incorporated into the soil undergo decomposition from the original residues, a series of products are formed. As the original material and the initial products undergo further decomposition, they become a brown black organic complex known by the name humus. Humus remains in dynamic yet fairly stable state. It is under continual attack by soil microorganisms. Decomposition and synthesis by microbial processes occur simultaneously, the rate depending on the nature and abundance of microorganisms involved, the moisture content, temperature, pH, aeration, quantity of freshly added organic matter and the extent of availability of carbon, nitrogen, phosphorus and potassium. The humus is a finally synthesized stable product in natural or agricultural conditions. The nitrogenous substances formed in this way, serve as slow release nitrogen source for plant growth and have a residual effect because they are only gradually subjected to microbial attack. The isotopic labeled studies have shown that there is a loss of 70, 80 and 90-92 % of incorporated organic matter into soil after 1, 2 and 8 - 10 years, respectively.

1. **Green manuring:** Green manuring can be defined as a practice of ploughing or turning into the soil undecomposed green plant tissues for improving physical structure as well as soil fertility (Fig. 24). Green manuring, wherever feasible, is the principal supplementary means of adding organic matter to the soil. The green-manure crop supplies organic matter as well as additional nitrogen, particularly if it is a legume crop, due to its ability to fix nitrogen from the air with the help of its root nodule bacteria. The green-manure crops also exercise a protective action against erosion and leaching. Green manure to be incorporated in soil before flowering stage because they are grown for their green leafy material, which is high in nutrients and protects the soil. Green manures will not break down in to the soil so quickly, but gradually, add some nutrients to the soil for the next crop. The nutritional potentials and nutritional contents of some important green manures are given in the Table 41 and 42, respectively.

Fig. 24: Intercropping of Dhaincha in rice and incorporation through cono weeder

Table 41: Nutrient potential of green manures

Green manure	Biomass (t ha^{-1})	N accumulation (kg ha^{-1})
Sesbania aculeate	22.50	145.00
S. rostrata	20.06	146.00
Crotalaria juncea	18.40	113.00
Tephrosia perpurea	06.80	06.00
Green gram	06.50	60.20
Black gram	05.12	51.20
Cow pea	07.12	63.30

Source: Krishan Chandra, 2005

Table 42: Nutrient content of important green manures

Crop	**Nutrient content (% dry weight basis)**		
Green manures	**N**	**P_2O_5**	**K_2O**
Sesbania aculeate	3.3	0.7	1.3
Crotalaria juncea	2.6	0.6	2.0
Sesbania speciosa	2.7	0.5	2.2
Tephrosia purpurea	2.4	0.3	0.8
Phaseolus trilobus	2.1	0.5	-
Green leaf manures			
Pongamia glabra	3.2	0.3	1.3
Glyricidia maculeata	2.9	0.5	2.8
Azadirachta Indica	2.8	0.3	0.4
Calatropis gigantecum	2.1	0.7	3.6

Source: Krishan Chandra, 2005

2. **Oilcakes:** Edible and non-edible oil cakes makes good proportion of organic materials in the country. They are rich source for nitrogen, phosphorus besides potassium. Some of the non-edible oilcakes such as castor and neem cakes are having the insecticidal properties also. The nutrient contents of oil cakes are given in Table 43.

Table 43: Nutrient composition of edible and non-edible oil cakes

Oilcakes	**N**	**P_2O_5**	**K_2O**
Edible			
Coconut cake	3.0	1.9	1.8
Groundnut cake	7.3	1.5	1.3
Niger cake	4.7	1.8	1.3
Rape seed cake	5.2	1.8	1.2
Sesame cake	6.2	2.0	1.2
Non-Edible			
Castor cake	4.3	1.8	1.3
Cotton cake	3.9	1.8	1.6
Karanj cake	3.9	0.9	1.2
Mahua cake	2.5	0.8	1.8
Neem cake	5.2	1.0	1.4
Safflower cake	4.9	1.4	1.2

Source: Hand book of manures and fertilizers, 1964

3. **Farm Yard Manure:** FYM is partially composed dung, urine, bedding and straw. Dung comes mostly as undigested material and the urine from the digested material. More than 50 % of the organic matter that is present in dung is in the form of complex products consists of lignin and protein which are resistant to further decomposition and therefore the nutrients present in dung are released very slowly. The nutrients from urine, becomes readily available. Dung contains about 50% of the nitrogen, 15% of potash and almost all of the phosphorus that is excreted by animals. Straw saw dust or other bedding materials are used in cattle sheds to reduce the loss of urine and to increase the bulk of manure. On an average, about 3-5 kg bedding material per animal is used by farmers. FYM contains approximately 5-6 kg nitrogen, 1.2-2.0 kg phosphorus and 5-6 kg potash per tonne. The quantity and quality of FYM depend upon the type (draught, mulch) and age of the animals, the way they are feed and the care taken to collect and store the material. Though FYM is the most common organic manure in India, the farmer, in general, do not give adequate attention to the proper conservation and efficient use of the

resource. For preparing better quality FYM, the use of pit method for areas with less than 1000 mm precipitation and heap method for other places is recommended. In the pit method, the cattle shed wastes are conserved in pits of 2 m wide, 1 m deep and of convenient length with a sloping bottom towards one end. In the pit, an absorbent layer is created at the bottom by spreading straw at the rate of 3-5 kg per animal kept. The substrate containing well mixed dung, urine and straw is spread over the absorbent layer daily to form a layer of 30 cm thick and the process continued until the pit is filled. Each day's layer should be pressed, moistened if dry and covered with a 3-5 cm layer of well ground fertile soil to hasten the decomposition and to absorb the ammonia. The pit should be prepared on high lying area to avoid the entry of rain water. In the heap method, the daily collections from cattle shed are spread in uniform layers until the heap attains a maximum height of one meter above ground. The top of the heap is rounded and plastered with dung and mud mixture. In both the pit and heap methods aeration is allowed in the beginning and later on anaerobic conditions set in and continue for a long period. The manure is ready for use after 5-6 months. These methods should be initiated prior to rainy season and continued throughout the year. If properly preserved, the quantity of manure that can be produced per animal per year would be as much as four to five tonnes containing 0.5% nitrogen. This is in contrast to one or two tonnes per animal per year containing 0.5% nitrogen, which is obtained by indigenous method. The materials should not contain any heavy metal (Krishan Chandra, 2005).

4. **Urban compost:** Metropolitian areas are facing major problem in the disposal of large volumes of liquid and solid wastes generated by urban and industrial activities. India’s per capita waste generation stands at 450±75 g per day and it grows at the rate of 4% per year in conservative locations and @5% per year in fast growing areas. Waste disposal in India simply involves rounding up the waste from different parts of the city, and dumping everything in a landfill. Once a landfill is completely occupied, a new landfill is discovered in a different part of the city. The Energy Research Institute estimates that 1400 sq. km. of land would be required by 2047 for municipal waste disposal. Biodegradable wastes can be separated and subjected to composting by soil microorganisms which can be used for enhancing the fertility of soil which in turn will make India greener. The composts thus produced from bio-degradable wastes could be source of nutrients for organic growers. Through

this multiple goals such as clean and hygienic city, reduction of greenhouse gases, 8 to 9 times saving of urban land, prevention of soil degradation from compost usage and employment potentials to unskilled workers can be achieved. Urban composting methods are either non-mechanical or mechanical. Mechanical composting (anaerobic) of city wastes is a natural process and in practice several months are required for the transformation of wastes into compost.

Maintenance of buffer zone

A clearly defined and identifiable boundary area bordering an organic production site that is established to limit application of, or contact with, prohibited substances from an adjacent area. This can be done through biological barriers by planting the green manure/ fodder trees/ bushes such as subabul, gliricidia etc. It is necessary to take the following measures to minimise the contamination from outside and within farm. If neighbouring fields are non-organic, a buffer zone should be maintained. The height of buffer crop shall be twice the height of organic crop and the width of the buffer shall be 25-50 feet. (When chilli is grown as the main organic crop, castor or Agathi (*Sesbania*) can be grown as buffer crop. The crops from the buffer zone should be sold as non-organic). If the farm is under conversion, equipment's used for conventional areas shall be well cleaned before using for organic areas. Products based on polythene, polypropylene and other polycarbonates are allowed to cover protected structure, insect netting, nursery, drying, etc. subject to the condition that these materials shall be removed from the field after use and they shall not be burnt or put in the soil. Use of polychloride based products like PVC pipe is prohibited. Typical plan for buffer area and parallel production is given in Fig. 25.

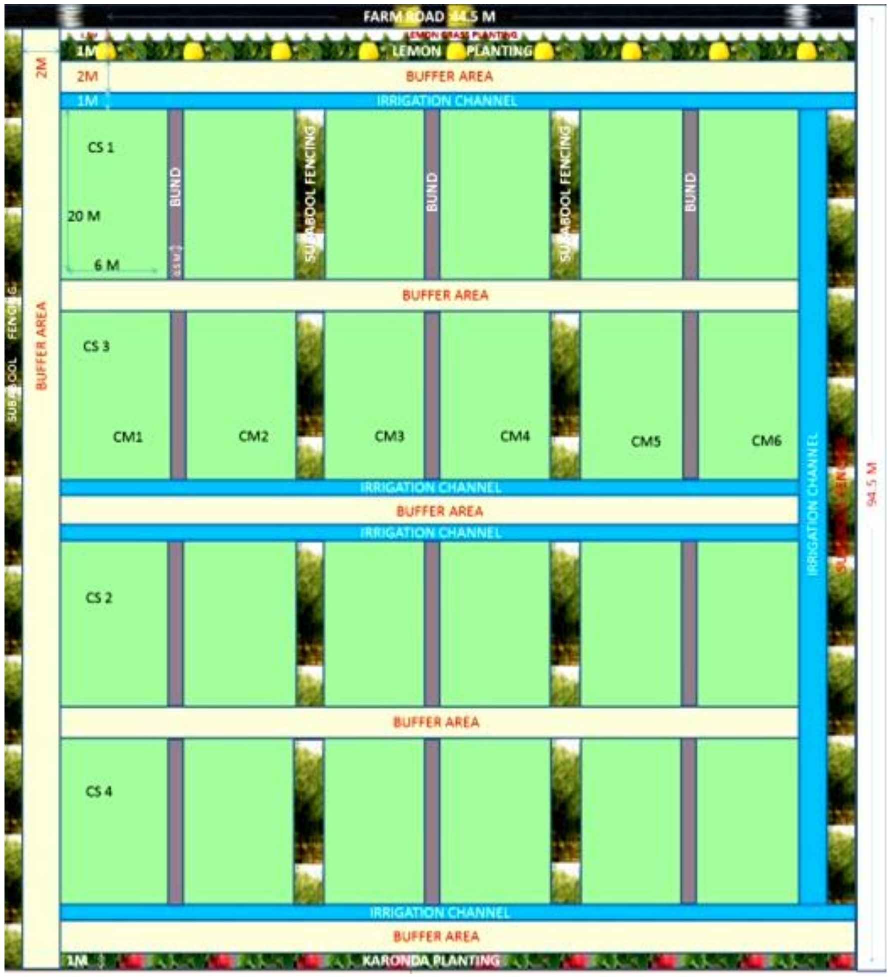


Fig. 25: Typical layout plan indicating the buffer zone and parallel production plans of organic, integrated and chemical management

Split production and parallel production

1. **Split Production:** Where only part of the farm or processing unit is certified as organic. The remainder of the property can be (a) non-organic, (b) in conversion or (c) organic but not certified.

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

production. Part conversion is the stage or situation when conventional, in conversion and/or organic production or processing occur in the same unit.

- that appropriate storage capacity exists to ensure separate handling;
- that the documentation regarding the production is well managed and
- makes a clear distinction between certified and not certified production;
- that inspections are carried out at critical times;
- that inspection is done in a timely manner;
- that accurate production estimates are available

If a farm is engaged in parallel production, the certification programme shall ensure, in addition to the requirements for part conversion, the following: -

- buffer zones are maintained for demarcation
- crops are visually distinguishable or
- crops are harvested in such a way that there are reliable methods to verify the actual harvest of the respective crops (i.e. inspections between harvests, extra inspections during harvests)

Such a system shall be approved by the certification programme for each individual situation. If parallel production is allowed in animal husbandry and bee keeping, the certification programme must develop documented procedures and inspection regimes appropriate for that kind of production.

Choice of crops and varieties

Following basic principles should be followed while selecting the crops and varieties for organic farming.

- Non-leguminous crops should be followed by leguminous crops and vice-versa e.g. Green gram – wheat/ maize. If preceding crops are legume or non-legume grown as intercrops or mixed crops, the succeeding crop may be legume or non-legume or both.
- Restorative crops should be followed by exhaustive or non-restorative crops e.g. Sesame – cowpea / green gram / blackgram / groundnut.

- Leaf shedding crop should be followed by non-leaf shedding or less exhaustive crops e.g. Pulses/ cotton – wheat/ rice.
- Green manuring crop should be followed by grain crops e.g. Dhaincha - rice, green gram/ cowpea – wheat/ maize.
- Highly fertilized crops should be followed by non-fertilized crop e.g. Maize - black gram/ gourds.
- Perennial or long duration crops should be followed by seasonal/ restorative crops e.g. Napier / sugarcane - groundnut /cowpea /green gram.
- Fodder crops should be followed by field or vegetable crops e.g. Maize + cowpea -wheat/potato/cabbage/onion.
- Multicut crops should be succeeded by the seed crops e.g. Green gram/maize.
- Ratoon crops should be followed by deep rooted restorative crops e.g. Sugarcane/ jowar-pigeonpea/ Lucerne/ cowpea.
- Deep rooted crops should be succeeded by shallow rooted crops e.g. Cotton/ castor/ pigeonpea – potato / lentil /green gram.
- Deep tillage crops should be followed by zero or minimal tillage crops e.g. Potato/ radish / sweet potato/ sugarcane - black gram/ green gram/ green manuring crops.
- Dicot crops should be followed by monocot crops e.g. Potato / mustard / groundnut / pulses – rice / wheat / sugarcane / jowar or dicot + Monocot crops should be followed by dicot + monocot or either dicot or monocot crops.
- Stiff stubble leaving crops should be followed by minimum inter-cultivation requiring crops e.g. Sugarcane / sorghum/ cotton / pigeonpea-fodder crops.
- The crops of wet (anaerobic) soil should be followed by the crops of dry (aerobic) e.g. Rice - Bengal gram/ Lathyrus/ pulses oilseeds. The tendency to buildup difficult-to-control weeds becomes less in such rotation than in continuous wet land rice culture.

- The crops that are susceptible to soil-borne pests and pathogens should be followed by tolerant / break / trap crops e.g. Sugarcane-marigold for pathogenic nematodes, tomato / brinjal / tobacco / potato-rice / pulses for Orobanche, jowar-castor for Striga and berseem-oats for Cuscuta.
- The crops with problematic weeds (weeds that are difficult to distinguish at any one stage of crop, may be seedling or seed stage) should be followed by cleaning crops / multicut crops / other dissimilar crops or varieties e.g. Wheat-wet rice for *Phalaris minor*, berseem-potato / boro rice for Cichorium intybus, mustard early potato for Cleome viscose, rice-jute/ sugarcane / vegetable/ maize + cowpea for Echinochloa crusgalli, jute- multicut fooder/ vegetable
- The rotational use of crop varieties and cultural practices in addition to rotational cropping provides more and assured benefits than that of adopting only crops or land rotation.

The cropping systems and varieties evaluated under network project on organic farming at various locations are given in Table 44. Package of practices for 18 crops and cropping systems have been developed over the years and placed in public domain (www.iifsr.res.in).

Table 44: Crops and varieties evaluated in different states under Network Project on Organic Farming (NPOF)

Crops	**Variety**	**Crops**	**Variety**
Bajaura (Himachal Pradesh)		**Bhopal (Madhya Pradesh)**	
Tomato	*RK123*	Soybean	JS-335
French bean	*Deepshikha, Falguni, Long Yard (TN-18)*	D.Wheat	HI-8498
Cauliflower	*Megha, Swati, 71 No*	Mustard	Pusa Bold
Maize	*Girja*	Chickpea	JG-130
Pea	*Azad P-1*	Linseed	JL-9
Garlic	*GHC-1*	**Dharwad (Karnataka)**	
Calicut (Kerala)		Groundnut	GPBD-4
Ginger	Varada, Rejatha and	*Rabi* sorghum	DSV-4

	Mahima		
Turmeric	Alleppey Supreme, Prathibha	Soybean	JS-9305
Black Pepper	Sreekara, Panniyur -1	Durum wheat	DWR 2006
Coimbatore (Tamil Nadu)		Pigeonpea	TS-3R
Sunhemp	CO 1, Suraj	Chickpea	JG-11, JS-335, JJ-11, ICCV-10, ICCV-2
Cotton	MCU 12	Cotton	DHB-915
Maize	NK6240, Co1	Frenchbean	Arka komal
Chillies	PKM 1, K1	Maize	Arjun
Sunflower	TNAU SFHCO2, Co4	Groundnut	TMV-2, GPBD 4, GPBD 5, JL 24
Brinjal	CO 2	**Jabalpur (Madhya Pradesh)**	
Sesbania aculeata	Local	Basmati rice	Pusa Basmati -1
Rice	White Ponni	Durum wheat	MPO – 1106
Greengram	CO 6	Chickpea	JG-322
Modipuram (Uttar Pradesh)		Berseem	JB-1
Basmati Rice	Basmati 370 / PB-2	Veg.Pea	Arkel
Rice	Saket-4	Sesame	TKG-55
Maize cob & grain	Star-56	Sorghum	MP Chari
Wheat	PBW-343	**Karjat (Maharashtra)**	
Barley	Ajad	Rice	*Karjat – 4*
Mustard	Pusa Bold	Groundnut	*SB-XI*
Radish	Ivory White	Maize (Sweet corn)	*Sugar-75*
Potato	Chipsona-3	Mustard	*Varuna*
Okra	Arka Anamika	*Dolichos* bean	*Konkan Bhushan*
Green gram	SML-668	Red pumpkin	*MPH 1*
Chickpea	Awarodhi	Cucumber	*Himangi*
Cowpea	Pusa barsati	Green gram	*Vaishali*
Mungbean	Pusa Vishal	**Raipur (Chhatisgarh)**	

Ludhiana (Punjab)		Soybean	JS – 335
Cotton	F-1861	Berseem	JB-2
Chickpea	GPP-2/BG-1053	Isabgol	GI-2
Maize	Peral Popcorn/PMH-1/J-1006	Onion	Nasik red
Basmati rice	PB-2	Safflower	NARI-NH 1
Wheat	PBW-621	Rice	Sugandhmati/ Kasturi
Summer greengram	SML-668	Chickpea	Vaibhav
Turmeric	Local	Mustard	Pusa bold
Onion	Pb.Naroya	Lentil	JL-1
Potato	Kufri Jyoti	**Pantnagar (Uttarakhand)**	
Pearlmillet	PCB-164	*Sesbania*	Ses pant – 1
Cowpea	CL-367	Rice	Pusa Basmati -1 / Pusa basmati – 1121
Sorghum	SL-44	Wheat	PBW-343/ PBW-502
Guar	Guara-80	Lentil	Pant Lentil – 8
Berseem	BL-10	Vegetable Pea	Arkel
Oats	OL-9	*B. napus*	PRB 2004-3-04
Ranchi (Jharkhand)		Chick pea	Pant Kabuli Chana1
Rice	Birsamati	Maize	Kanchan
Wheat	K- 9107	Moong	Pant Moong-5
Potato	Kufri Ashoka		
Linseed	Shekhar		
Lentil	PL 406		
Umiam (Meghalaya)			
Maize(green cob/seed)	DA 61-A		
Soybean	JS-80-21		
French bean	Naga local		

Toria	M-27	
Tomato	Avinash-2	
Potato	Kufri jyoti	
Rice (sunken bed) *kharif*	IR-64/Lumpnah/Vivek dham/Sahsarang-1	
Rice (raised bed)	Bhalum-1	
Carrot	New curoda	

Source: Consolidated report (2004-11)

Fig. 26: Organic basmati rice (PB-1) under NPOF at Pantnagar

Fig. 27: Intercropping of soybean+basmati rice (Pusa-1121) under NPOF at Pantnagar

Source: NPOF centre, Pantnagar

Fig. 28: Intercropping of Pigeonpea+maize+basmati rice (Pusa-1121) under NPOF at Pantnagar

Natural safe products for control of pest, disease, weeds, diseases and growth management

Under organic systems, use of synthetic/ chemical pesticides, fungicides and weedicides is prohibited. Natural enemies shall be encouraged and protected e.g. raising trees in the farm attracts birds which kills pests of the crops, nest construction etc. Products collected from the local farm, animals, plants and micro-organisms, and prepared at the farm are allowed for control of pests and diseases (e.g. Neem Seed Kernel Extract, cow urine spray). Use of genetically engineered organisms and products are prohibited for controlling pests and diseases. Similarly, use of synthetic growth regulators is not permitted. Slash weeding is to be done between the plants. Weeds under the base of the plants shall be cleaned and put as mulch around the plant base. The weeded materials should be applied as mulch in the ground itself. The products that are permitted for control of pest and diseases are neem oil and other neem preparations like Neem Seed Kernel Extract, Chromatic traps, Mechanical traps, Pheromone traps, Plant-based repellants, Soft soap and clay. The following products shall be used when they are absolutely necessary and taking environmental impact into consideration. The certification agency shall be consulted before using these inputs.

- Bordeaux mixture
- Plant and animal preparations e.g. Cow urine spray, Garlic extract, Chilli extract

- Light mineral oils e.g. Kerosene

Natural enemies of crop pests and diseases such as Coccinellids, syrphids, spiders, Micromus, Chrysopa and campoletis were higher under organic management compared to integrated and inorganic management. Coccinellids, which naturally reduce the hoppers and leaf folders, was found to be two to three times higher under organic management in cotton, groundnut, soybean, potato and maize crop fields. Similarly, spiders which also control the pests are found to be twice higher under organic management compared to inorganic management. The diversity of arthropod population in soil viz., Collembola, dipluran, pseudoscorpians, cryptostigmatids and other mites population was also found to be higher under organic management compared to integrated and chemical management (Annual Progress Report, 2010-2013, Network Project on Organic Farming, University of Agricultural Sciences, Dharwad, Karnataka). Identified pest and disease (Table 45) and weed management (Table 46) packages for various cropping systems through network project indicates the pest and diseases of crops can be managed through cropping systems approach along with suitable natural pesticides. Further the weeds can be managed through live and organic mulches.

Table 45: Identified pest and disease management packages for various locations

Centre	Cropping System	Pest/ disease	Recommended practice
Modipuram (Uttar Pradesh)	Basmati rice-chickpea Basmati rice-mustard	Soil borne pests and diseases	Summer ploughing + green manure incorporation
Calicut (Kerala)	Ginger-fallow	Shoot borer	Ginger Endophytic Bacteria 17 and 18, Ginger Rhizobacteria 57
Bajaura (Himachal Pradesh)	Cauliflower-peas-tomato	Fruit borer and fruit rot	Karvi (*Roylea cinerea*) @ 10% aqueous leaf extract + cow urine (3%) + tween-80 (0.05%) as emulsifier

Umiam (Meghalaya)	Maize + Soybean	Monolapta Mylloceros Ephilechma Leaf folder	Derisom (3 ml l^{-1}) + Panchagavyya @ 10% and cow urine 3% Anomin 3 ml l^{-1} or Panchagavyya @ 3%
		Rust	Panchagavyya @ 3% + lantana @ 10% + vermiwash @ 10%

Table 46: Identified weed management packages for various locations and cropping systems

Centre	Cropping System	Recommended practice
Raipur (Chhatisgarh)	Rice-mustard	Conoweeder with square planting for rice, Stale seed bed for mustard
Coimbatore (Tamil Nadu)	Rice-blackgram-GM	2 hand weeding + spray of aqueous leaf extract at 3-4 leaf stage of weeds
Jabalpur (Madhya Pradesh)	Rice-wheat	2 hand weeding + spray at 3-4 leaf stage aqueous spray of weeds
Dharwad (Karnataka)	Groundnut	Spray of cassia and *Prosppis juliflora* as post emergent
Ludhiana (Punjab)	Basmati rice-wheat	High density planting + hand weeding at 25-30 DAT
Pantnagar (Uttarakhand)	Basmati rice-wheat-sesbania	one hand weeding at 25-30 DAT during kharif and 2 hand weeding at 25-30 and 45-50 DAS during rabi
Umiam (Meghalaya)	Maize (green cob)-mustard	Mulching with fresh eupatorium/ ambrosia @ 10 t ha^{-1} (after earthing up)

Preparation of bio-pesticide inputs recommended for organic farming

Availability of Bio-pesticides (Table 47), microbial pesticide for pest control (Table 48, 49), intercropping approach (Table 50) and indigenous technical knowledge (Table 51) increases the scope of preventive and post pest and disease incidence management for organic farming.

Table 47: Preparation methods of natural bio-pesticides and its time of application

Name of the input	Source and Preparation	Time, rate and purpose of application
Panchagavya	It is a cow excreta based indigenous nutrient solution. Panchagavya consists of products viz. cow dung, cow urine, milk, curd, jaggery, ghee, banana, Tender coconut and water. When suitably mixed and used, these have miraculous effects. The preparation steps of panchagavya are as follows. 1. 7 kg cow dung and 1 kg cow ghee is mixed thoroughly and kept for 3 days. 2. After 3 days, 10 litres cow urine and 10 litres water is added, mixed and kept for 15 days with regular mixing both in morning and evening hours. 3. After 15 days the following ingredients are added and mixed • Cow milk - 3 litres • Cow curd - 2 litres • Tender coconut water - 3 litres • Jaggery - 3 kg • Well ripened banana – 12 nos. Panchagavya is ready after 30 days	3% solution was found to be most effective compared to the higher and lower concentrations investigated. 3 litres of Panchagavya to every 100 litres of water is ideal for all crops.
Lantana leaf extract 10%	Leaves of *Lantana camara* were collected from the nearby area of the	The extract is diluted with water @ 10% before spraying.

	farm and 10% aqueous leaf extract is prepared firstly by grinding the leaves and then soaking 100g of grinded leaves in 200 ml. distilled water for 24 hours at a room temperature of 30^{o}C. The aqueous extract was obtained by filtering the mixture (leaf and water) through a Whatman No .42 filter paper and diluted with distilled water to prepare 10% concentration.	This foliar spray act as insect-pest repellent. It can be sprayed 3-4 times during the crop duration according to pest infestation.
Derisom	It is a bio-pesticide based on botanical extract of *Derris indica*.	It is applied as foliar spray @ 0.2% or 2 ml l^{-1}. of water. It can be sprayed 2-3 times during the crop duration according to pest infestation. Derisom has Karanjin as active principle and acts as antifeedant and also acts on central nervous system of the Mites and Insect pests. Derisom works as Acaricide (Miticide) and Insecticide.
Pestoneem	Neem biopesticide is made from cold pressed neem kernels and its active azadirachtin 1500 ppm is used as a general insecticide, fungicide	It is a bio-based pest controller containing 0.5% Azadirachtin and other vital bio-energizers. Application of pestoneem increase resistance to infestation of pest and disease.
Vermiwash	It is a liquid that is collected after the passage of water through a column of worm action in vermicomposting.	This liquid manure is applied as foliar spray (10% solution) to the plants for better growth and insect-pest and disease management
Anonine	Plant based product	Organic pesticide used as foliar spray @ 3 ml l^{-1}.

Source: ICARNEH, 2014

Table 48: Candidate microbial pesticides available for pest control

Pathogen	**Major Target Groups**
Bacillus thuringiensis (Cry I A-G, Cry II A-C, Cry III A-D, Cry IV A-D, Cry II A)	Lepidoptera, Coleoptera, Diptera
Bacillus sphaericus	Diptera
Nuclear Polyhedrosis Viruses	Lepidoptera
Granulosis Viruses	Hymenoptera
Beauveria bassiana and Metarhizium anisopliae	Coleoptera, Lepidoptera, Hymenoptera, Orthoptera
Beauveria Brongniartii	Coleoptera, Lepidoptera, Homoptera, Diptera
Nomuraea rileyi	Lepidoptera
Verticillium Lecanii	Homoptera, Thysanoptera, Diptera
Lagenidium Giganteum	Mosquito Larvae
Paecilomyces Fumosoroseus	Coleoptera, Homoptera, Nematodes

Source: Prasad, 2008

Table 49: Field use recommendation for NPV/ GVs in food and commercial crops

Baculovirus type	**crop**	**Crop stage**	**Dosage (LE ha^{-1})**	**Number of applications per crop season**
Helicoverpa armigera (gram pod borer/ American bollworm) NPV	Red gram	Flower initiation, 50% flowering and peak flowering	250-500	2-3 at 10-14 days interval
	Chickpea	30 DAS and flowering	250	2-3 at 7-12 days interval
	Tomato	Fruiting stage	250	3 at 7 days interval
	Cotton	Fruiting stage	500-750	1-2 at 10 days interval
	Sunflower	Flower head	250	1
	Groundnut	Flowering onwards	250-500	3-4 at 7-10 days interval
Spodoptera	Tobacco	Need based	250-500	1-3 applications at 7-14

Litura (tobacco caterpillar or leaf worm) NPV	Vegetables Groundnut Cotton			days interval
Achaea janata (semilooper) (Granulosis Virus)	Castor	35-75 days after sowing	500	2 sprays first applied between 35-50 days and second at 60-75 days crop age based on pest incidence

Source: Prasad, 2008

Table 50: Examples of crop pest population management through intercropping

Agro-ecosystem	**Pest**	**Factor/ Effect**
Pigeonpea + paddy	Pod borer	Incidence reduced than sole crop of pigeonpea
Beans + maize	Empoasca krameri Ross and Moore	Reduction of pest incidence
Cowpea + maize	M. testulalis C. ptychora. M and M. sojostedti. T.	Increased Decreased
Pigeonpea + pearlmillet	H.armigera	More Damage
Cowpea+sorghum	Ophiomyia phaseoli	Reduced and higher yields
Pigeonpea + sorghum, greengram and groundnut	E. kerri	Highest Reduction
Cowpea + Maize, Pepper and cassava	M. sjostedti, A. craccivora K., Mylabris sp.	Reduction of pests
Pigeonpea+coriander	H.armigera	Low incidence
Short and medium duration pigeonpea + Sorghum or caster	Many insect pests including pod borers except C. gibbosa	Lower incidence than sole crop of pigeonpea

Source: Sreenivasa Rao, 2008

Table 51: ITKs practiced by farmers for managing the pest and disease under organic management

Crop	**Pest/disease/rodent**	**Materials**	**Method**
Rice	Brown plant hopper and green leaf hopper	Garlic	Grind one kg of garlic and mix in one litre of kerosene. Keep it overnight and filter. Mix in 200 litres of water and spray
	Stem borer and leaf folder	Neem leaves, Citronella grass, rhizome of *Alpinia galanga*	4 kg each are chopped and ground in mortar. Mix in 40 litres of water. After 1 day, dilute with water @ 1:60 ratio
Millets	Stemborer	Lablab or cowpea	intercropping in sorghum
	Earhead bugs	Ash	Application during flowering
	Grass hoppers	Onion bulb	onion bulb extract (2-3 kg) spray in maize
	Stem borer	Napier grass/ lucerne	Napier grass (2-3 rows) planting along the maize field border Lucerne intercropping
Pulses	Pod borers	Cow urine and cowdung Castor oil	3 to 5 litres each mixed and kept for 4 days. Filter and add lime @ 200 g and make to 80 litres. Spray to redgram Coat the oil on mud pots and traps sucking pests
	Yellow mosaic virus	Butter milk	Spray act as good barrier for vectors of YMV

	Chickpea pod borer	Coriander	Intercropping
	Aphids	Tobacco decoction	Mixed with soap and spray
Oilseeds	Red hairy caterpillar in groundnut	*Calatropis leaves* Roasted seeds of maize or sorghum	Digging trench around field and spreading leaves in trenches Broadcasted @ 5 kg acres^{-1}
	Semilooper in castor leaves	Popped sorghum grains Cooked rice and turmeric powder	Spread around castor field attracts birds which pick up semiloopers Placed in castor field during morning and late in the evening for 2 to 3 days continuously attract birds
	Rhinoceros beetle in coconut	sand and salt crystals	Apply in leaf axils
	Leaf webber in sesame	cow urine	Diluted spray
	Helicoverpa armigera in groundnut	*Prosopis juliflora* leaf	200 ml of *Prosopis* leaf extract is mixed with 10 litres water and sprayed
Vegetables	Shoot and fruit borer in Brinjal	*Tagetes*	Border cropping
	brinjal shoot and fruit borer, ribbed gourd stem borer, hairy caterpillar of drumstick and armyworms	Syrianangai *Andrographis paniculata*	One kilo gram of plant is cut into small pieces and mixed with 4 litres of water and placed in a mud pot, boiled and reduced to 1 litre and 500 ml of this extract is mixed with 100 ml of soap solution and 9.4 litres of water and spray

	pumpkin beetle, Epilachna beetle and pod bugs	cowdung	One kg of cow dung is mixed with 10 litres of water. Filter the extract with a gunny cloth and add 5 litres of water to the filtrate and again filter and spray
	Pests in Mango	Coriander, mint, ginger and turmeric	Intercropping *Ocimum sanctum* in mango orchard acts as a trap crop for fruit flies
	Insect pests in grapevines	cow urine or tobacco decoction	Spray
Cotton	Boll worm	Curd, Neem	15 litres of curd is mixed with 15 litres of water. Neem leaf extract prepared from 5 kg of neem leaves is added to the curd and allowed for 15 days with stirring at least once in a day
	Spotted bollworm	Mechanical control	Deep summer ploughing, bonfires and light traps. Nipping of the terminal buds and destruction is practiced to destroy eggs and larvae of spotted bollworm
	White fly	Castor oil	Papers coated with castor oil are hung at 5-6 places in the cotton field to manage white flies. For that air is blown using a sprayer over the crop which disturbed the adult

			flies and stick to the oily paper.
	Aphids	Extracts of neem seeds/ leves	Spray
	All pests	Neem seeds, tobacco, Acorus calamus, Asafoetida and sapindus emarginata	grounding 500g of neem seeds, 1000g of tobacco, 100g of *Acorus calamus*, 250g of *Asafoetida* and 50g of *Sapindus emarginata* seeds and the extract is sprayed for one acre
	Cutworms	*Citrullus grandiflora* (periya kumuttikai), *Cissus quadrangularis* (perandai kodi), *Tecoma stans* (yellow arali seeds), *Azadirachta indica* (neem)	Leaves and seeds are ground and fermented for 10 days and sprayed
Turmeric	Insect pests	Garlic, ginger, chillies, tobacco, pepper, neem oil	1kg garlic + 500g of ginger, + 500g of green chillies + 500g of tobacco + 200g of pepper + 200ml of Neem oil + 30g of khadi soap checks the most of the insect pests infecting turmeric crop. 700 ml of the mixture is to be diluted in 10 lit of water and sprayed

Source: TNAU, 2014

ITKS for Termite management

- The dye prepared from Noni (*Morinda citrifolia*) is mixed with garlic extract which completely checked the termite ravages in trees.
- Paint prepared from 1 part of gum of *Gardenia gummifera*, 2 parts of *Asafoetida*, 2 parts of Aloe and 2 parts of castor oil cake controlled termite menace in trees.
- Application of tank silt in sandy wetlands is practiced for termite control.
- *Calotropis* plant material (8-10 kg) soaked in sufficient quantity of water for 24 hr and filtered and poured on termite infested soil.
- Application of sheared human hair obtained from barber’s shop, applied on live mounds and along the infested pathways has good control termites which are followed Pudukottai district of Tamil Nadu.

ITKs for Rat management

- Pieces of cotton or thermocole, dipped in jaggery solution, made into small packets and spread in field/ orchard. Rats which consume these will suffer from gastric bloating disorders due to the swelling of cotton or thermocole in stomach.
- Partly cooked sorghum grains are coated with cement or white cement and packed into small packets and spread in the field. Rats that consume this mixture will die due to gastric disorders.
- Mix powder of fused electric bulb with coconut flakes and used in coconut gardens to manage rodents. This practice is followed in Thanjavur district of Tamil Nadu.

ITKs on Herbal insect repellent

- A popular natural pest repellent paste mixture prepared by Tamil Nadu farmers containing each 1kg of *Vitex nigunda* leaf, *Agave cantala* leaf , *Datura methal* leaves, *Calotropis* leaves and neem seeds. The paste mixture is dissolved in 5 litres of cow urine and keeps the mixture in plastic or earthen ware. Allow the content to ferment for 15 days and then filter. Add 100 litres of water to the filtrate and spray in the field. Most of the insect pests are repelled from the treated area.

Quality of food and crop productivity under natural ecological systems

1. **Quality:** Various sources claim better quality of organic products by virtue of higher nutrients and antioxidants. The concentrations of a range of antioxidants such as polyphenolics were found to be substantially higher in organic crops/ crop-based foods, with those of phenolic acids, flavanones, stilbenes, flavones, flavonols and anthocyanins being estimated 19, 69, 28, 26, 50 and 51% higher, respectively. Many of these compounds have previously been linked to a reduced risk of chronic diseases, including CVD and neurodegenerative diseases and certain cancers, in dietary intervention and epidemiological studies. The frequency of occurrence of pesticide residues was found to be four times higher in conventional crops, which also contained significantly higher concentrations of the toxic metal Cd (Marcin Baranski *et al*., 2014). A study at ICAR-IIFSR, Modipuram through Network project on organic farming indicated slight to moderate improvement in protein content of soybean, groundnut, maize and dolichos bean under organic management, compared to conventional management with full NPK dosage. Piperin content of black pepper was significantly higher under organic management. (Consolidated report, 2004-2011, Network Project on Organic Farming, ICAR-Indian Institute of Farming Systems Research, Modipuram). Comparative quality of Pusa Basmati rice 1 variety in terms of quality under organic and inorganic management is given in Table 52.

Table 52: Quality of Basmati rice influenced by organic (second year of conversion) and inorganic management

Parameter	Organic (2nd year of conversion)	Inorganic
Physical		
Length (mm)	8.1	7.1
L:B ratio	2.4	2.4
1000 kernal weight (g)	18	14
Proximate composition		
Moisture (%)	12.08	13.12
Total ash (%)	0.78	0.59

Crude fat (%)	0.72	0.83
Crude fibre (%)	0.20	0.26
Crude protein (%)	4.63	7.10
Carbohydrates (%)	81.8	71.9
Energy (Kcal/100g)	352	348
Minerals and Trace elements		
Iron (mg/100g)	4.86	1.62
Calcium (mg/100g)	16.37	15.38
Copper (mg/100g)	0.29	0.27
Manganese (mg/100g)	1.71	0.95
Zinc (mg/100g)	1.26	1.31
Phosphorus (mg/100g)	140.4	157.3
Cooking quality		
Swelling rate	0.75	0.50
Elongation ratio	1.60	1.52
Amylose content (%)	30	24

Source: Annual Report, 2005-06

2. **Crop productivity:** Crop productivity is an important factor for providing the food security of the nation as the land resources are declining year after year. Analysis of yield recorded at various locations under organic management over inorganic indicates as many as 18 crops (Table 53) responds positively to yield higher under organic systems. The variation in yield is due to location specific package of practices adopted. However, it should also be noted that as many as 55 observations across the locations and over the years in wheat resulted in 7 % reduction in yield. Any significant change in yield on the negative side especially on wheat is going to affect the food security in future. Hence, instead of blanket approach, niche crops which are responding positively to organic and natural practices should be promoted. Sustainability of yield is also very important to provide stable food for the ever growing population (Fig 29). Sustainable yield index of basmati rice, rice, cotton, soybean, sunflower, groundnut, lentil, cabbage and French bean are higher

under organic management compared to integrated and inorganic management systems. The lower sustainable yield index in cereals under organic production was mainly due to unstable yield in wheat crop.

Table 53: Number of data entries, averages and ranges (%) of relative yields between organic over inorganic for selected crops in India

Crops	n[a]	Organic over inorganic		Crops	n[a]	Organic over inorganic	
		Mean	Range			Mean	Range
Positive organic							
Basmati rice	67	104	88-121	Okra	10	118	90-142
Rice	52	100	89-122	Chilli	12	109	107-112
Maize	37	110	62-137	Onion	13	107	87-127
Sorghum	17	114	89-132	Garlic	9	104	86-121
Greengram	12	107	96-122	Cauliflower	12	104	90-117
Chickpea	24	100	65-114	Cabbage	5	111	81-142
Soybean	54	104	96-123	Tomato	11	106	83-130
Groundnut	16	103	83-116	Ginger	12	120	108-129
Pea	21	125	94-162	Turmeric	18	146	93-242
Negative organic							
Wheat	55	93	78-113	Lentil	12	92	83-101
Mustard	32	93	67-137	Potato	32	95	48-162
Sunflower	8	99	94-103	Radish	9	75	43-108

n[a] = the number of yield entries

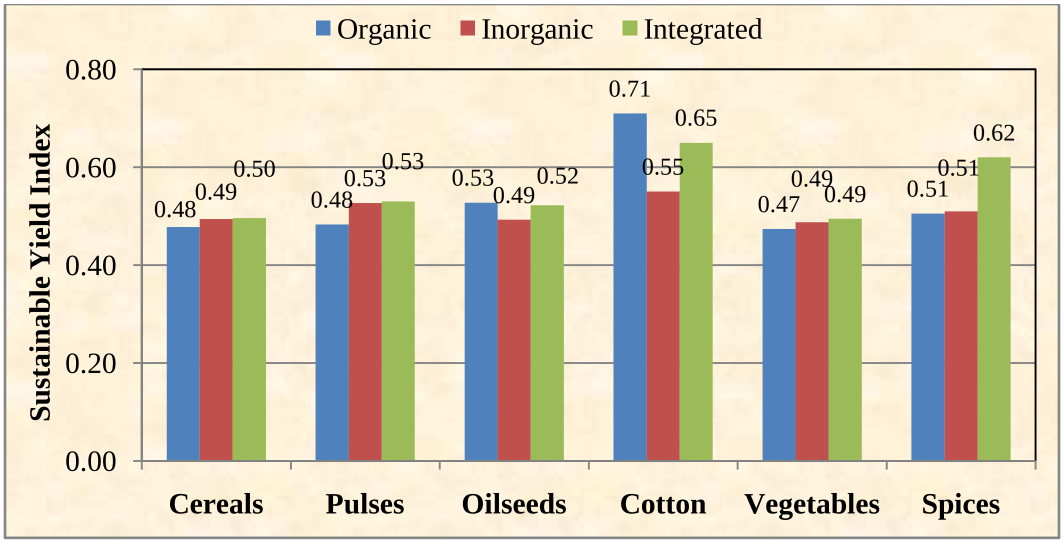


Fig. 29: Sustainable Yield index (SYI) of various group crops under organic, inorganic, integrated and farmers practices

Processing, Handling and Packaging

Processing technologies like solar drying, freeze drying, hot air chambers are permitted. Irradiation of agricultural produce is not permitted. No synthetic additives/ day are to be added during processing.

The label should convey clear accurate information on the organic status of the product (conversion in progress or organic). The labels for organic and conversion in progress products should be distinguishable by different coloured labels. The details like name of the product, quantity of the product, name and address of the producer, name of certification agency, certification, lot number etc. are to be given in the label. Lot number is helpful in tracing back the product particularly the field number in which it is grown in case of contamination. Lot number should include the crop, country, field number, date of harvest and production year.

For packing, recycling and reusable materials like clean jute bags, shall be used. Use of bio-degradable materials shall also be used. Unnecessary packaging material should be avoided. Organic and non-organic products shall not be stored and transported together except when labelled.

South Asian organic farming and trade/ market analysis

Agriculture is very important component in the economies of all the SAARC nations. The South Asian Economies (SAEs), comprising Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, represent 22% of world's population but only account for just over 1% of world trade. All the south Asian country's organic market is at a different stage of development and it is difficult to predict at this stage. India has established a prominent position in South Asia for its agricultural products. The total regional agricultural trade accounted for 22% of regional trade in 2004, with India accounting for 80% of that trade. Bangladesh and Sri Lanka are the main markets for Indian agricultural products. Pakistan and Sri Lanka account for 8% and %4, respectively, of agricultural trade in the region. In December 1991, the 6th Summit held in Colombo approved the establishment of an Inter-Governmental Group (IGG) to formulate an agreement to establish a SAARC Preferential Trading Arrangement (SAPTA) by 1997. Given the consensus within SAARC, the Agreement on SAPTA was signed on 11 April 1993 and entered into force on 7 December 1995 well in advance of the date stipulated by the Colombo Summit. The Agreement reflected the desire of the Member States to promote and sustain mutual trade and economic cooperation within the SAARC region through the exchange of concessions. Four rounds of trade negotiations have been concluded under SAPTA covering over 5000 commodities. The identified sectors for harmonization of standards include food and agricultural products, jute; textile and leather; building materials; chemicals and chemical products and electrical and electronic products. India's exports to SAARC member countries rose 15.8% to $17.5 billion in 2013-14 while import from these countries contracted to 7.72% ($2.5 billion).

Issues and scope of marketing organic produce

Issues: Marketing plays vital role in development of organic agriculture in any country. Marketing organically grown crops, fruits, vegetables, flowers and herbs is not fundamentally different than marketing similar produce grown under a more "conventional" production regimen. As with any product, the producer must assess the needs of the consumer, determine the benefits (real or perceived) to that consumer and then deliver a product of consistently high quality that meets those needs at a price the customer is willing to pay. Presently 96 organic exporters and 34 organic importers are operating in India (www.agritech.tnau.ac.in).

The major issues related to marketing of organic products are;

- Lack of reliable supply chain
- Lack of sufficient retail chains
- Limited size of domestic market
- Lack the skills and creativity to find profitable markets
- Produce aggregation costs for distributed small growers
- Certification complexities

Market development for the organic products is a crucial factor to promote domestic sales. Supplies do not match the demand for organic products in the country and the absence of proper links between the two has been pointed out for the tardy growth of organic farming in the country. An important role of the government in this direction is giving various supports to the producer and consumer associations to market the products (NABARD, 2005).

Producer organizations: Organic crops can be produced under contract as 85% of farmers are small holders in the country. The contract production can add value and reduce risk. Farmer producer organizations are being recently promoted which can help to produce and market for organic products. National Bank for Agriculture and Rural Development (NABARD) has taken an initiative for supporting producer organizations, adopting a flexible approach to meet the needs of producers. In order to give a special focus, the "Producers Organization Development Fund" (PODF) has been set up wef 01 April 2011, with an initial corpus of Rs. 50 crore. Any registered Producers Organization viz, Producers Company (as defined under Sec 581 A in part IXA of Company's Act 1956), producers Cooperatives, registered farmer federations, MACS (Mutually aided cooperative society), industrial cooperative societies, other registered federations, PACS, etc. set up by producers are eligible under the fund. Credit Support is provided for financial intervention. Support in the form of grant, loans, or a combination of these is also available for capacity building and market interventions. The producer organizations can be encouraged to get accredited for inspection and certification from APEDA.

Anand Pattern in Organic farming: Anand pattern of milk cooperatives are highly successful and it can be replicated for organic systems also. The steps which can be followed are selection of contiguous organic clusters on micro-water shed basis, formational of self-hep groups, villages in cluster as operating unit for federation marketing, integration of technology and farmer led innovations and hand holding in management by government agency.

Certification Process: Certification of organic farms is required to satisfy the consumers that the produce is totally organic. Certification agency conducts the inspection that minimum requirements prescribed for organic agriculture is fully met and issues certificate. The producer makes contact with certifying agency. Certification agency provides information on standards, fees, application, inspection, certification and appeal procedures. The producer then submits application along with field history, form map, record keeping system etc. Then the contract indicating scope, obligation, inspection and certification, sanction and appeals, duration, fee structure is executed. Then the Inspector of agency comes and carries out inspection. The Inspector gives inspection report with his recommendation to the agency. Then the agency issues approval or denial of certificate. Certificate is given for current year's harvest only and hence annual certification is required. In the recent times, grower group certification and participatory guarantee certification are being given importance.

Market potential of top metros: Currently, the major distribution channels connect the organic food producers to the metros such as New Delhi, Chennai, Mumbai, Bangalore, Hyderabad, and Kolkata. In order to understand the market potential for organic food products in Delhi-NCR region, traders, shopkeepers, retail outlets were asked to indicate the demand for organic food products (altis.unicatt.it/altis-120612_Organic_Food_Market_in_NCR.docx). It is found that only one in ten shops under the open trade segment actually stocked organic products, this was mainly on account of low demand. The organic food products were mainly localized to major retail outlets such as Big Bazar, Spencer, More and Easy Day. Additionally, some of the major consumer goods players such as ITC Foods, Reliance, FabIndia, Godrej Agrovet and Organic India operated out of stand-alone stores. It indicates that vegetables, fruits, tea and coffee (not including milk and daily products) are the products that are preferred in the organic segment. In Delhi-NCR region, it is also observed that as demand varied by area, there was a marked difference in the availability of organic products.

Marketing and Sales Strategy

- **Point of Sale (POS) material:** Often in smaller shops, there is not enough space for dedicated sections. Hence, the promotional material and the product both need to be displayed prominently in the shop. These materials serve as the key factor in increasing awareness
- **Packaging and Branding:** Almost all the packaged organic food products have visually appealing packaging. These packs also highlight the potential health benefits of the product
- **Wet Sampling:** For products such as vegetables and fruits, a kiosk like set-up that provides samples for immediate consumption can be set-up
- **Visual Signage:** Prominent displays highlighting the benefits of organic food product at high visibility in/ around the location. Most shops use posters, banners and stickers and in-store dedicated shelf (specially in bigger shops)

With the organic food industry still in a nascent stage in India, huge business opportunities exist in the areas of organic adoption and certification facilitation, post-harvest processing, storage and production, input production, value chain development and retailing, organic seed production and sales and market development. These activities can give direct and indirect employment to many. The organic food industry provides the agribusiness firms an opportunity to look at farming and trade in accordance with the larger development goal of sustainability. This is one more historic opportunity for the agribusiness industry to contribute to human progress substantially as they are best placed to tailor the chain organically.

Research and Development Institutes

1. **Academic courses:** Indian Council of Agricultural Research (ICAR)-Indian Agricultural Research Institute, New Delhi has a course on Principles and Practices of Organic Farming (AG604) with 2+1 credit hours at post graduate level. Some of the State Agricultural Universities (SAUs) are also offering courses on organic farming at post graduate level. In fact, three State Agricultural Universities (SAUs) *viz.*, CSK Himachal Pradesh Agricultural University, Palampur (Himachal Pradesh), University of Agricultural Sciences, Dharwad (Karnataka) and Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu) are having separate departments for carrying out

research on organic farming and sustainable agriculture. Indira Gandhi National Open University is offering a certificate course on organic farming. Amity Institute of Organic Agriculture (AIOA) under Amity University, Noida is offering MSc (Organic food production and certification) and PhD (Organic Agriculture) degrees. National Centre for Organic Farming, Ghaziabad is conducting certificate courses on organic agriculture on a regular basis.

2. **Research and development:** ICAR is promoting research and development on organic farming through a Network Project on Organic Farming (NPOF) involving 11 State Agricultural Universities, 8 ICAR institutes/ centres and 1 deemed to be special heritage university, since 2004. The details of the network centres are given in Table 54. ICAR also approved 'Network project on Organic farming in Horticulture crops from 2014-15 with the objectives of evaluation of suitable organic amendments for meeting the nutrient requirement, developing an organic package for different horticulture crops. This network includes 9 ICAR research Institutes (Table 55).

Table 54: Locations of Network Project on Organic Farming (NPOF) under ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, Uttar Pradesh, India

Sl.No.	State	University/ Institute	Location
1	Chhattisgarh	Indira Gandhi Krishi Vishwavidyalaya, Raipur-492 012	Raipur
2	Gujarat	Sardarkrushinagar Dantiwada Agricultural, University, S.K. Nagar-385 506 (Gujarat)	S.K. Nagar
3	Himachal Pradesh	CSK HPKVV Hill Agri. Research and Extention Centre, Bajaura-175 125	Bajaura
4	Jharkhand	Birsa Agricultural University, Kanke, Ranchi – 834 006	Ranchi
5	Kerala	ICAR-Indian Institute of Spices Research, P.B. No. 1701, Marikunnu PO, Calicut – 673 012	Calicut
6	Kerala	ICAR-Central Tuber Crops Research Institute, Sreekarlyam, Thiruvananthapuram – 695 017, Kerala	Trivandram

7	Karnataka	University of Agricultural Sciences, Yettinagudda Campus, Krishinagar, Dharwad-580 005	Dharwad
8	Madhya Pradesh	Jawaharlal Nehru Krishi Viswa Vidyalaya, Jabalpur-482 004	Jabalpur
9	Madhya Pradesh	ICAR-Indian Institute of Soil Science, Nabi Bagh, Berasia Road, Bhopal – 462 038	Bhopal
10	Maharashtra	Dr. Balasaheb Sawant Konkan Krishi Vidypeeth**,** Daploi	Dapoli
11	Meghalaya	ICAR Research Complex for NEH Region, Umiam – 737 102	Umiam
12	Punjab	Punjab Agricultural University, Ludhiana-141 004	Ludhiana
13	Rajasthan	Maharana Pratap University of Agriculture & Technology, Udaipur-313 001 (Rajasthan)	Udaipur
14	Rajasthan	ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer – 305 206, Rajasthan	Ajmer
15	Sikkim	ICAR Regional Centre, Sikkim of ICAR Research Complex for North-Eastern Hill Region, Umroi Road, Barapani-793 103, Meghalaya	Sikkim
16	Tamil Nadu	Tamil Nadu Agricultural University, Coimbatore – 641 003	Coimbatore
17	Uttarakhand	G.B.P.University of Agriculture and Technology, Pantnagar, Udham Singh Nagar – 263 145	Pantnagar
18	Uttarakhand	ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansdhan, Almora – 263 601, Uttarakhand	Almora
19	Uttar Pradesh	ICAR-Project Directorate for Farming Systems Research, Modipuram, Meerut - 250 110	Modipuram
20	West Bengal	Ramakrishna Mission Vivekananda University (RMVU), PO Belur Math, District Howrah-711 202, West Bengal	Narendrapur

Table 55: Locations of Network Project on Organic Farming of Horticulture Crops under ICAR-Indian Institute of Spices Research, Calicut, Kerala, India

Sl. No.	State	Institute	Location
1.	Kerala	ICAR-Indian Institute of Spices Research	Calicut
2.	Kerala	ICAR-Central Plantation Crops Research Institute	Kasargod
3.	Kerala	ICAR-Central Tuber Crops Research Institute	Thiruvananthapuram
4.	Karnataka	ICAR-Indian Institute of Horticultural Research	Bengaluru
5.	Maharashtra	ICAR-NRC for Citrus	Nagpur
6.	Rajasthan	ICAR-NRC Seed Spices	Ajmer
7.	Rajasthan	ICAR-Central institute for Arid Horticulture	Bikaner
8.	Uttar Pradesh	ICAR-Central Institute for Subtropical Horticulture	Lucknow
9.	Uttar Pradesh	ICAR-Indian Institute of Vegetable Research	Varanasi

Besides the above two network projects exclusively working on developing package of practices for organic production of crops, following ICAR institutes and AICRP's also directly or indirectly contributes to the cause of research and development in organic agriculture systems.

- ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan
- ICAR-Central Institute for Cotton Research, Nagpur, Maharashtra
- ICAR-NRC on Meat, Hyderabad, Telangana
- ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh
- AICRP on Integrated Farming Systems, ICAR-IIFSR, Modipuram

- All India Network Project on Soil Biodiversity-Biofertilizers, ICAR-IISS, Bhopal

Legal framework and policy of organic agriculture

National Programme of Organic Production (NPOP) launched by the Ministry of Commerce during 2001 and National Project on Organic farming (NPOF) launched during 2004 by the Department of Agriculture and Cooperation, Ministry of Agriculture were the two milestones towards institutionalization of organic farming in the country. National Programme of Organic Production (NPOP) was initiated in the year 2000 to provide a focused and well directed development of organic agriculture and quality products under the Ministry of Commerce and Industry, Government of India which was formally notified in October 2001 under the Foreign Trade and Development Act (FTDR Act). It provides information on standards for organic production, systems criteria, and procedures for accreditation of inspection and certification bodies, the national organic logo and the regulations governing its use.

India organic logo for export **PGS logo for domestic**

The standards and procedures have been formulated in harmony with international standards such as those of Codex and IFOAM. The NPOP provides an institutional mechanism for the implementation of National Standards for Organic Production, through a National Accreditation Policy and Program. National Accreditation Body (NAB) is the apex decision making body. Certification and inspection agencies accredited by NAB are authorized to undertake certification process. The NPOP notified under FTDR act and controlled by Agricultural Processed Foods Export Development Authority (APEDA) looks after the requirement of export while Organic Agricultural Produce Grading and Marking

Rules, 2009 notified under Agricultural Produce (Grading & Marking) act, 1937 controlled by Agriculture Marketing Advisor, Directorate of marketing and inspection looks after domestic certification. Efforts are on to have NPOP standards to be included under the Food Safety and Standards Act, 2006. Currently 25 certification agencies (Table 56) have been authorized to undertake certification process. In 2006, India's organic certification process under NPOP has been granted equivalence with European Union and Switzerland. It has also been recognized for conformity assessment by USDA's national organic production. The standards for aquaculture, anumal husbandry and textiles approved by the National Steering Committee for organic products and are expected to be notified by Directorate General of Foreign Trade (DGFT) shortly. Low cost alternative certification namely grower group certification (GGC) and participatory guarantee systems (PGS) are also being actively considered for adoption under the various acts for promotion of organic farming in the country. The Bureau of Indian Standards is under process of developing domestic standards for organic farming in consultation with ICAR, APEDA, MoA, QCI, FSSAI and SAUs. There is a growing need for PGS Certification System in view of the high cost of third party certification under NPOP.

Since, agriculture is state subject, the respective state governments also frames the policies. Till now, 9 states namely Kerala, Karnataka, Andhra Pradesh, Sikkim, Mizoram, Madhya Pradesh, Himachal Pradesh, Nagaland and Gujarat have formulated organic farming policies. In addition, Maharashtra, Chhatisgarh, Tamil Nadu, Uttarakhand and Goa are in the process of framing organic farming policies. Invariably, all the states except in North Eastern region have stated in the policy that organic farming will be promoted in the niche areas (tribal and hilly regions) and crops (hi-value crops) in the initial stages.

Table 56: Accredited certification agencies in India (As on June 2015)

Name of the Certification Agency With Certification Mark	Name of the Certification Agency With Certification Mark
Bureau Veritas Certification India (BVCI) Pvt. Ltd.	**Indian Organic Certification Agency (INDOCERT)**
ECOCERT India Pvt. Ltd.	**Lacon Quality Certification Pvt. Ltd.**
IMO Control Pvt. Ltd.	**OneCert Asia Agri Certification (P) Ltd.**
SGS India Pvt. Ltd.	**APOF Organic Certification Agency (AOCA)**

Control Union Certification	**Rajasthan Organic Certification Agency (ROCA)**
Uttarakhand State Organic Certification Agency (USOCA)	**Vedic Organic Certification Agency**
ISCOP (Indian Society for Certification of Organic Products)	**Chhattisgarh Certification Society, India (CGCERT)**
Food Cert India Pvt. Ltd	**Tamil Nadu Organic Certification Department (TNOCD)**
Aditi Organic Certifications Pvt. Ltd	**Intertek India Pvt. Ltd.**

Madhya Pradesh State Organic Certification Agency	**Natural Organic Certification Agro Pvt. Ltd.**
Biocert India Pvt. Ltd	**Fair Cert Certification Services Pvt. Ltd.**
Odisha State Organic Certification Agency (OSOCA)	**Gujarat Organic Products Certification Agency (GOPCA)**
Uttar Pradesh State Organic Certification Agency	

Source: APEDA, 2014

Public perception and attitude on organic farming

1. **Farmers (producer) perception:** A study conducted in Madhya Pradesh revealed that 67% of respondents have positive perception towards organic farming (Suresh Patidar and Himanshu Patidar, 2015). Farmers were interested in converting to organic farming in the near future due to the low cost of production in Madhya Pradesh and due to the price premium and health benefits in Tamil Nadu and Uttarakhand. The years under conversion were positively associated with reduced input costs in all three states and with increased income in Tamil Nadu and increased yield in Madhya Pradesh. Both organic and conventional farmers found the two production factors, low yield and pest control, to be of major concern. However, organic farms in Madhya Pradesh and Uttarakhand experienced yield increases because most of the farms were in the post-conversion period, while the farms in Tamil Nadu were in the conversion period and experienced yield reduction (Panneerselvam *et al.,* 2011). The study suggests that the government scheme for compensating yield loss during the conversion period and a price premium may help farmers adopt organic agriculture on a large scale in India.

2. **Consumer perception and preference:** Consumers world wise are becoming health conscious and are concerned about nutrition. ACNielsen, a leading market research firm, recently surveyed about 21,000 regular Internet users in 38 countries to find their preference for functional foods – foods that have additional health benefits. The survey revealed that India was among the top ten countries where health food, including organic food, was demanded by the consumers. A study by Ragavan and Mageh (2013) in Chennai city (Tamil Nadu) shows that perceptions towards organic food product depict the strongest relationship with buyers' intention to buy organic food product followed by the buyers' belief that consuming organic food product is contributing to preserving the environment (Table 57). It seems that perception towards organic food and belief that organic food is environmentally friendly are not independent from each other. Besides, the availability of product information is also supporting the consumers' intention to purchase organic products. The perception towards organic products, beliefs about product safety for use, belief about product friendliness to the environment and availability of product information are the major

determinants for the consumers' purchase intention towards organic products. The results indicate that about 15.33 % of the consumers are regular buyer of organic products followed by occasional buyer (14.67 %), started again buyer (8 %) and non-buyer (62%). Hence, it is inferred that just more than one third of consumers are buyers of organic products (Table 58). A study by Radhika *et al.*, (2012) clearly indicates that 53 % of the respondents agreed that they liked the organic but at the same time expressed they were expensive, however 41 % were neutral and 7 % disagreed they were expensive (Table 58). While buyers of organic food like to try new categories, they are yet to feel convinced enough to completely overhaul their purchase patterns. The typical product categories that they prefer to purchase are usually perishable goods – fruits and vegetables and dairy products (Fig 30, Technopak, 2012). This pattern hints towards consumers' concern regarding the quality of regular varieties currently available in these categories – as fresh products, the need for 'freshness' and 'quality' is paramount in consumers' minds.

Table 57: Buying pattern of organic products in Chennai city (Tamil Nadu)

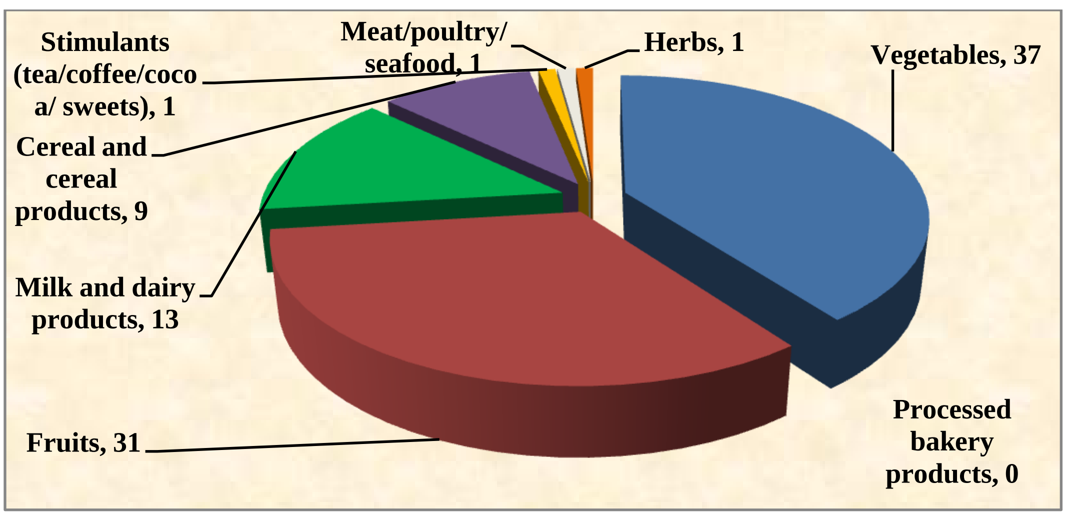
Particulars	**Frequency**	**Percent**	**Consumer type**
I have not bought organic products in the past and I am not thinking about buying organic products now	42	14.00	Non buyer
I have not bought organic products in the past and I am thinking about buying organic products sometimes in the near future	58	19.33	Non buyer
I have not bought organic products in the past and I am definitely planning to buy organic products in the future	86	28.67	Non buyer
I used to buy organic products, but I no longer buy them, I might start buying them again in the future	24	8.00	Started again buyer
I buy organic products, but not regularly	44	14.67	Occasional buyer
I buy organic products on most if not all, trips to market	46	15.33	Regular buyer

Source: Ragavan and Mageh, 2013

Table 58: Consumer perception about organic foods in Hyderabad and Secundrabad (Telangana)

Parameter	Response in %		
	Agree	**Neutral**	**Disagree**
Good but expensive	53	41	07
Available at right place	23	54	24
Ready to buy at high price	25	61	14
Satisfaction	48	49	03
Not easily accessable	31	54	15
Non availability of range of varieties	24	65	11
Right information on the pack	38	56	07
Sufficient knowledge with retailer	19	63	18
Superior taste of organic product	28	64	09
Authenticity of being organic	17	73	10
Difficulty in cooking	14	64	23

Source: Radhika *et al.*, 2012



Source: Technopak, 2012

Fig. 30: Types of organic food preferred (based on 175 respondents who have bought any organic food ever from Delhi, Mumbai, Bengaluru, Pune and Chandigarh cities)

Social and economic factors, contribution to rural livelihood development, food and nutrient security

Farmer families in Thirthahalli Taluk Shimoga district (Karnataka) holding up to one acre of land were studied and documented with the help of the case study methodology, living patterns, attitudes and farming practices by Nazeer udin (2014). The study revealed that the organic farming not only fulfill the requirement family consumption but also give fair amount of income and reduce the cost of cultivation with a sustainability of agro-eco system. Further, it concluded that Government support is only supplementary in nature and individual efforts have to come from innovative perceptions of the farmers with a philosophical attitude towards integrated approach to farming system keep in view of ecological, economical and rural social setting for sustainability. The study indicates that there is a wide scope of diversification of farming practices such as Manure, water and Pest management and also generation of rural employment, provides food security at the house hold level where all these are possible actions with a maximum utilization of local natural capital inputs may offer the best prospects for poverty reduction and sustainable livelihood outcomes. However, the need of the hour is to promote organic farming by increasing capacity building of the farmers through interventions of expertise NGOs and Government support. The study also found that there is a much scope to establish organic input preparation units in nearby villages and observed that the study area has favourable agro climatic conditions suitable for organic farming for marginal farmers are concerned.

Existing programmes/ approaches to promote organic agriculture

Department of Agriculture and Cooperation (DAC) under the Ministry of Agriculture promotes various components of organic farming through various programmes *viz*. National Mission on Sustainable Agriculture (NMSA), Mission for Integrated Development of Horticulture (MIDH), Rasthtriya Krishi Vikas Yojana (RKVY) and 'Network Project on Organic Farming under ICAR'. National Project on Organic Farming (NPOF) which was started in the year 2004 has been concluded in March 2014. The existing components of organic farming have been put together under a programme called 'Paramparagat Krishi Vikas Yojana (PKVY)' to be implemented in a cluster mode from 2015-16, wherein it is proposed to increase certified area by 2 lakhs ha under organic farming within a period of 3 years. Government has also made a budget announcement to develop commercial organic farming in the North Eastern States. This scheme is being implemented through Department of North Eastern Region. Further, easy certification through GGC and PGS are also considered. There are three components of organic farming under MIDH *viz*. adoption of organic farming, organic certification and establishment of vermi-compost units/ organic input units.

Other relevant information

Organic livestock systems: Mahesh Cahnder (2011) made the study on the organic livestock systems in India. In the study area of hills, a majority of farmers (87.38%) reported that they don't spend any amount on veterinary medicines for their animal and rest of them were incurring expenditure ranging from Rupees 100 to Rupees 2000 only, which augurs well for organic livestock production. Around 62.1% of the farmers were rearing local breeds. This number was maximum in case of farmers of dryland states at 69.6% followed by hill states at 54.6% and irrigated states at 18.9%. A good percentage of farmers were feeding their animal with home grown feed and fodder, which is appreciated under organic management of livestock. The farmers' willingness to convert to organic farming was taken. 14.1% of the farmers among all states were not willing to convert. They were further asked whether they would convert to organic farming if technical support, financial support, marketing support and all support are given to them. 78.5% of the farmers said that they would convert to organic farming if all support is provided to them. Popularization of organic farming will certainly require some kind of support mechanism.

Animal husbandry practices of registered organic farmers

1. **Breeds and Breeding:** The breeds maintained by registered organic farmers were mostly local breeds and the method of breeding followed was natural service. Whereas, artificial insemination (A.I) was not very popular. The breeds and breeding system followed by registered organic farmers were similar or nearer to the recommended organic livestock production standards, since in organic systems, locally adaptable breeds and breeding methods are given preference.
2. **Nutrition/ Feeding system:** Though the registered organic farmers had no proper idea about the feeding requirements of livestock to get the optimum

yields from the local breeds they were maintaining, most of the feed, both roughages and concentrates were produced within the same agro-ecological region. The dependence on external sources like market purchased feeds was very less. It was not ascertained, whether these feeds were 100 per cent organic, otherwise there is a need to establish their organic status in order not to exceed the recommended percentage of conventional feed allowed in organic livestock production systems.

3. **Health care:** Health care in organic production systems insists on the selection of suitable breed to the agro-ecological regions, species specific feeding and rearing the animals in stress free environment conditions. Moreover, preventive management plays major role than curative management in organic systems. The animals were mostly treated using locally available plant materials, while the allopathic treatment was given in rare cases. The routine use of antibiotics was very limited, in case of emergencies only. The local practices of health are generally encouraged as per the organic production standards, but the local treatment may require proper validation in order to be qualified for organic systems. Under organic management, though the alternative treatments are emphasized, but the animal should not be allowed to suffer for the want of treatment.

4. General health care was maintained through provision of fresh air and exercise through open grazing. This practice was found to be in line with the organic standards which encourage the natural immunological defence of the animals. Registered organic farmers were rich in possession of Indigenous Technical Knowledge (ITK) which, however, needs scientific validation for approval by the certification agencies.

5. **Management of animals:** Animals should be provided access to open areas including grazing, sufficient space for movement when indoor, their behavioural needs should be taken care of so that animals feel comfortable. Most of these aspects were taken care of under the existing production practices of the farmers, yet proper training is essential so as to fully consistent with the requirement of organic production systems. Farms of registered organic farmers were well diversified with crop-livestock integrated systems. Cattle were found to be kept in groups which graze together during day time, which fulfils the organic standard of providing animals' social contact, sufficient free movement and opportunity to express normal

behavioural pattern. Though the livestock housing pattern in the study area was protecting them from extreme cold, it needs modification in a way to facilitate exchange of gases and moisture free environment. Moreover, from zoonotic point of view, cattle housing should be located away from human dwellings, whereas, in the study area especially in hill areas, they were located adjacent to human dwellings.

Plants used as animal health care

Sl. No.	**Scientific name**	**Vernacular/ common name**	**Use of therapeutic importance**
1	*Asparagus filicinus* Buch.- Ham. ex D. Don. (Liliaceae)	Sansbai / Sanspan	The tuberous roots are crushed and mixed with flour and the mixture is given to milching cattle for increasing milk production.
2	*Betula utilis* Buch. - Ham. ex D. Don. (Betulaceae)	Takpa, Bhojpatra	The ash obtained after burning of stem bark is used to cure rheumatic pains. It is also used as a healing agent against deep cuts.
3	*Delphinium vestitum* Wall. ex Royle. (Ranunculaceae)	Changuthpa, Salyan	The root powder is used in healing of ulcers and wounds in cattle.
4	*Heracleum candicans* Wall. ex DC. (Apiaceae)	Rasal	The plant powder is given in giddiness. The leaves and shoots are dried, preserved and given as nutritious fodder in lean period, particularly in winter.
5	*Leucas lanata* Benth. (Lamiaceae)	Dhurlughas	The leaves are roasted in ghee (refined butter) and are administered orally to expel placenta after delivery. The infusion of the leaves with bamboo leaves is given in diarrhoea and dysentery in cattle. It is also given with buttermilk as a laxative agent.
6	*Thalictrum foliolosum* DC. (Ranunculaceae)	Pilijari	The plant is reported to be useful to cure foot and mouth disease of animals. The root is applied cure boils and ulcers.

SUCCESSFUL STORIES

1. **Strong belief can innovate:** Mr. Sundara Raman of M/s Thayalu Ammal farms lives in Sathyamangalam near Erode district in Tamil Nadu. Mr. Sundara Raman tried a few of the new options but stood out as the only ‘organic farmer’ in the zone. “Everyone thought I was impractical,” he adds. “I tried farming with my own methodology but I knew there was a better way.” By cutting his inputs and chemical costs, he kept the farm alive and profitable. He also formulated many forms of plant and microbial consortia to put into various uses as growth promoters and pest management. To address soil fertility and other natural resource concerns on the farm, Raman developed and implemented a Conservation Plan. A number of practices like micro irrigation with microbial consortia, bird perches, livestock waste management system, multiple cropping and an agro-forestry unit. Organic crops grown on Raman’s farm included a variety of marketable organic grains like corn, hybrid seed corn, vegetables, redgram, turmeric and organic lime. Over the years, the Tamil Nadu Agricultural University recognized his hard efforts and offered a number of farmer to farmer collaborations. Mr. Sundara Raman took the plunge and got involved with these programmes and with those of other conservation-oriented farmers as much as he could. He worked and collaborated with other organic farmers within and from other states, sharing his own knowledge and successes as well.

2. **Organic farming system in cluster approach:** A village in Ri-Bhoi district of Meghalaya namely Mynsain have been adopted for disseminating organic production technology developed in the ICAR Research Complex for NEH Region, Umiam through a model village concept under Network Project on Organic Farming-Tribal Sub Plan (NPOF-TSP) with financial assistance from ICAR-Indian Institute of Farming System Research, Modipuram. The village is having 130 households with an approximate area of 60 ha. Under the program, seeds of improved verities of crops and vegetables, planting materials, lime, rock phosphate, neem cake and other organic inputs were provided to the adopted farmers. For effective soil fertility management application of weed, decomposed farm yard manure, pig manure, green leaf manure, composts, liming, rock phosphate etc. were promoted. For pest and disease management use of neem oil, trichoderma, derisom, indigenous technical knowledge was emphasized. Crop rotation with legumes such as

groundnut, soybean, French bean etc. were introduced. To promote small scale mechanization, implements and tools like paddy thresher, cono-weeder, sprayer, rose cans, maize sheller and electric pump has been provided to the village. The farmers were given training in various aspects of organic farming along with conservation of natural resources and residue recycling. Successful cultivation of pea, rapeseed and lentil were followed in rice fallow under no-till. Three new ponds were constructed and seven existed ponds were renovated in farmer's field of Mynsain village for multiple uses like irrigation and composite fish culture. A total of 17 small rain water harvesting structure - jalkund having 30,000 litres capacity each were developed for growing vegetables such as French bean, cabbage, broccoli, tomato, lettuce, cucurbits and for rearing of animals such as pig and poultry specially during dry season. A community vermicomposting unit (size 6m x 8m x 2.6m) consisting of eight tanks (size 2m x 1.5m x 0.75m) has been constructed in the village with an objective to produce vermicompost by recycling farm biomass. Raised and sunken beds with 1:1 dimension were developed in 10509 m^2 area after rice harvest in lowland for cultivation of vegetables like tomato (var. Avinash, Rocky), French bean (var. Naga local), potato (var. Kufri Megha), carrot (var. New Kuroda), lettuce, etc. Six hundred numbers of improved varieties of Guava seedlings were planted in farmer's field covering an area of about 4500 $^{m2.}$ Multipurpose trees along with fodder were also grown for rehabilitation of degraded land and supply of fodder to cattle in lean period. Farmers were provided with improved breeds of pig (75% Hampshire and 25% mixed local) and poultry (Vanaraja) for higher productivity, nutritional security and income. Mostly the farmers were doing mixed cropping of ginger-colocasia – chili for higher income. Mrs Hynniew Rynghang, an adopted farmer of the village narrated that 'The integrated organic farming system given very good returns with using very less quantity of external inputs'.

As the villagers were not using any synthetic fertilizers or pesticides earlier, the chance of reduction in yield due to adoption of organic farming does not arise. Rather due to adoption of improved organic production technology, the yield of rice, maize, French bean, ginger, tomato, carrot and chilly had been enhanced by about 15, 22, 40, 33, 45, 37 and 27%, respectively over conventional practice. Villagers are currently selling their produce in local market and along the highway side as uncertified organic produce with 10-15% higher market price as compared to conventional produce.

3. **Manar Vanadesa Farmers Group:** Fifty tribal farmers including 20 women were trained under ICAR-Network Project on Organic Farming for modern organic Farming methods and techniques in 5 villages of Karamadai block in Coimbatore district of Tamil Nadu. Special lectures on mushroom cultivation, apiculture, bio-fertilizer production were given. Inputs such as 10,000 number of Jasmine seedlings, 16.4 kg vegetable seeds, 200 kg of Azospirillum, Phosphobacteria, VAM and 100 kg of bio-control agents such as Pseudomonas fluroscens and trichoderma viridie were also given for practicing the organic farming in the form of Participatory Guarantee System (PGS). From the trained group, **Manar Vanadesa Farmers Group** was formed for organic certification and registered at Joint Registrar Office, Coimbatore.

Farming Initiative (www.tribalhealth.org)

People from the local malavasi communities have lived by rain fed subsistence farming and the produce of their forests for a very long time. Traditionally they grew about fifteen different varieties of crops suited to the environment and had ample food the whole year around. This tradition has been displaced by the pressures of a modern consumer economy to grow cash crops. These crops are water intensive and people are forced to use chemical fertilisers and pesticides in an attempt to maximise returns. Eventually the tribal farmer finds himself in a situation where he is easily exploited. Nutrition and livelihood are two factors that contribute significantly to an individual's health. Thus, when the people of the surrounding villages started bringing their farming troubles to THI's attention, an opportunity for growth became apparent and THI expanded its programs to include a farming initiative. This work was also encouraged in the report of the 10-year organizational review, summarized as follows: "unless we start dealing with the determinants of health, we would not be able to bring the tribal community to achieve a better health status." Working with the credibility they had already gained in the community, THI began teaching the farmers various organic techniques, aimed at saving the cost of chemical pesticides, increasing the farmers' yields, and improving the health of the consumers. Since its inception in 2005, the Tribal Farming Initiative has grown to include the following components/ programs.

- Formation of SOFA (Sittilingi Organic Farmers Association), an association of farmers currently practicing organic methods, and is in the process of receiving organic certification from the government. Currently there about 200 farmers who are registered of which half have got ‘organic certification’ from the Govt. of Tamil Nadu.

- Creation of the SVAD (Sittilingi Valley Agricultural Development) brand, under which 25 organic products are sold in various cities in south India
- Formation of Women’s Self-Help Groups (SHGs), which perform value-addition processing, increasing the profit margin for specific products
- Creation of Seed Banks, ensuring the survival of various minor millets and other traditional seeds, which were at risk of extinction due to the increased demand for rice and decreased demand for other similar sources

Important Publications on Organic Farming in Indian Context

Sl. No.	Author (s)/ organization	Year	Title	Published by or in
1.	NAAS	2005	Organic Farming: Approaches and possibilities in the context of Indian Agriculture	National Acdemy of Agricultural Sciences, New Delhi
2.	Ramesh, P., Mohan Singh and A. Subba Rao	2005	Organic Farming: Its relevance to Indian context	Current Science 88 (4):561-568
3.	Bhattacharyya, P and G. Chakraborty	2005	Current status of organic farming in India and other countries	Indian Journal of Fertilizers 1(9):111-123
4.	Narayanan, S (NABARD)	2005	Organic Farming in India: Relevance, Problems and Constraints	Occasional paper-38
5.	Venkateswarlu, B., SS Balloli and Y.S. Ramakrishna	2007	Organic Farming in Rainfed Agriculture: Opportunities and constraints	Central Research Institute for Dryland Agriculture, Hyderabad
6.	Yadav, A.K	2008	Organic Agriculture: Concept, Scenario,	NCOF, Ghaziabad, New Delhi

			principles and practices	
7.	Kumara Charayulu, D and Subho Biswas	2010	Organic input production and marketing in India: Efficiency, issues and policies	CMA publication No. 239
8.	ICAR-NPOF	2011	Consolidated Report of NPOF	ICAR-IIFSR, Modipuram
9.	Venkateswarlu, B and JVNS Prasad	2012	Carrying capacity of Indian Agriculture: issues related to rainfed agriculture	Current Science 102 (6):882-888
10.	Panneerselvam, P, Jhon E Hermanson, Niels Halberg and P. Murali Arthanari	2013	Impact of large-scale conversion on food production and food security in two Indian states, Tamil Nadu and Madhya Pradesh	Renewable Agriculture and Food systems
11.	Mohamed Ragab Abdel Gawwad	2013	Status, trends and prospects of organic farming in India: A review	Journal of Plant Biology Research 2(2):38-48
12.	Mahesh Chander	2013	Organic Livestock Farming	ICAR-DKMA
13.	Aman Deep Kumar	2014	Organic Farming for Sustainable Agriculture: Global and Indian perspective	Global journal for research analysis 3(2):57-59
14.	ICAR-NPOF	2014	Package of Practices for organic production of crops in cropping systems perspective	ICAR-IIFSR, Modipuram
Comprehensive information portal: http://agritech.tnau.ac.in/org_farm/orgfarm_index.html				

Conclusion

Organic farming systems are very much native to India as traditionally crops and livestock are reared together and as of today also, present in more than 85% of the farm households. India’s average fertilizer and pesticide consumption stands at 128.3 kg ha^{-1} and 0.31 kg a.i ha^{-1} and many of the states have lower than the national average consumption of these inputs. Inspite of technological advancements, the nutrient use efficiency is on lower side (33% for N; 15% for P; 20% for K and micronutrients). It is estimated that various organic resources having the total nutrient potential of 32.41 mt will be available for use in 2025. Since, integrated approach of crop management including inter/mixed cropping (is also considered as **"towards organic"**) is found to increase the use efficiency of all costly inputs especially fertilizers and water, it would be appropriate to adopt the integrated crop management in the states contributing major share to the food basket. Organic production of niche crops (crops which yield higher under organic condition and have market demand) can be considered in the hilly and rainfed areas. It will also add to the increase in overall food production of the country. However, organic farming technologies need to be fine-tuned and updated to further enhance the yields. Farmer friendly certification policies and supply-demand chain management is essential for the growth of organic farming in the country. It can be concluded that **"towards organic"** (integrated crop management) approach for intensive agricultural areas (food hubs) and **"certified organic farming"** with combination of tradition, innovation and science in the de-facto organic areas (hills) and rainfed/ dryland regions will contribute for safe food security in future besides increasing the income of farm households and climate resilience. This approach will also positively contribute to the cause of human, livestock and eco-system health.

Way Forward and Recommendations

Organic agriculture includes several aspects starting from crop husbandry to livestock to horticulture with complimentary activities on the farm. Instead of covering all the states for promotion of organic agriculture in one go, it would be more appropriate to promote it in the phased manner by identifying the niche areas and niche crops, considering the domestic and international demands of organic food production. Presently, in India, several schemes have been formulated and implemented to promote the organic agriculture which have resulted in many fold increase in area and export over the years, but still lot has to be done. The salient recommendations for penetration of organic farming in the country are given below.

1. Availability of authentic statistical data is essential for planning, policy formulation, implementation and impact assessment. The present system of

collecting data on organic farming by Agricultural Exports Development Authority (APEDA) is through producers, processors and certification agencies using TRACENET. In the recent times, lots of variations have been observed in reporting of area and production. Moreover, the area reported does not include the extensive areas under natural farming and/or uncertified chemical-free farming, as those do not come under the definition of either in-conversion or certified. Hence, a comprehensive statistical data collection on all aspects of organic farming is essential and this needs to be institutionalized like other agricultural censuses. Similar mechanism is also required for sharing the data among all SAARC nations.

2. Organic farming growth is constrained due to several factors, such as; a decline in yield in the initial years of conversion, insufficient availability of organic manures within the farm to meet out the nutrient demand, slow release of nutrients from organic manures leading to mismatch between crop demand and soil supply, difficulty in handling the bulky manures, and inadequate certification and marketing infrastructure. Hence an integrated strategy of addressing all these issues is essential.

3. The main problem of organic growers is lack of continuous and reliable supply of certified inputs (such as; seeds, bio-agents, bio-fertilizers, manures et c.) and economically viable marketing of organic farm produce. Hence, steady and reliable input-output chains need to be established in potential organic clusters. The organic input production units established in public/ private sectors, under various developmental schemes in the country, should be linked up with suitable marketing channels to improve upon their capacity utilization and make them responsible and viable. Establishment of organic input marketing channels is the need of the hour for expansion of organic farming in the country.

4. To exploit high-end domestic and international export markets, potential organic agriculture zones need to be identified on the lines of “Special Economic zone” and be named as “Special Organic Agriculture Systems Zone”. For example, potential exists for creation of “Organic Spice” zone in Kerala, “Organic Coconut zone” in Nicobar district of Andaman and Nicobar Islands, “Organic Basmati Rice zones” in Uttarakhand, Western Uttar Pradesh, Haryana and Punjab, “Organic Cotton Zones” in M.P, Gujarat and Maharashtra, “Organic Seed-Spices Zones” in Rajasthan and Gujarat.

Similarly, several specialized organic zones may be identified for production and marketing of different vegetables and fruits within the well established horticultural belts in different states. These zones can also be made as Agro-ecotourism centres for attracting the nature loving tourists. Tax holidays for those private investors, who will invest in establishing organic input production/ processing and packing units within the zone, may be considered. The zone should be planned in such a manner that all requirements of inputs, certification, processing and packing are met within the zone itself.

5. Wide spread existence of crop + livestock farming system is the strength for organic India. This should be considered a great opportunity for establishing integrated organic farming system in in all the niche areas, which should serve as research-cum-demonstration unit. Cluster of villages must be encouraged for organic farming systems depending upon the niche.

6. Organic farming package adoption and its promotion for individual crops should be done away with. The system approach should be adopted. Cropping and farming system approach of providing required nutrient and other inputs are proved to be successful. “Model Organic Farm” in farming system mode for marginal and small farmers should be developed in each District of identified and potential states.

7. The approach of “Towards Organic” should be adopted instead of immediately switching over to organic from inorganic in the high intensive agricultural areas to have safe food security in the country. This approach will reduce the immediate heavy yield losses during the conversion period and also will contribute for increased use efficiency of fertilizers and water. Government schemes of Integrated Nutrient Management, Plant Protection and Water Management needs to be amalgamated so as to get desired output.

8. The guidelines of national standard for organic production are having the equivalence with European Union and other important countries. It is good for the export. However, the domestic standard which also follows the export standards for organic production and certification needs to be reviewed. As **“safe food for all”** is possible through **“towards organic”** approach which includes integrated crop management practices. The domestic standard can consider the production practices of integrated approach with prescribed maximum use of nutrients (can be up to 50 %) in the form of chemical

fertilizers. However, the pest, disease and weed management practices should be as per the export standard. This recommendation also holds well in the light of the argument that regardless of sources including organic, plants absorb nutrients in the form of inorganic.

9. **“Certified organic farming”** with combination of tradition, innovation and science in the de-facto organic areas (hills) and rainfed/ dryland regions will contribute for safe food security in future besides increasing the income of farm households and climate resilience. This approach will also positively contribute to the cause of human, livestock and eco-system health. Hence, organic farming should be promoted in niche areas and crops.

10. Favourable certification policy is essential. Certification agencies should be able to practically audit the organic farms instead record verification. Government support is required for cheaper access to organic certification of farms. Presently only 25 certification agencies are involved in the entire country. This needs to be increased to atleast 100 by involving the government departments and agencies. Grower Group Certification (GGC) and Participatory Guarentee Systems (PGS) which are recognized by the international agencies like IFOAM should be promoted and government support is essential in formation of clusters and groups. “Know Your Farmer and Know Your Pattern” will also be successful. Sustainable Fund (TSF) should be created in all the organic clusters promoted by government.

11. Farmer Producer Organizations (FPO’s) should be involved in production, processing and marketing of organic produces in the country. Infact, linking with assured market will be very important for organic promotion. Anand pattern which was successful in dairy should also be explored for organic farming expansion in the country.

12. On the line of Minimum support price, the organic produces should also have premium minimum support price to ensure the better profitability to organic growers. Support for organic seed production with seed production chain of arable crops, green manures (dhaincha/ sunhemp) should be given thrust.

13. Establishment of sufficient and accessible labs for testing of products mainly for pesticide residues to maintain the quality of organic produce and inputs are essential.

14. The North Eastern Region of India is having very good potential for organic farming considering the fact that the use fertilizers, chemicals etc. are negligible especially in hills. They should be given preference and infrastructure support especially for input production and output storage, branding and marketing. At least one cold storage facilities/ godown should be considered for each hub/ cluster to store organic produce and get adequate benefit for the farmers.

15. Optimally utilization of scare resources particularly natural resources should be top priority in terms of development of community institutions ie. SHGs, Mahila Groups, Youth Groups and user group associations which may provide better option of management of fragmented land and water resources.

16. The awards and recognition should be given at regional/state level to the researchers/ extension workers/ organizations/ farmers involved in promotion of organic farming.

17. Capacity building followed by arranging critical inputs, implementation cum monitoring, linking with assured market using cluster approach will be a way forward for success of organic farming.Cluster Approach: Organic farming practices are for the farmers, by the farmers and of the farmers. All locality based scientific research should include an analysis of farmer’s knowledge. The organic farming practices should be implemented in farmers participatory mode right from the planting, implementation and monitoring. Further, cluster approach of demonstrating the organic farming can help to reach organized organic market.

18. **Farmer education:** As a farmer-centered and grassroots movement, organic agriculture has largely relied on farmer-to-farmer networks and exchanges to disseminate information. Research has to support the linking of the farmers with the other stakeholders in the food supply chain, specifically markets for organic food in developing countries. At the same time, farmer knowledge needs to be valued as a source of experience and a base for innovation. This can be accelerated by investing in farmer education, which will also empower the rural communities.

19. Participatory planning of organic agriculture should be given top priority and decision making process may be simplified.

20. **Networking:** Organic agriculture research is still at a formative stage, and needs to build related human capacities. Farmer innovators and farmer organisations grouped around value chains have to build networks to commonly solve their many problems and address their specific research needs to the scientists. All the SAU's in the country should start the department of organic farming or sustainable agriculture and offer courses on these areas. Research network to be further strengthened to undertake basic research and develop innovative organic inputs for higher productivity. Plant Breeding for organic farming is still lacking in the country and needs to be given thrust as performance of varieties varies under organic, integrated and inorganic management.

21. **Knowledge dissemination:** Organic farming research stands to benefit all farmers and consumers. Organic food should not be limited to affluent consumers in wealthy countries – as access to healthy food is a fundamental human right. Organic farmers have pioneered a number of sustainable technologies, allowing researchers to fine-tune solutions that can inturnbe adopted by non-organic farmers, as was the case for the use of pheromones and the introduction of beneficial fungi as antagonists to soil-borne pathogens.

22. **Traditional crops and varieties hub:** Organic agricultural practices adopted for traditional crops and varieties by forefathers needs to be documented and a hub on this can be established in all states.

23. Government of India has recently launched Parambaraghat KrishiVikasYojana (PKVY), development of indigenous cattle and Swacch Bharat Abhiyan (Clean India campaign). Synergy among all these three schemes is essential as the contribution of indigenous cattle in organic farming is immense. Also, the recyclable and bio-degradable wastes from clean India campaign can go for making green farming.

24. Low awareness among state extension functionaries on benefits of organic agriculture systems is also major problem in promotion of organic farming. Regular capacity building programmes should be organized to sensitize the important field level functionaries.

25. Networking of academic, research institutions, markets, certifying agencies and NGOs in SAARC nations are essential for sharing of technologies and harvest the benefit of complementarity. Authentic web enabled information system for an organic agriculture system in the SAARC nations is essential.

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Status and Future Prospect of Organic Agriculture for Safe Food Security in Maldives

Rifaath Hassan

Assistant Director, Ministry of Fisheries and Agriculture, Republic of Maldives
Email: rifath.hassan@fishagri.gov.mv

Summary

Food security and livelihoods depends on sustainable agriculture. Achieving food security requires adequate food availability, access and absorption. It is more important to maintain fertility on existing land and to restore fertility on degraded lands. For these approaches to work organic agriculture has an important role to play. Organic agriculture is not only concerned with the end- product, but it is involved with the entire system used to produce and deliver the agricultural product. The entire cycle should be organic, from production to processing, to handling and delivery, excluding the use of external agricultural inputs such as pesticides and fertilizers.

Agriculture has provided crucial support to the livelihood of the Maldivian people over the centuries, despite the nutrient poor soils. Agriculture plays an important role as a source of income for the rural population of Maldives. It is carried out in mixed home gardens, settled rain-fed cropping fields, bush fallow shifting cultivation areas and year-round horticultural production fields across the agricultural islands of Maldives.

Like many other data, agro chemical usage data is also lacking, but based on imports it is evident that the use of agro chemicals has increased over the years. Fertilizer use is heaviest in agricultural islands. The amounts of fertilizers consumed in each island are, however, not recorded. Use of pesticides has also increased in the recent years due to outbreak of diseases and also due to the introduction of new pest and diseases. Regular uses of pesticides have caused resistance in pest population resulting in increasing in the dosage and frequency of application of pesticides.

It is unlikely that organic agriculture will play a significant role in Maldives in meeting the food production required due to limited land

scarcity and limited amount of food production which is mainly limited to fruits and vegetables. Maldives fresh food market is heavily dependent on imported goods and the market spends millions of dollars for this. It is to supply to the resort markets and the local communities. The consumer purchases the basic fruits and vegetable at a higher cost as it has additional food miles to travel to Maldives.

However there is scope in expanding the present productions, which are organic by production like taro, mangoes, papaya, coconuts and few horticultural crops. Consumers are aware of agriculture inputs used in production and also in post-harvest management, which has raised public concerns through various media outlets. The produce that is locally produced is still very much sought after rather than the seasonal foods that are imported.

Concept, Brief History and Strategic Importance of Organic Farming

Food security and organic agriculture

Food security exists when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet to meet their dietary needs and food preferences for an active and healthy life (FAO 2003).

Food security and livelihoods depends on sustainable agriculture. Achieving food security requires adequate food availability, access and absorption. Agriculture plays a vital role in contributing to all the three components of food security (Dev, 2011).

The global demand for food and farmland is rapidly growing due to a variety of factors including rising human population numbers, increased meat consumption, urbanization, competing land uses for non-food crops and the alteration in the suitability of land to grow crops due to climate change. The increase demand for food in the future means to increase production in order to cater to the food insecure populations.

Some of the options to meet the increase in demand for food are area expansion, increased productivity in industrialized countries and export of surplus production and increased productivity in developing countries. However it is more important to maintain fertility on existing land and to restore fertility on degraded lands. For these approaches to work organic agriculture has an important role to play.

Organic agriculture is not only concerned with the end- product, but it is involved with the entire system used to produce and deliver the agricultural product. The entire cycle should be organic, from production to processing, to handling and delivery, excluding the use of external agricultural inputs such as pesticides and fertilizers.

The demand for organic food has been increasing over this period. According to a report of the United Nations Conference on Trade and Development, worldwide organic food markets expanded by 10–15% in the last 10 years, whereas conventional markets only grew by 2–4% (UNCTAD, 2008).

Overall the benefits of organic agriculture are expected to be environmental, social and economic. Organic agriculture seeks to offer a responsible alternative to conventional practices in the face of ever-growing concerns over climate change and environmental degradation.

Overview of organic agriculture

Organic Agriculture as defined by the International Federation of Organic Agriculture Movement (IFOAM 2014) includes all agricultural systems that promote the environmentally, socially, and economically sound production of food, fibers, and bio-fuels. These systems take local soil fertility as the key to successful production. Organic agriculture allows the powerful laws of nature to increases both agricultural yield and pest resistance.

Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM, 2014).

Data on organic agriculture are available from 164 countries. There were more than 1.9 million organic producers in 2012. Of this 36 of the world's organic producers are in Asia. The countries with the most producers are India (600,000), Uganda (189,610) and Mexico (169,707) as shown in Table 59. One third of the world's agricultural land (10.8 million hectares) and more than 80% of the producers are in developing countries and emerging markets (FiBL and IFOAM, 2014). This is something that is of high importance as the world's most food insecure also resides in these communities.

The Asia markets for organic products are growing but data on domestic market are available from very few countries. The organic agricultural land in Asia decreased by almost 0.5 million hectares due to a major decrease in India. The demand for organic produce has been steadily growing in recent years for three main reasons, including health, environment and food security.

Table 59: Organic Agriculture 2014: Key Indicators and Leading Countries

Indicator	**World**	**Leading countries**
Countries with data on certified organic agriculture	2012: 164 countries	-
Organic agricultural land	2012: 37.5 million hectares 1999: 11 million hectares	Australia (12 mio. hectares, 2009) Argentina (3.6 mio. hectares) US (2.2 mio. hectares, 2011)
Producers	2012: 1.9 million producers 2011: 1.8 million producers 2010: 1.6 million producers	India (600’000) Uganda (189’610) Mexico (169’707)
Organic Market size	2012:63.8 billion USD (approx. 50 billion Euros)	US (22.6 billion Euros), Germany (7 billion Euros) France (4 billion Euros)
Number of countries with organic regulations	2012: 88 countries 2011: 86 countries	-
Number of IFOAM affiliates	2013: 732 affiliates from 114 countries	Germany: 85 affiliates India: 44 affiliates United States: 37 affiliates China: 34 affiliates

Source: (IFOAM, 2014)

Overview of organic agriculture in the SAARC region

Table 60 gives an overview of organic agriculture in the SAARC region. From this, it can be seen that India has the largest number of producers and also the largest agricultural land used in organic production including wild collections. However, the highest percentage share of organic market at global level is Bhutan at 1.21%.

Table 60: Overview of organic agriculture in SAARC region

Country	Share of world OA (%)	Organic Agriculture land (ha)	Aquaculture land (ha)	Wild collections (ha)	Total OA (ha)	Organic producers
Afghanistan		61			61	264
Bangladesh		68,660	9,338		77,998	9,337
Bhutan	1.21	6,156		15,605	21,761	
India	0.28	500,000		4,700,000	5,200,000	600,000
Maldives						
Nepal	0.12	10,273		24,422	34,695	247
Pakistan		22,397			22,397	105
Sri Lanka	0.75	19,517			19517	404

Around 33, 800 hectares were used for aquaculture. Most of this is in Vietnam (58%) and Bangladesh (28%). Countries with regulations on organic agriculture fully implemented are Bhutan and India. Countries that are in the process of drafting the organic agriculture regulations are Bangladesh, Pakistan and Nepal.

Principles of organic agriculture

There are four basic principles of organic agriculture that are followed globally.

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

Principle of ecology Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

Principle of fairness	Organic Agriculture should build on relationships that ensure fairness with regard to common environment and life opportunities.
Principle of care	Organic Agriculture should be managed in precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

Adapted from: (IFOAM 2014)

Components of organic farming

Organic farming is a major contribution to sustainable development, to increasing the economic activities with an important added value and to increasing the interest in rural areas (Frumusanu, Andritoi and Paulescu, 2009). Organic farming relies on sound crop rotations to include fertility building and fertility depletion stages, returns of crop residues, nitrogen fixation by legumes, and nutrient retention by green manures and effective use of manures/ composts.

It plays a major role in protecting the long-term fertility of soil by maintaining soil organic matter levels, nurturing soil and biological activity and careful mechanical inversion. Plant nutrients are supplied through relatively insoluble nutrient sources (organic sources) made available by the action of soil microbes. It aids in meeting crop need of nitrogen through nitrogen fixation by leguminous crops in the cropping systems and recycling of farm organic materials including crop residues and livestock wastes that are applied. It gives high importance to crop rotation, natural predators, resistance varieties and other agronomic manipulations of plant protection including weed management. Overall it helps in biodiversity management, soil and environmental health.

Country Profile

Location and Terrain

The Republic of Maldives is a small, low-lying archipelago located in the Indian Ocean, where its closest neighbors are India, 595 km to the north and Sri Lanka, 670 km to the North-East. Maldives covers an area of over 90,000 km^2 in the Indian Ocean, of which 99% is ocean. Geographically, Maldives is made up of flat and low lying coral islands, barely reaching 1.5 m above the sea level. The elevation, size, shape and vegetation of these islands vary enormously from island to island. Size of the islands ranges from 0.5 km^2 to 5 km^2 and the shape varies from sand banks to elongated strip islands (Fig 31).

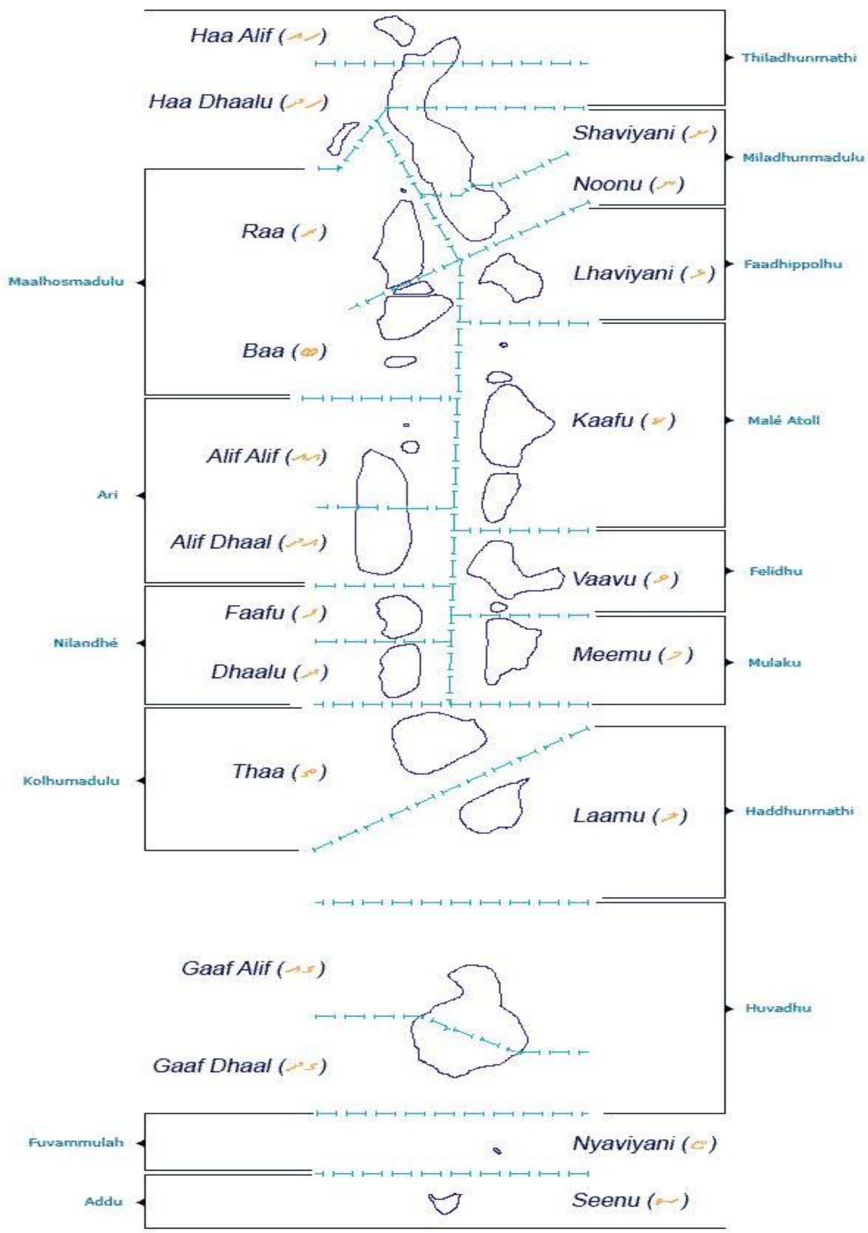

Fig. 31: Map of Maldives showing the islands (Wikipedia)

Apart from the capital city Male', islands can be sorted into the following categories: resort, primarily fishing, mixed fishing and agriculture, and predominantly agriculture practicing islands. Majority of the islands depend on fishing and mixed farming. Very few islands have land area bigger than one km^2 (Nihad, 2008).

Physical and demographic context

This section highlights a few vital statistics of the Maldives, to provide a clearer understanding of the current situation (Table 61).

Table 61: Statistics of Maldives

Statistics	Description
Size of country:	300 km^2 and a total coastline of 644 km
Form of government:	Republic
Official languages:	Dhivehi. English is widely spoken and understood.
Population:	341,256 in July 2014 consisting of 173,172 males and 168,084 females. The average age of the population is 27.1 years. The urban population was 41.2% of the total population as of 2011.
Unemployment rate:	11.7% in 2010, calculated from the population 15 years and above.
Registered farmers at MoFA:	5000
Number of islands leased for agriculture:	30
Major atolls involved in Agriculture Production:	Laamu, Kaafu, Alif Alif, Haa. Dhaalu, Gnaviyani.

Climate

Maldives being a tropical country experiences a warm and humid climate throughout the year with an annual average temperature of 28 ^oC and annual mean rainfall is 2000mm. The weather of Maldives is dominated by two monsoons - North east monsoon (Iruvai moosun) occurs during December to March and Southwest monsoon (Hulhangu moosun) occurs during May to November. Highest rainfall is during Southwest monsoon and it is common to have strong wind throughout this season (Meteorology, 2006).

Soil

The soil generally consist of coral sand with varying amounts of organic matter at the top which is associated with the distance from the shore and height above the water table. Soil is generally poor in nutrient with extremely low water and nutrient capture capacity. Due to the low density and high porosity of primary aggregates (mostly of limestone and/or dolomite origin), high degrees of evaporation and erosion can be expected. Nutrients are quickly either evaporating into the atmosphere e.g., ammonia or leaching into the groundwater layer e.g., nitrates (UNEP 2005).

Atoll island soils are generally deficient in major plant nutrients essential for plant growth such as nitrogen, phosphorous and magnesium (Stone, Migvar and Robison 2000). This is also the case for all the soils of Maldives. These are relatively young top soils comprised of sand, various sizes of broken pieces of coral and varying quantities of humus. The soils are highly alkaline due to the excess of calcium from the basic coral rock, with an average pH of 8.5. In low lying areas the pH ranges from 7.7 while in swamp based areas the pH varies from 5.8 to 6.6 (Butany, 1974).

Water resources

Water is available as underground reserve of rain water or as above ground reserve in the form of ponds and lakes which may contain saline or non-saline water (Butany, 1974). There are often cases of salt water intrusion which leads to high salinity and which limits proper crop growth.

Agriculture in Maldives

The relatively small size of most islands limits the type and extent of natural vegetation and the plants and crops grown on them. The potential of agriculture in the Maldives is concentrated in 36 islands that are large enough to support commercial activity. Agriculture is important to a large sector of the population that is marginalized from the country's commercial fisheries and tourism industries.

Agriculture has provided crucial support to the livelihood of the Maldivian people over the centuries, despite the nutrient poor soils. Agriculture plays an important role as a source of income for the rural population of Maldives. It is carried out in mixed home gardens, settled rain-fed cropping fields, bush fallow shifting cultivation areas and year-round horticultural production fields across agricultural islands of Maldives.

Agricultural land in Maldives is 26.67% of the total land area last measured by the World Bank in 2009 (Table 62). Land holdings for agriculture are very much limited due to the geography of islands. Most farm lands are generally surrounded by swamps where taro and other crops are grown and also by coconut groves. The arable and permanent cropland accounts for only 10% of the total land area, which strongly limits the sustainable development, expansion and diversification of agriculture in the country also added to the fact that the soil is poor in nutrients.

Maldives does not have livestock (meat/ dairy) industry as such. Goats, rabbits and chickens are raised for meat production. Poultry diversification is a major policy by MoFA as a means of enhancing the livelihood security of the community. Chicken being the major poultry bird is grown in householder levels but farm level is limited due to size, feasibility and its commercial viability.

However, there is great potential for a growth in the sector’s productivity to supply the booming tourism markets. This may help stimulate intensification and improvement of farming systems as commercial enterprises in the future.

The communities still retain traditional subsistence characteristics due to the constraints that exist for these activities to expand into fully-fledged commercial activities. This pattern is more noticeable in the field of agriculture where there has been limited intervention in the form of programs that would help the subsector to become commercial. Agriculture is still a family activity. Size of the island physically limits agricultural production, typically resulting in low diversity of crops and food products, significantly increasing import dependence

MoFA has given a lot of emphasis to diversify agriculture and mainstream it into enterprises and have introduced various policies to address this. In 2014, a major policy in farmland registration has been conducted through which social protection services such as loan programs and agriculture related programs were subject to those farmers who register their farms in the MoFA. Likewise, Maldives is very much prone to climate change and natural disasters such as salt water intrusion, tsunamis, flooding etc, the government introduced crop insurance schemes to garner people’s interest that agriculture sector even though minor, have a lot of impact on the livelihood aspect of the peoples of Maldives.

Table 62: Main agricultural land-use types in Maldives (adapted)

Agricultural land-use type*	Scale of operation (land areas**)	Purpose of farming	Agricultural land-use	Remarks+
Mixed home gardens (backyard agriculture)	Small scale (approx. 90m^2)	Subsistence and some cash sales	**Perennials** (Coconuts, breadfruit, mango) **Annuals** (Brinjal, chillies, tomatoes etc.) + **Free-Range** Poultry keeping at times	Most common land-use on agricultural islands; almost 50% of farmers have a mixed home garden; low input use. Home garden land available varies between islands
Settled rain-fed cropping	Medium scale (approx 1000m^2)	Subsistence and some cash sales	Taro pits + Annuals like sweet potato, cassava + Cereals (sorghum, millets) at times	Common on larger agricultural islands; about 60% of farmers use this system, usually in addition to having mixed home gardens; low input use; dependent on rain and limited irrigation
Bush fallow shifting cultivation	Small scale (approx. 200m^2)	Subsistence and some cash sales	Taro pits + Annuals like sweet potato, cassava + Cereals (sorghum, millets) at times	Very much the traditional farming type and heavily dependent on rain; very few farmers practice this nowadays; very low input use
Year-round horticultural production	Medium to large- scale on agricultural islands (2,000m^2–10,000m^2) Large scale in Government leased out islands (approx. 150,000m^2 per farm)	Commercial	**Annuals** like bananas, chilies **Short term** vegetables + Sometimes **livestock** such as chicken and goats + **Specialized crops** like watermelon in commercial agricultural islands	New and widely accepted system of farming in the country; high input use; increasing numbers of farmers use this system; all Government leased out commercial horticultural islands use this system; also on crop specialized larger agricultural islands. All farms irrigated

Crop production

Traditionally, the agriculture sector in the Maldives has consisted largely of subsistence agriculture based on traditional crops including coconut, pumpkin, papaya, banana, chili, eggplant, leaf cabbage, taro, cassava and sweet potato. Generally the islands where subsistence farming is the mainstay are isolated and lack of proper transport facilities and marketing structure are the main reasons for advancing to commercial or semi-commercial stages of development. With the increase in transportation, farmers have been able to market their crops on other atolls. Most significant hereof is the capital Male', where the demands for food of a rapidly growing population provide a profitable opportunity for farmers in nearby atolls, in particular those on larger islands where the soil is better for cultivation. As such, crops now marketed in regional centers are mentioned in the Table 63.

Table 63: **List of food plants commonly grown in Maldives Islands**

- Banana
- Bean
- Betel leaf
- Betel Nut
- Cassava
- Chilli (bell pepper)
- Chilli (bird chilli, habenaro)
- Coconut
- Corn
- Cucumber
- Curry leaf
- Custard apple
- Eggplant
- Guava
- Gourds
- Jujube/ stone apple
- Leaf cabbages
- Leafy vegetables
- Lemon
- Lime
- Malay apple
- Mango
- Papaya
- Passion fruit
- Pond apple
- Pumpkin
- Rose apple
- Sapodilla
- Sour orange
- Spring onion
- Sweet lime
- Sweet potato
- Tamarind
- Taro
- Tomato
- Watermelon
- Wax apple

The islanders also have access to community forestland, where they can plant forest trees or tree crops (mango, breadfruit, coconut and other fruit trees) or practice intercropping with field crops.

The demand for fruits and vegetables for the domestic market varies seasonally (Table 64). While demand stays fairly constant throughout most of the year, it almost doubles during the month of Ramadan for some crops, such as watermelon, chilies and other fruits, which increase in importance during that time.

Table 64: Salt sensitivity of food plants grown in the Maldives

Salt Sensitivity	**Food Plants**
Highly sensitive plants (all individuals killed)	Banana, papaya, guava, mango, watermelon, chili, aubergine (brinjal), green peppers, and green leafy vegetables
Sensitive plants (most individuals killed or defoliated/ some recovery)	Breadfruit, Malay apple (janbu) (Syzygium malaccense Merr. and Perry), lime (Citrus aurantifolia Swingle)
Salt tolerant plants (most individuals survived or showed only mechanical damage)	Coconut, ahi (Morinda citrifolia), jam (Muntingia calabura L.), tamarind (Tamarindus indica), Natal plum (Carissa macrocarpa), tropical almond (Terminalia catappa)

The symptoms of salt damage (small or misshapen, yellowing leaves, marginal leaf burn, shoot dieback, poor seed germination) are similar to those of some nutrient deficiencies. Some farmers, therefore, may be tempted to apply fertilizers to encourage salt-damaged plants to recover. The toxic effects of excessive salt can, in fact, be compounded by the addition of soluble chemical fertilizers. Salt can only be removed from the plant root zone by frequent and heavy watering. (UNEP, 2005) observed that large agricultural fields suffered soil erosion.

A crude estimate, based on the reduction in the soil surface level around surviving structures, suggests that approximately 4 cm (out of an average of 15-20 cm) of topsoil was lost or covered. Home gardens were less vulnerable to soil loss due to the cover of woody perennials. It would appear that intensive horticulture is an intrinsically vulnerable production system in a flood-prone island (UNEP 2005).

The availability of freshwater resources is similar to atolls in the Pacific that is limited to groundwater. The groundwater table lies about 1.0 to 1.5 m below the ground level and is available in the form of a fresh water lens overlying brackish water at sea level. It is also extracted from wells dug in agricultural areas and used for irrigation of crops. On some islands (e.g., Thoddoo), it is extracted on a large scale with electrical pumps to irrigate crops such as watermelon, cucumber, pumpkin and egg plant which are grown intensively. In these areas, there may be a risk of over extraction of groundwater, which can lead to a breaking up of the groundwater lens and subsequent salination of the resource.

Traditional food security crop: TARO

Taro is a traditional crop that has been grown in the Maldives and has been considered a national cuisine. It is grown in organic conditions, as in that taro grown in Maldives do not use any form of chemicals for production. The Maldivian climate and the swamp in which they are grown are viable for its high production. However it is not able to sustain the demand. Added to the limited land scarcity for its growth, the cost of taro is higher and is difficult to obtain during monsoon times. It was the main staple food from ancient times and was able to sustain the island food security. Its production and the way of life associated with it are gradually being lost due to the scarcity of land and lack of people involved in its production. Organic amendments are the most that are used to maintain soil fertility. Neither do farmers apply fertilizer, although mulches are used, both for nutritional purposes and weed control (Jackson, 2008).

Most of the global taro production comes from developing countries, characterized by smallholder production systems relying on minimum external resource inputs. This makes this food crop very important for food security, especially among subsistence farmers in developing countries.

Marketing

There is limited data available on the agriculture production due to the remoteness and displacement of major agricultural islands. Currently, the market data is available from the Male' Local Market, which is the main market for local produce in the capital city of Male' (Table 65). The farmers are able to sell their produce in this market. However, if we are capturing this data, it is very minuscule compared to the production that has been estimated by market forecasts. We have yet to tap into the existing resort markets, which procure local produce from the agricultural islands, from the agriculture cooperatives and also, the island/ atoll markets.

Table 65: Male' Market Production (2010-12)

Atolls (North)	2012 (kg)	2011 (kg)	2010 (kg)
HA	222,871.00	213,410.00	105,753.00
HDH	27,005.00	93,298.64	-
SH	823,328.37	676,661.00	483,540.00
NO	68,818.00	70,965.00	1,795.00
RA	-	23,915.00	-
BA	375.00	28,354.00	-
LH	-	700.00	51,985.00
AA	1,215,906.00	3,467,000.00	2,605,493.00
ADH	506.00	19,826.00	-
KA	607,362.85	1,670,760.00	1,604,514.00
Total	**2,966,172.22**	**6,264,889.64**	**4,853,080.00**

Atolls (South)	2012 (kg)	2011 (kg)	2010 (kg)
Vaavu	-	-	-
Meeu	21,773.00	48,540.00	1,017.00
FA	-	6,346.00	-
DH	-	5,354.00	-
TH	120,951.00	296,725.00	11,252.00
LA	1,807,028.00	2,507,543.00	603,119.00
GA	5,939.00	64,367.00	12,229.00
GDH	23,070.00	135,974.00	21,695.00
GN	291,926.00	899,892.00	282,095.00
SE	148,989.00	592,362.00	570,467.00
Total	**2,419,676.00**	**4,557,103.00**	**1,501,874.00**

Agrochemicals

Like many other data, agro chemical usage data is also lacking, but based on imports it is evident that the use of agro chemicals has increased over the years.

Farmers need training on the use of fertilizers and other inputs to ensure quality products while maintaining environmentally friendly standards. Most farmers operate through trial and error and sometimes lose their crops due to wrong instructions given by retailers. Lack of access to farm inputs is also noticeable. Farmers often have to travel long distances to other islands to buy inputs mainly from the capital city male'. Increased field assessments that were conducted revealed little use of awareness of pest and disease control measures. However various programs have been conducted by MoFA on the limited use of pesticides and fertilizers on crop growth.

Fertilizers

The chemical pollution emissions from the agricultural sector in the country are currently unmonitored, but it is generally known that agrochemicals have the potential to pollute the environment through land, water or air. For instance, fertilizers used in the agricultural industry are known to release excess levels of nitrogen and phosphorous into the water and disturb aquatic habitats; and misapplication of fertilizers, herbicides, and pesticides can result in an aerial drift of these chemicals, causing harm. Agricultural soils can also release greenhouse gas emissions into the environment (NCMC 2015). Fertilizer use is heaviest in agricultural islands. The amounts of fertilizers consumed in each island are, however, not recorded.

The total amount of fertilizers imported to Maldives in 2014 was 9,680 tonnes. A major proportion of the imported fertilizers was represented by cow dung (6,950 tonnes), constituting 72% of the total fertilizer imports (NCMC 2015). The major exporters of fertilizers to the country in 2014 were India, Sri Lanka and Thailand.

The Maldivian agricultural sector receives most fertilizers from Sri Lanka and these accounts for approximately 95% of the total chemical fertilizer imports. The main products of import are compound fertilizers containing Nitrogen, Phosphorous and Potassium (N, P, K) compounds. The country also imports large amounts of straight nitrogen based and straight phosphatic fertilizers such as ammonium sulphate, urea, calcium nitrate, super phosphates, potash and potassium chloride.

Pesticides

Liquid pesticides were imported comparatively more than solid pesticides and the total amount of imports rose steadily after 2011. Pesticides imports into Maldives from 2010- 2014 were primarily from Singapore, Indonesia, Thailand and Australia. The main products of import were insecticides, herbicides, fungicides and rodenticides. Insecticides (at 92.6%) were the main type of pesticides imported to Maldives in the past five years. These primarily came 25% from Singapore, 24% from Indonesia and 22% from Thailand (NCMC, 2015).

Use of pesticides has also increased in the recent years due to outbreak of diseases and also due to the introduction of new pest and diseases. Regular uses of pesticides have caused resistance in pest population resulting in increasing in the dosage and frequency of application of pesticides.

Pesticides are a relatively cheap and effective way to limit economic losses to disease and pest attacks in agriculture and forestry. Most resorts and some island authorities spray insecticides to reduce the nuisance of mosquitoes. Much of the harm that is done by pesticides comes from their misuse rather than their use. Misuse includes unsafe storage, over-application and unsafe application methods (UNEP, 2005).

Conversion of conventional to organic farming

During recent years, a number of inter-related crises have caused concern, such as the so-called ‘global food crisis’ the financial crisis, and the climatic crisis (Varst, 2010). The attention has mostly been on trying to protect those most vulnerable to food insecurity, primarily by creating long term strategies to ensure food for increasing number of chronically hungry people (now estimated to be close to 1 billion), and to prevent crises for future generations.

Where the yield often drops when converting chemical farming systems to organic production (as is shown in Europe), several studies show that yields often more than double when converting from traditional farming systems or through consciously building up soil fertility using purely non-chemical methods.

Conventional farming puts its focus on achieving maximum yields of a specific crop. It is based on a rather simple understanding: crop yields are increased by nutrient inputs and they get reduced through pests, diseases and weeds, which therefore must be combated. Organic agriculture is a holistic way of farming:

besides production of goods of high quality, an important aim is the conservation of the natural resources fertile soil, clean water and rich biodiversity.

Organic agriculture is a production system that sustains health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than on the use of inputs with adverse effect. It has the potential to produce enough food on a global per capita basis to sustain the total human population without increasing the agricultural land base:

a. Organic systems are diverse and evaluated on the basis of total farm productivity. They produce more than just one single crop. Moreover, organic systems provide environmental services, for example in the form of nitrogen-fixing in plants, increased pollination and pest control, bringing cleaner water and increased biodiversity.

b. Organic Agriculture uses green manure (leguminous plants), compost, mulch, and seaweed for fertilization. It is estimated that nitrogen fixation from leguminous cover crops are sufficient to replace the global amount of synthetic fertilizer currently in use. Green manure can easily be applied by

c. Many studies have demonstrated the positive impact of OA on soil fertility, showing increase in soil organic matter and available nutrients. Increased soil fertility contributes in long term to higher and more stable yields.

d. Organic Agriculture systems have great resilience which is helpful as climatic conditions become more extreme. This again improves the stability of food access.

e. Organic systems rely on local ecosystems; they increase food availability and access exactly in those locations where poverty and hunger are more severe.

f. Organic Agriculture recognizes the value of traditional and indigenous knowledge (Dittrich, 2012).

Hazards of inorganic farming

With increase in cost of production inputs, inorganic fertilizers became increasingly expensive. Health hazards associated with intensive modern agriculture such as pesticide residues in food products and ground water contamination are a matter of concern. Such concerns and problems posed by modern day agriculture gave birth to new concepts in farming such as organic farming.

There has been an overall decline in public confidence in modern farming and processing methods and increasing consumer awareness of food borne hazards such as pesticides, antibiotics, hormones and artificial ingredients.

Nutrients in commercial fertilizers are highly soluble, so nutrient availability is quite predictable and nutrients are quickly available to plants.

Soil and crop management

Agro-ecological farming methods include, for instance, inter-cropping, mulching, use of compost, crop rotation and non-chemical pest and disease prevention (Varst, 2010). The diagram below summarizes a variety of different organic practices that are being used (Fig. 32).

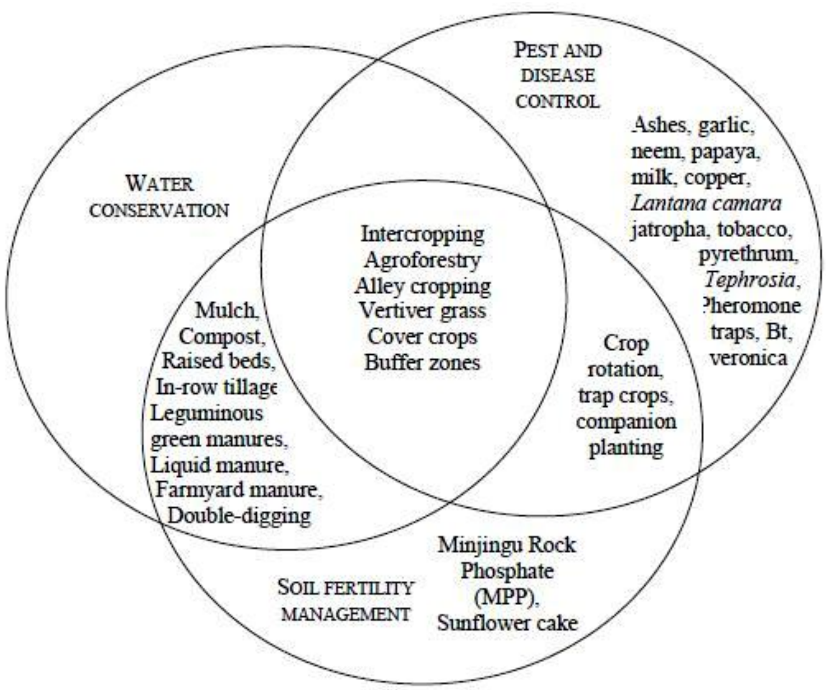

Fig. 32: Summary of a variety of different organic practices being practiced

Farm waste recycling, organic mulches

Organic mulches include many materials that can be produced on-farm such as hay, straw, and livestock or poultry bedding. Other materials, such as leaves, composted municipal wastes, bark, and wood chips, may be available from off-farm sources. Farmers must consider both the quantity and type of mulch to be applied, and the cost of the mulch and the equipment needed to manage it (Finney and Creamer, 2015).

Strategies to apply mulch

- Investigate locally available organic mulches. Municipalities will often deliver organic materials for free because it saves them landfill costs.
- Investigate ways in which mulches can be produced on farm.
- Have organic mulch materials analyzed for both nutrient concentration and potential contaminants such as heavy metals, especially those procured off farm.
- Consider growing vigorous summer cover crops, such as sorghum, sudan grass and pearl millet

Organic farmers give central importance to the maintenance and improvement of soil fertility. They stimulate the activity of soil organisms with organic manures and avoid harming them with chemical pesticides. Mulching and cover crops are used among other methods to prevent soil erosion.

Status of Organic Agriculture in Maldives

1. **Future of organic farming**

   It is unlikely that organic agriculture will play a significant role in Maldives in meeting the food production required due to limited land scarcity and limited amount of food production which is mainly limited to fruits and vegetables. Maldives fresh food market is heavily dependent on imported goods and the market spends millions of dollars for this. It is to supply to the resort markets and the local communities. The basic fruits and vegetable are purchased at a higher cost by the consumer as it has additional food miles to travel to Maldives.

However, there is scope in expanding the present productions which are organic by production like taro, mangoes, papaya, coconuts and few horticultural crops. Consumers are aware of agriculture inputs used in production and also in post-harvest management which has raised public concerns through various media outlets. The produce that is locally produced is still very much sought after rather than the seasonal foods that are imported.

2. Non- availability of farm inputs for organic farming

Agricultural production in the Maldives requires relatively high amounts of farm inputs to compensate for the relatively poor soil fertility. These inputs vary from fertilizer and manures to pesticides, seeds, farm materials, wire, tools and labour.

It requires awareness and willingness on the use of bio-fertilizers and bio-pesticides. Bio-fertilizers and bio pesticides are yet to become popular in the country. There is no demand or limited demand for them so retailers are not interested to bring in bio-fertilizers and bio-pesticides. Also the knowledge about the availability and usefulness of supplementary nutrients for certain crops are lacking among the farming communities. Farmers lack knowledge of compost making using the modern techniques and also its application. Very few communities have adopted the techniques of composting and its added benefits when it comes to agriculture. Also very few consumers are transferring from the high usage of fertilizers and other chemicals production. Major leased agricultural islands add high amounts of these chemicals to the already fragile soil in order to compensate for the limited nutrients in the soil so that yield will maximize and the produce will reach their desired markets, mainly the resorts.

Existing Programs/ Approaches to Promote Organic Agriculture

Composting program by MoFA

In 2015 a program under which to expand and establish a composting mechanism in selected islands has been carried forward. The island is selected on the basis of organic waste that is available and also the viability of its use by the farmers. The program will aid the community who are involved in composting the wastes such as fish waste, kitchen waste and green waste, as a means to be used as agriculture fertilizer. This is to make people aware of alternatives that can be used to enrich the soil that they use for cultivating the fruits and vegetables that is commonly found Maldives.

Currently, there are three islands that are practicing organic composting. That is A.D.H. Fenfushi, A.A. Ukulhas and Lh. Naifaru. The island of Fenfushi covers the whole island with their sale of the organic compost. The island of Ukulhas markets the composts to nearby resorts. The island of Naifaru uses their compost in vegetable production to supply to the local community. The major composting items in many of these islands are fish waste that is available in large quantities as Maldives is primarily a fishing community. There is a very high demand for organic compost and they are unable to meet this demand due to the limited amount of raw materials that they have and also due to the lack of know how.

The demand for organic compost has emerged due to the high price for fertilizers that they have to buy. As the chemicals are imported it is sold at a higher price and the procurement of fertilizers is difficult for some islanders so that they are opting for other means of plant nutrients through organic composting.

1. **Composting in Soneva**

   Typically 50% of waste is organic matter. For Soneva it is as high as 70%. For this reason handling organic waste is crucial. At Soneva Fushi, all food waste is composted using a force aeration method, which turns organic food and garden waste to nutritious soil that is reused in the herb and vegetable gardens.

2. **Food safety – GAP**

   GAP Standards are to be established in partnership with the Maldives Food and Drug Authority (MFDA). This is an initiative by the FAO. It is believed the introduction of GAP standards would prevent the excessive use of chemicals (fertilizers and pesticides).

3. **Resort markets**

   Most resorts import fruit and vegetables from countries in the region such as Dubai, India and Sri Lanka, because, among other reasons, supplies can be reliably delivered and quality assured. The resort market holds tremendous and, at present, under-realized potential for further development of the country's agriculture sector. Assistance would be needed to establish the techniques and transport modalities necessary for successful development of these markets. There already exist initiatives between the CSR and the island communities who supply locally grown vegetable to the resort markets. Resorts markets are a niche market, which we can tap into in order to take the organic produce way forward.

Challenges

Soils can play an important role in mitigating the diverse effects of climate change; poor soil management could worsen the effects of climate change (Ganpat 2014). Even without climate change, deteriorating soils are one of the main challenges to future of agriculture in Maldives.

Many farmers are not familiar with planned farming approaches to respond to market demand forecast, and assistance is required to help farmers realize the benefits that may increase with such planning to market demand.

Large taro patches traditionally owned by families are heavily underutilized and used for personal consumption, despite there being a robust market for taro in Male'. Coconut palms are widespread and not fully harvested by farmers, who often own more than hundred palms but fail to mention them as one of their crops. As a result of the lack of harvesting, yields tend to be very low. In a country where arable land is scarce, underutilization of land needs to be eliminated and yields improved, and where crops like taro fail to provide reasonable incomes, processing techniques and marketing mechanisms need to be introduced to make them commercially viable. One of the most apparent obstacles to achieve food security was the problem of food-import dependency (Marki, 2013).

To reduce food-import dependency we need to achieve the following measures:

1. Increase the production and variety of locally produced foodstuffs.
2. Develop "adequate marketing systems" in order for locally produced food to reach urban markets "regularly and in good condition".
3. Carefully integrate between programs "for this increased local production and the existing pattern of food importation and consumption".

The best organic farming strategy for Maldives would be involving integrated nutrient management (INM), integrated pest management (IPM) , enhanced input use efficiency and adoption of region specific and climate promising systems. To begin with OA can be practiced in crops where the country has comparative advantage such as papaya, chilli (*Githeyo mirus*) and banana and other tropical fruits and vegetables.

Organic farming can be practiced without synthetic pesticides but complete exclusion of fertilizers may not be advisable at the initial stage as the soil is nutrient poor to sustain production. Also the availability of organic manures in adequate amounts and at costs affordable by the farmers could be a major issue. Feasible technologies are needed for in-situ recycling or composting of on farm residues and other wastes that is highly available from the islands like fish waste. Green manure use can be practiced to an extent in big commercial lands.

The success of the organic agriculture in Maldives depends upon its ability to support its own domestic market, as it is the only source where local agriculture produce reaches the consumers. For example the domestic market demand often exceeds supplies of chilli which are inconsistent. National standards for organic farming for domestic markets need to be researched and put forward to decision makers. The success lies in the effective use of locally available organic materials which can act as an amendment to nutrient poor soils.

A niche foreign market for high-end consumers of quality products originating from exotic places like the Maldives could be a starting point as well.

Conclusion and Recommendations

Existing agriculture is primarily dependent on crops such as coconuts, bananas, papaya, mangoes etc. There is limited scope to increase the production from existing lands due to inadequate potential for expansion.

Maldives can start by organizing and keeping the farm, business, tourism and government in communication about organic production, facilitating dialogue and policies and initiatives that will help to develop organic agriculture and help change towards enhanced food security through sustainable organic production.

Things that can be facilitated	**Key needs by Policymakers**
1. Conduct a feasibility study on whether the prospect of organic agriculture in the Maldives' islands can be commercially viable in selected islands 2. Survey of organic producers, on the island, what is grown, how much is grown	1. Assessment of the harm caused by current practices on agro-ecological systems 2. Work with farmers to validate and adapt approaches to local ecosystems
3. Outreach to potential farmers , the media, government officials, businesses and other organizations	3. Decisions at national level about which production systems are unsustainable and which sustainable approaches are suitable for starting up
4. Identify and pursue sources of funds to support the organizations and its activities ; funding sources can include grants, government funding	4. Large-scale investment in agricultural research to find out what works, where it works and how to adapt it to local contexts
5. Survey of resorts (major market) about barriers of purchase 6. develop distinctive crop types for the foreign market (e.g. high quality papaya and chilli)	5. Preparation of plans for investment in appropriate policies and institutions, including farmers' organizations

Apart from regulations, plans and programs, government and especially its highest representatives play a big role in forming public opinion and in raising awareness of organic farming on all levels.

The challenge facing policymakers is to find effective ways to scale up sustainable approaches so that hundreds of millions of people today and tomorrow can benefit (IFAD 2012). For many, organic is about the substitution of agro-chemicals for natural products, e.g. instead of using a chemical pesticide, a plant extract is used; instead of chemical fertilizers, manures or compost are used. With that perspective, ensuring that there are appropriate inputs available for organic farmers or even supplying them to the farmers seem like good ways to promote organic farming.

It is important to link the organic development to general objectives for agriculture in the country. These can be issues such as: increased income to the agriculture sector; protection of environment, e.g. water; protection of biodiversity; strengthening the competitiveness of small-holders; promoting quality over quantity as a market strategy. Furthermore more importance needs to be given in support of increasing local food and also a more effective distribution and systematic planning are also necessary for balancing against the increased local production and to avoid food being wasted.

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Status and Future Prospect of Organic Agriculture for Safe Food Security in Nepal

Dinesh Babu Tiwari

Senior Plant Protection Officer, Department of Agriculture, Nepal
Email: dineshtiwari21@gmail.com

Summary

Organic agriculture is an eco-friendly farming practice. It began unscientifically but has adopted traditional scientific methods in its present form. The Science of organic farming has emerged as a combined study of soil fertility, plant protection, and other biological and environmental sciences. Organic agriculture limits the use of diverse practices including synthetic fertilizers, pesticides, growth regulators, genetically modified technology, sewage sludge and so on. Organic growers should focus on the production and use of good quality organic manure, bio-fertilizers, green manures, cover cropping and bio-pesticides while discouraging the indiscriminate use of inorganic fertilizers and pesticides. Organic agriculture movement is leading ahead based on the standards developed by IFOAM - as international umbrella organization and Codex as recognized standard setting body.

The world economy has changed profoundly over the last 50 years. The growing world economy has been accompanied by environmental degradation, including deforestation, losses in bio-diversity, global warming, air pollution, depletion of the ozone layer, overfishing and so on. With increasing health consciousness and concern for environment, organic farming system has been drawing attention all over the world. As a result, there is widespread organic movement and large demands for organic products. The main aim of organic agriculture is to ensure sustained productivity, environmental protection and making available food and food products raised without chemicals of any kind.

Agriculture system in Nepal is mostly "non-certified organic agriculture or products". Thus, it can capitalize rural natural resources which are sustainable in nature. Organic agriculture took momentum in Nepal during

1990s along with introduction of Integrated Pest Management (IPM) and Integrated Plant Nutrient Management System (IPNS) programmes. Currently, organic agriculture promotion policies are enacted and certification procedures are initiated by public and private sectors. Farmers healthy crop production scheme is in practice. Majority of agriculture in rural and remote village is still organic in nature. Urban population is increasing. Likely due to product safety and quality, demand for organic product is increasing. Regionalization and globalization is creating conducive environment for product marketing. Such circumstances show the greater scope of organic products in national, regional and global market. These show the greater prospect for organic agriculture in South Asia.

Nepal Country profile

Nepal is a land locked country situated between India and China. Geographically, it is divided into Mountain, Hill and Terai regions. The altitude varies from 60 m to 8848 m (the highest peak of the world) from MSL. Four great rivers flow transversely from north to south. The temperature, rainfall and the overall climate in Nepal vary from tropical to arctic. Despite of having diverse agro-ecosystem and plant species only a limited number of plant species are utilized. An estimate indicates the existence of 7000 flowering plants. Out of which 245 species are endemic. About 200 species are cultivated among 500 edible plant species available in the country (Tiwari, 2012).

About 65.6% active populations are engaged in agriculture and its contribution to GDP is 34% (MOAD, 2014). Adoption of improved technology is limited. Agricultural growth rate is low, erratic and clear indication of weather change and supply of agri-inputs. Average agriculture growth rate of last 5 years is 3.4% (MOAD, 2015). Still dominantly, the nature of agriculture is subsistence type where use of chemical fertilizers and pesticides is comparatively lower, instead farmers use own production inputs in rural Nepal. Crop production and consumption pattern which are described in ancient mythological texts are found organic in nature .The agriculture system which is followed in most part of the country especially in rural and remote area still are organic.

Nepal at a glance

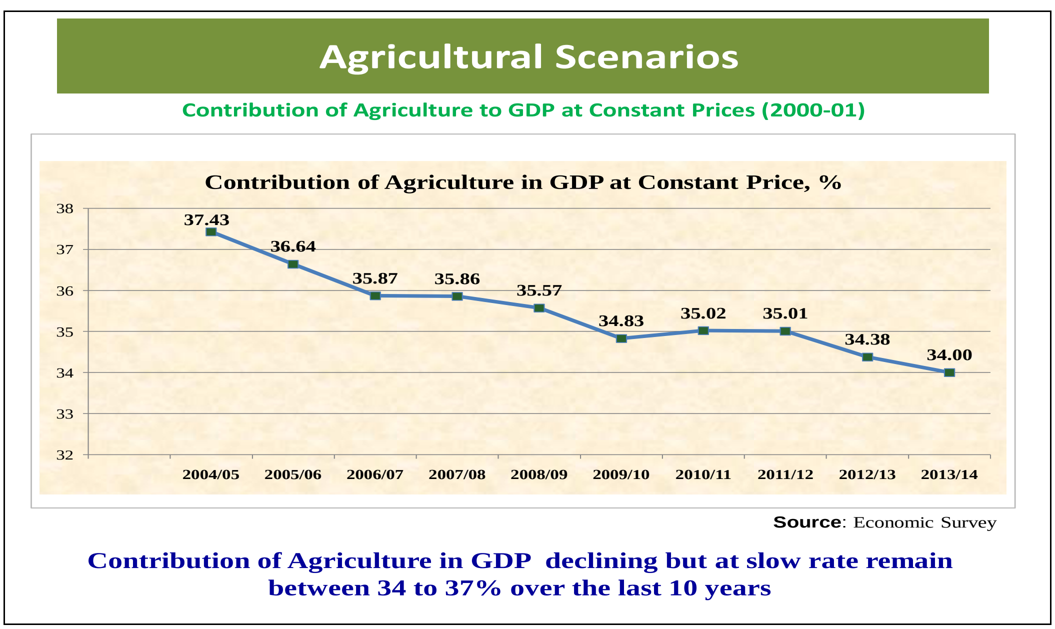
	Area (km^2)	Area (%)
Mountain	51817	35.21
Hill	61345	41.68
Terai	34019	23.11
Total Area	**147181**	

Source: CBS, 2012-13

Land Use Statistics

	Area (000 ha)	Area (%)
Agricultural Land Cultivated	3091	21.04%
Agricultural Land Uncultivated	1030	07.05%
Forest (including shrub 1560)	5828	39.87%
Grass Land and Pasture	1766	12.08%
Water	383	01.94%
Others	2620	17.92%

Source: CBS, 2012-13



Concept, brief history and strategic importance of organic farming

The term organic farming was introduced into common usage around 1940, following farming movements that had begun in the 1920s and 1930s promoting the concept of management of a farm as a living unit or whole system. During the period 1920s and the 1930s, Albert Howard in the United Kingdom, and based on his work in India, laid out the social and practical groundwork for the organic gardening movement (Barker, 2010). Until recently with the applications of legal restraints to organic farming, no universally accepted definition or identification of organic farming and gardening was developed. In some cases, terms such as naturally grown, wild, biologically grown, and ecologically grown were used to characterize organic production. Interpretation and application of these terms are often as difficult as defining organic.

An understanding of organic as this term is defined by different scientists is helpful in the definition of organic agriculture. To biologists, organic means existing in or derived from a living organism. For arguments, may be made about the levels of existence in an organism, about contamination, and about modifications that may occur after the death of an organism. In chemistry, organic refers to the study of carbon-containing compounds with exception of some compounds, such as carbonates, which are considered to be inorganic compounds. Combination of these two definitions into one may indicate that organic farmers and gardeners can work with carbon-containing materials obtained from living organisms. Limestone, largely calcium carbonate, is derived from living organisms and is an inorganic, calcium containing compound. Diatomaceous earth for insect control is mostly silica and is strictly inorganic in chemistry, but is derived from unicellular algae, which are living organisms. Rocks and minerals such as granite dust and green sand are considered to be organic fertilizers by some people, and these materials were never living and are essentially void of carbon (Barker, 2010).

Organic farming has been defined as crop or animal husbandry with natural materials, whether these are from living or nonliving matter. Naturally occurring is a restrictive term and does not permit the use of manufactured materials, even though they may be identical to the materials produced in nature. For example, urea from the fertilizer plant is chemically equivalent to urea from urine but urea is used as inorganic fertilizer and urine is considered organic. Wood ashes are organic materials, although they are not naturally occurring.

Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM, 2008).

International Federation of Organic Agriculture Movements (IFOAM) over 40 years leading, uniting and assisting the worldwide organic movement has occupied an unchallenged position as the only international umbrella organization of the organic world, i.e. all stakeholders contributing to the organic vision. This allows IFOAM to unite, lead and assist the organic movement - all IFOAM Affiliates - in its full diversity, while providing a common voice on relevant organic issues.

Codex definition - Organic Agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. 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 synthetic materials, to fulfill any specific function within the system" (FAO/WHO Codex Alimentarius Commission, 1999).

Apart from agricultural land, organic areas are for wild collection, aquaculture, forests and grazing areas on non-agricultural land. Asia is the largest continent in terms of population and area. Food security issues are very challenging in countries with large populations. Most governments in these countries promote policies to increase agricultural production of foods with less consideration of the quality and safety of foods. Environmental impacts are less considered.

Some facts about organic agriculture

1. **Consumer or market-driven organic agriculture:** Products are clearly identified through certification and labeling. Consumers take a conscious decision on how their food is produced, processed, handled and marketed. Therefore, the consumer has a strong influence over organic production.

2. **Service-driven organic agriculture:** In countries such as in the European Union (EU), subsidies for organic agriculture are available to generate environmental goods and services, such as reducing groundwater pollution or creating a more biologically diverse landscape.

3. **Farmer-driven organic agriculture:** Some farmers believe that conventional agriculture is unsustainable and have developed alternative modes of production to improve their family health, farm economies and/or self-reliance. In many developing countries, organic agriculture is adopted as a method to improve household food security or to achieve a reduction of input costs. Produce is not necessarily sold on the market or is sold without a price distinction as it is not certified. In developed countries, small farmers are increasingly developing direct channels to deliver non-certified organic produce to consumers. In the United States of America (USA), farmers marketing small quantities of organic products are formally exempt from certification.

4. The World Food Summit Plan of Action recognized the importance of "appropriate input technologies, farming techniques and other sustainable methods, such as organic farming, to assist farming operations to be profitable, with the goal of reducing environmental degradation, while creating financial resources within the farming operation."

5. Many developing countries have begun to export organic products successfully (e.g. tropical fruit to the European baby food industry, Zimbabwean herbs to South Africa, and six African nations export cotton to the European Community). Chinese farmers also produce organic food for export (e.g. tea to the Netherlands, soybeans to Japan).

6. Organic farmers rely on natural pest controls (e.g. biological control, plants with pest control properties)

7. While most certification programmes prohibit the use of sewage sludge and night-soil they are still used in some places. However, sludge may contain many contaminants including heavy metals which can have a deleterious and cumulative effect on the soil, while night-soil contains human pathogens and must be carefully composted before use.

8. Codex disallow genetically engineered organisms (GEOs), including transgenic crops, in organic production

9. Manuring - soil building crop rotations, pathogen problems associated with manure use,

10. IPNS, and IPM information to ensure that all such techniques are available to farmers

11. FAO-sponsored Farmer Field Schools in organic agriculture could evaluate, on a local basis, the contributions of organic production to food security through adaptive field trials.

12. A transition period is generally 3 years following the ending of applications of non-organic practices.

One of the greatest challenges facing mankind at the inception of the 21st century is how to accommodate a growing population and material aspirations in developed and developing countries without compromising the natural environment. This challenge is compounded by the vast difference in living standards in the world, and hence differences in immediate policy priorities. It is also compounded by the fact that many environmental problems are trans-boundary or global in nature, and hence beyond the control of any individual nation.

Thus, the concern of organic agriculture is seems towards soil health maintenance, ecosystem and bio-diversity conservation, sustainable production and ultimately the food security and food safety. Organic agriculture needs to demonstrate sufficient productivity, high quality and safety of the foods, and quantify environmental services and public goods provided. Organic agriculture movement is leading ahead based on the standards developed by IFOAM - as international umbrella organization, Codex as recognized standard setting body. Countries have developed their own national standards on organic production and certification to ensure the product safety and sustainable agriculture production.

Organic and inorganic area and types of organic and inorganic manure

It is estimated that by the end of 2013 about 43.1 million ha land is under organic agricultural management worldwide (FBiL & IFOAM 2015). Australia (17.2 million ha) has major growth of organic land since 2011. Argentina (3.2 million hectares) is second followed by USA (2.2 million hectares) in third rank. The top 10 countries with largest organic agricultural area share more than 70% of world organic agricultural land. Organic Agriculture has shares of 0.98% of total agricultural land. It has market size of $ 72 billion. The growth rate was recorded as more than 10% in most advanced market for organic products in 2013.

Area under Organic Agriculture

- OCEANIA : 17.3 m ha (40.2%)
- Europe : 11.5 m ha (26.0%)
- Latin America : 6.6 m ha (15.3%)
- Asia : 3.4 m ha (08.0%)
- North America : 3.0 m ha (07.1%)
- Africa : 1.2 m ha (2.8%)

Source: FiBL-IFOAM Survey, 2015

Organic Agriculture land in South Asia, by 2013

- Afghanistan : 61 ha (0.0002%)
- Bangladesh : 68,660 ha (0.1%)
- Bhutan : 6,726 ha (1.3%)
- India : 510,000 ha (0.3%)
- Nepal : 9,361 ha (0.2%)
- Pakistan : 22,397 ha (0.1%)
- Sri Lanka : 19,517 ha (0.7%)

Source: FiBL-IFOAM Survey, 2015

Global share of organic market

- Europe : 54%
- North America : 43%
- Others : 3%
    - Asia/Pacific : 2%
    - Oceania : 1%

Principles of Organic Agriculture

Followings are various principles developed by IFOAM:

1. Produce sufficient quantities of high-quality food, fiber and other products
2. Work compatibly with natural cycles and living systems through the soil, plants and animals in the entire production system
3. Maintain and increase long-term fertility and biological activity of soil using locally adopted cultural, biological, and mechanical methods – as opposed to relying on inputs
4. Maintain and encourage agricultural and natural biodiversity of the farm and its surroundings through the use of sustainable production systems and the protection of plant and wild life habitats
5. Maintain and conserve genetic diversity through attention to on-farm management of genetic resources
6. Promote the responsible use and conservation of water and all life and therein
7. Use as far as possible renewable resources in production and processing systems and avoid pollution and waste
8. Foster local and regional production and distribution
9. Create a harmonious balance between crop production and animal husbandry
10. Provide living conditions that allow animals to express the basic aspects of their innate behavior
11. Utilize biodegradable, recyclable and recycled packaging materials
12. Provide everyone involved in organic farming and processing with a quality of life that satisfies their basic needs, within a safe, secure and healthy working environment
13. Support the establishment of an entire production, processing and production chain that both socially just and ecologically responsible
14. Recognize the importance of, and protect and learn from, indigenous knowledge and farming systems

The principles are summarizes as:

1. The Principle of Health
2. The Ecological Principle
3. The Principle of Fairness
4. The Principle of Care

1. The Principle of Health

- Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.
- This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems -healthy soils produce healthy crops that foster the health of animals and people
- Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health.

2. Principle of Ecology

- Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.
- This principle roots Organic Agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment.

3. Principle of Fairness

- Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities
- Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

- This principle emphasizes that those involved in Organic Agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties -farmers, workers, processors, distributors, traders and consumers.

4. Principle of Care

- Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.
- Organic Agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of Organic Agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

Scope

- Increasing demand of the organic products in the national and international market
- Possibility of organic production
- Maintenance of soil productivity, biodiversity, Sustainability,

Objectives of Organic Agriculture

Followings are major objectives of organic agriculture (Satyam Organics Inc.).

- To produce sufficient quantities of high quality food, fiber and other products.
- To work compatibly with natural cycles and living systems through the soil, plants and animals in the entire production system.
- To recognize the wider social and ecological impact of, and within the organic production and processing system.
- To maintain and increase long-term fertility and biological activity of soils using locally adopted cultural, biological and mechanical methods as opposed to reliance on external inputs.

- To maintain and encourage agricultural and natural biodiversity on the farm and its surroundings through the use of sustainable production systems and the protection of plant and wildlife habitats.
- To maintain and conserve genetic diversity through attention to on-farm management of genetic resources.
- To use, as far as possible, renewable resources in production and processing systems and avoid pollution and waste.
- To foster local and regional production and distribution.
- To create a harmonious balance between crop production and animal husbandry.
- To provide living conditions those allow animals to express the basic aspects of their innate behaviour.
- To utilize biodegradable, recyclable and recycled packaging materials.
- To provide everyone involved in organic farming and processing with a quality of life that satisfies their basic needs, within a safe, secure and healthy working environment.
- To support the establishment of an entire production, processing and distribution chain which is both socially and ecologically responsible.
- To recognize the importance of, and protect and learn from, indigenous knowledge and traditional farming systems.

Components of organic farming

Major components of organic farming are crop rotation, maintenance and enhancement of soil fertility through biological nitrogen fixation, addition of organic manure and use of soil microorganisms, crop residues, bio-pesticide, biogas slurry, waste etc. Vermiculture has become a major component in biological farming, which is found to be effective in enhancing the soil fertility and producing large numbers of horticultural crops in a sustainable manner.

The various components of organic farming have been discussed in details below.

1. Crop rotation

It is a systematic arrangement for the growing of different crops in a more or less regular sequence on the same land covering a period of two years or more. The selection of optimal crop rotation is important for successful sustainable agriculture. Crop rotation is very important. Soil fertility management, weed, insect and disease control. Legumes are essential in any rotation and should 30 to 50 percent of the land. A mixed cropping, pasture and livestock system is desirable or even essential for the success of sustainable agriculture.

2. Crop Residue

There is a great potential for utilization of crop residues/ straw of some of the major cereals and pulses. About 50% of the crop residues are utilized as animal fed, the rest could be very well utilized for recycling of nutrients. Adequate care is required to use the residues after proper composting with efficient microbial inoculants. While the incorporation of crop residues (e.g. Wheat and Rice straw) as such or inoculated with fungal species had beneficial effects on crop yields and important in physico-chemical properties of soil.

3. Organic manure

The organic manure is derived from biological sources like plant, animal and human residues. Organic manure act in many ways in augmenting crop growth and soil productivity. The direct effect of organic manure relates to the uptake of humic substances or its decomposition products affecting favourably the growth and yield of plants. Indirectly, it augments the beneficial soil microorganisms and their activities and thus increases the availability of major and minor plant nutrients.

a. **Bulky organic manure:** It generally contains fewer amounts of plant nutrients as compared to concentrated organic manure. It includes FYM, compost and Green manure.

   - **FYM:** It refers to the well-decomposed mixture of dung, urine, farm litter and left over or used up materials from roughages or fodder fed to the cattle. The waste material of cattle shed consisting of dung and urine soaked in the refuse is collected and placed in trenches. Each trench is filled up to a height of about 0.5 m above the ground level and plastered over with slurry cow dung and earth. The material is allowed to decompose undisturbed 3-4 months for anaerobic microorganism for completion of fermentation. FYM becomes ready to apply after 3-4 months. Well-rotted FYM contains 0.5% N, 0.2% P205 and 0.5% K2O.

- **Compost:** Large quantities of waste material are available as vegetable refuse, farm litter, such as weeds, forest litter, stubble, crop residues, Sewage sludge and animal waste in houses and in areas like human and industrial refuse; therefore, excreta can be converted into useful compost manure by conserving and subjecting these to a controlled process of anaerobic decomposition. Compost is used in the same way as FYM and is good for application to all soils and all crops.

- **Green Manuring:** It is a practice of ploughing or turning into the soil under composed green plant tissues for the purpose of improving physical structure as well as fertility of the soil. From the time immemorial the turning in a green crop for improvement of the conditions of the soil has been a popular farming practice. Green Manuring, wherever feasible, is the principal supplementary means of adding organic matter to the soil. It consists of the growing of quick growing crop and ploughing it under to incorporate it into the soil. The green manure crop supplies organic matter as well as additional nitrogen, particularly if it is a legume crop, which has the ability to fix nitrogen from the air with the help of its root-nodule bacteria. A leguminous crop producing 25 tonnes of green matter per hectare will add about 60 to 90 kg of nitrogen when ploughed under. This amount would equal an application of 3 to 10 tonnes of FYM on the basis of organic matter and its nitrogen contribution. The green manure crops also exercise a protective action against erosion and leaching. The most commonly used green manuring crops are: **Sunhemp** (Crotalaria juncea), **Dhaincha** (Sesbania aculeata), **Cluster bean** (Cyanopsis tetragonoloba), **Senji** (Melilotus parviflora), **Cowpea** (Vigna catjang, Vigna sinensis), **Berseem** (Trifolium alexandrium).

b. Concentrated Organic Manure: Concentrated organic manures are those materials that are organic in nature and contain higher percentage of essential plant nutrients such as nitrogen, phosphorous and potash, as compared to bulky organic manures. These concentrated manures are made from raw materials of animal or plant origin. The concentrated organic manures commonly used are oilcakes, blood meal, fishmeal, meat meal and horn and hoof meal.

4. Waste

a. **Industrial waste:** Among the industrial by products, spent wash from ditilisers and molasses and press mud from sugar industry have good manurial value. It is important to use only well decomposed press mud at 10 tonnes ha^{-1}. Addition of press mud improves the soil fertility and enhances the activity of microbes. Coir waste is the by-product from coir industry and can be used as manure after proper decomposition.

b. **Municipal and Sewage waste:** It also forms an important component of organic waste. In India, the total municipal refuse is about 12 mt per annum containing about 0.5% N, 0.3% P_2O5 and 0.3% K_2O. Sewage sludge is available to an extent of 4 million tonnes per annum containing 3% N, 2% P and 0.3% K (Bharadwaj and Gaur, 1985). Sewage sludge particularly from industrialized cities is contaminated with heavy metals and these pose hazards to plants, animals and human beings. Separation of the toxic waste at the source will minimize the concentration of such elements in the sludge.

5. Bio-fertilizers

It has been observed that there is a decline in crop yield due to continuous application of inorganic fertilizers. Therefore, increasing need is being felt to integrate nutrient supply with organic sources to restore the health of soil. Bio-fertilizer offers an economically attractive and ecologically sound means of reducing external inputs and improving the quality and quantity of internal sources. Bio-fertilizer is microorganism's culture capable of fixing atmospheric nitrogen when suitable crops are inoculated with them. The main inputs are microorganisms, which are capable of mobilizing nutritive elements from non-usable form to usable form through biological process. These are less expensive, eco-friendly and sustainable. The beneficial microorganisms in the soil that are greater significance to horticultural situations are biological nitrogen fixers, phosphate solubilisers and mycorrhizal fungi.

Bio-fertilizers containing biological nitrogen fixing organism are of utmost important in agriculture in view of the following advantages.

- They help in establishment and growth of crop plants and trees.
- They enhance biomass production and grain yields by 10-20%.

- They are useful in sustainable agriculture.
- They are suitable organic farming.
- They play an important role in Agroforestry/ silvipastoral systems.

Types of Bio-fertilizers

There are two types of bio-fertilizers.

1. Symbiotic N-fixation
2. Asymbiotic N-fixation

- **Symbiotic N-fixation:** These are Rhizobium culture of various strains which multiply in roots of suitable legumes and fix nitrogen symbiotically. Almost 50% demands of N are met by these microorganisms in legumes.
  - **Rhizobium:** It is the most widely used bio-fertilizer, which colonizes the roots of specific legumes to form tumors like growths called rot nodules. It is these nodules that act as factories of ammonia production. The Rhizobium legume association can fix upto 100-300 kg N ha^{-1} in one crop season.

2. **Asymbiotic N-fixation:** This includes Azotobacter, Azospirillium, BGA, Azolla and Mycorrhizae, which also fixes atmospheric N in suitable soil medium. They grow on decomposing soil organic matter and produce nitrogen compounds for their own growth and development, besides that they leave behind a significant amount of N in surroundings.
   - **Azotobacter:** Application of Azotobactor has been found to increase the yields of wheat, rice, maize, pearl millet and sorghum by 0-30% over control. The beneficial effect of Azotobactor biofertilizers on cereals, millets, vegetables, cotton and sugarcane under both irrigated and rainfed field conditions have been substantiated and documented (Refering Pandey and Sushil Kumar, 1989, megapib.nic.in/org). Apart from nitrogen this organism is also capable of producing antibacterial and anti-fungal compounds, hormones and siderophores.
   - **Azospirillium:** It is an important bacterium, which colonize the root zones and fix nitrogen in loose association with plants. The crops which response to Azospirillum is maize, barley, oats, sorghum, pearl millet and

forage crop. Azospirillum applications increase gain productivity of cereals by 5-20%, of millets by 30% and of fodder by over 50%.

- **Blue Green Algae**: The utilization of blue-green algae as biofertilizers for rice is very promising. Recent researches have shown that algae also help to reduce soil alkalinity and this opens up possibilities for bio-reclamation of such inhospitable environments.
- **Azolla:** A small floating fern, Azolla is commonly seen in low land fields and in shallow fresh water bodies. This fern harbours blue-green algae, anabaena azollae. The Azolla anabaena association is a live floating nitrogen factory using energy from photosynthesis to fix atmospheric nitrogen amounting to 100-150 kg N^{-1} ha^{-1} $year^{-1}$ from about 40-64 tonnes of biomass (Referring Hamdi, 1982; Singh, 1988, megapib.nic.in/org).
- **Mycorrhizae:** Mycorrhizae are the symbiotic association of fungi with roots of Vascular plants. The main advantage of Mycorrhizae to the host plants lies in the extension of the penetration zone of the root fungus system in the soil, facilitating an increased phosphorous uptake. In many cases the Mycorrhizae have been shown to markedly improve the growth of plants. In India, the beneficial effects of Vascular-arbuscular Mycorrhizae (VAM) have been observed in fruit crops like citrus, papaya and litchi. Recent studies showed the possibility of domesticating Mycorrhizae in agricultural system (Referring Hayman, 1982; Tilak, 1987, megapib.nic.in/org).

6. Bio-pesticide

Bio-pesticides are natural plant products that belong to the so-called secondary metabolites, which include thousands of alkaloids, terpenoids, phenolics and minor secondary chemicals. These substances have usually no known function in photosynthesis, growth or other basic aspects of plant physiology; however, their biological activity against insects, nematodes, fungi and other organisms is well documented.

Botanical insecticides are ecologically and environmentally safer generally affect the behaviour and physiology of insects rather than killing them. Among the botanical pesticides investigated. Neem (Azadirachta indica) has justifiably received the maximum attention. All parts of the Neem tree possess insecticidal property but seed kernel is most active.

Biopesticides and other preparations of plant origin used in agriculture seem to have a good scope especially in view of the environmental problems being faced with the synthetic agrochemical. Some of the commonly used botanical Insecticides are Nicotine, Pyrethrum, Rotenone, Subabilla, Ryanin, Quassia, Margosa, Acorus etc. Their used need to be promoted under the Integrated Pest management Programmes.

7. Vermicompost

It is organic manure produced by the activity of earthworms. It is a method of making compost with the use of earthworms that generally live in soil, eat biomass and excrete it in digested form. It is generally estimated that 1800 worms which is an ideal population for one sq. meter can feed on 80 tonnes of humus per year. These are rich in macro and micronutrients, vitamins, growth hormones and immobilized microflora. The average nutrient content of vermicompost is much higher than that of FYM. It contains 1.60% N, 5.04% P_2O and 0.80% K_2O with small quantities of micronutrients. Application of vermicompost facilitates easy availability of essential plant nutrients to crop.

Conclusion

A large fraction of farm by-products of plant and animal origin is utilized for non-farm use i. e. for fuel or other domestic purposes. Small and scattered lands holding of the large farming community compel them to leave the crop residue in the farm itself rather than recycle it for recycling. Lack of location specific technology to recycle organic waste and lack of awareness to recycle organic waste in agriculture are the main reason for its slow adoption even though is a native technique for the farmers which got lost during the period of Green Revolution. So, in order to popularize this eco-friendly farming practices like organic farming we have to give attention to strengthen the production of good quality organic manure, bio-pesticides, biofertilizers and green manuring crops, discourage the indiscriminate use of inorganic fertilizers and pesticides, development of pesticides of plant origin (such as Neem) and use of agents especially under integrated Pest Management system as well as steps to reduce hazardous chemical residues in seeds, fodder, food products and milk.

Country status of agriculture today including pesticides and fertilizers (Organic, inorganic, cultivation system, adoption of their environmental conditions) used

Nepal is an agricultural country. The nature of farming is mostly subsistence type. Family farming, local resource used, consumption of local produce are the major characteristics of Nepalese farming. By default these are the features of organic farming prevailing since very beginning. Food safety issues are getting due importance since the decades of nineties. Agriculture perspective Plan (APP) – a twenty years (1995-2015) visionary plan has given emphasis to food security and food safety. The APP stressed to increase production and increased used of agricultural input including chemical fertilizer. However it has stated the integrated pest management (IPM) as a national strategy in pest management. Recently endorsed Agriculture Development Strategy (ADS) – a twenty years strategic plan of the Government of Nepal has stressed on environment protection, biodiversity conservation and sustainability of agriculture (ADS, 2014). ADS also emphasized the green technology, food and nutrition security and food safety as well. ADS vision towards agricultural quality and safety systems are based on standards of best practice (GAP, GVP, GMP) operating procedures, internal control systems and product traceability. This is supportive to promotion of modern organic agriculture as guided by IFOAM and Codex.

Organic Agriculture promotion initiatives have been taken by governmental (Deparment of Agriculture, Nepal Academy for Science and Technology, Nepal Agricultural Research Council, Institute of Agriculture and Animal Science, Tea and Coffee Development board, Kathmandu Metropolitan Corporation), Non-governmental (I/NGOs – SSMP, Winrock international, ECOCENTER, Nepal Permaculture group, SECARD, HOPTA, AEC) and private sector as well.

Organic agriculture is addressed in policies of Government of Nepal and supportive programmes are initiated. The Gender Equity and Environment Division of Ministry of Agricultural Development is the state apex body responsible to coordinate the environmental aspects of agriculture including organic farming of the country. In the world the practice of agriculture promotion is seen by using hi-tech, developing costlier infrastructure, providing government subsidy, in contrast nature has gifted Nepal with diverse climatic variation and better environment for sustainable agriculture. In Nepal more than 80% of farming by default is organic in nature (Pokhrel and Pant, 2008).

Government Policies Related to Organic Agriculture Promotion in Nepal

1. National Agriculture Policy 2004 – Organic agriculture will be promoted. Support to the organic product exporter in certification.
2. Agriculture Enterprises Promotion Policy 2006 – Based on the market demand special pocket area for Organic production will be identified
3. Poultry Policy 2012 - Based on geographical area climate suitable organic production will be promoted.
4. Directives on National Technical Standards for organic agriculture production and processing system 2007
5. Organic fertilizer subsidy directives 2011
6. Working Procedures for National Organic Agriculture Accreditation Body 2012
7. Directives for Internal Control System for collective certification of organic agriculture production 2012
8. Guidelines for Participatory Certification of organic agriculture production 2012
9. Working procedures for organic production certification fees subsidy 2012

Directives on national technical standards for organic agriculture production and processing system, 2007:

Major contents of the directives

A. Points to be considered while producing and processing organic products :

a. Co-existance

b. Appropriate processing

c. Environment protection and pollution minimization

d. Labour and social welfare

e. Appropriate distance - Buffer zone

B. Standards of organic Agriculture: The directive has specified the conditions in the following subjects.

a. Land

b. Conversion period

c. Crop Production

d. Soil, water and manure/ fertilizer

e. Plant protection measures

f. Product/ seed storage

g. Livestock

h. Fish culture

i. Apiculture

j. Processing, packaging, storage and conservation

k. Social right and fair trade

l. Miscellaneous

C. Structure for organic certification

a. Organic Agriculture National Coordination Committee under the chairmanship of Secretary Ministry of Agricultural Development (MOAD) which has 17 members from concerned institutions.

b. Technical inspector

c. Nine members National Accreditation body

d. National organic technical committee

e. Certification process

f. Certification logo

g. Appendix

h. Materials allowed for seed and seedlings treatments

i. Materials to be used for soil fertility increased

j. Plant protection materials

k. Veterinary drugs

l. Designated structure

Working procedures for national organic agriculture accreditation body, 2012:

Major coverage

A. Scope of organic accreditation

a. Agricultural products

b. Livestock products

c. Honeybee products

d. Fish and aqua products

e. Organic manure and pesticides production

f. Herbs and forest products

g. Floriculture products

h. Processed products of the above

B. Process of accreditation

a. Accreditation fees for National accreditation body Rs 1000.

b. Accreditation fees for International level accreditation body Rs 10000.

c. Monitoring and evaluation

d. Accreditation

e. Suspension and deregistration

f. Provision of penalties

C. National Organic Agriculture Accreditation Body

a. Under the chairmanship of Executive Director of Nepal Agricultural Research Council - 10 members committee

Directives on participatory quality assurance system of organic agriculture 2012:

Major Provisions

A. Participatory Quality Assurance System

B. Measures and Recognition procedures

C. Coordination with internal control system

D. Stakeholders

E. Working procedures for participatory quality assurance system

   a. Principles and values

   b. Written documents on management system

   c. Producers code of conduct verification procedures

   d. Structures for assisting producers

   e. Logo of certification

   f. Evaluation process

   g. Fees

Directives on internal control system (ics) for collective certification of organic agriculture production, 2012:

Major Provision

A. Institutional structure and responsibility

B. Scope and activities of Internal Control System (ICS)

   a. ICS running procedures

   b. ICS structures and work division

   c. Internal standards

   d. Internal inspection

   e. Control at farm

   f. Approval procedure

   g. Risk management

h. Capacity development of concerned officials

i. Record management

C. Farm management and approval procedures

D. External inspection and certification

E. Penalties

F. Appeal

G. Directive amendment

Working procedures for organic production certification fees subsidy, 2012: Major Provision

A. Specially focused on export oriented organic production

B. Selection of exporter

C. Basis for providing certification fees subsidy

a. Subsidy is provided only in certification fees

b. Ist year cent percent, second year 75%, from 3rd year onward 50% subsidy on certification fees

D. Based on budget allocation support on training, format printing and external inspection will be provided

E. A nine member Organic Certification fees subsidy direction committee under the chairmanship of Director General - Department of Agriculture

Organic Agriculture Promotion Programme in the year 2014-15

1. Interest subsidy for export promotion of organic products
2. Subsidy in organic certification fees, including expenditure for internal control system of organic products
3. Procedure development for internal control system for organic tea
4. support to stall management for the promotion of organic agriculture in international fair
5. Support to organize national fair of organic products

6. Interaction, training on organic agriculture
7. Recognition of the National and International Organic Certification agencies by the National Organic Certification Accreditation body

Production program including organic agriculture in the current fiscal year (2015-16) program

1. Organic agriculture promotional activities in budget speech of GON
2. In the 5 development regions of the country infrastructure development work in entrepreneurs participation will be made to produce Bio-fertilizers and bio-pesticides
3. To develop the export oriented organic agriculture industry at least 100 farms will be identified. The work is performed in public-private, public-cooperative participation. Where about 200 million rupees is disbursed for this activities.
4. 10 crore NR is disbursed for subsidy to Organic fertilizer - at least for 10000 mt.
5. Microbial production and distribution of beneficial microbes (Trichoderma viridie and Azotobacter etc.).

Organic certification work at National Level

1. Establishment of Organic Certification Nepal (OCN), Member of Certification Alliance
2. Organic Association of Nepal (ORGAN): Coordination of organic stakeholders in Nepal link with regional and international organic movement

Organic certifying agencies in Nepal

1. One cert - America
2. IMO – Switzerlands
3. NASAA – Australia
4. Control Union – The Netherlands
5. Cert All (ACT- Thailand, OCN – Nepal, ICEA-Italy, Bio cert-Indonesia, OCCP – Phillipines, OFDC – China, Sri cert – ShreeLanka, OAM – Malyasia, HOKSALIM –S. Korea, PROFILL – Laos, Vietnam)

Some of the organic certified products and their export from Nepal

S. No.	Company	Product	Market
1.	Kanchanjungha Tea Estate	Large Cardamom, Tea, Ginger, Lemongrass, Cinnamon	USA, JAPAN, Germany, Austria
2.	Guranse Tea Estate	Tea	Japan, Germany, USA
3.	Sambala Herbal	Essential Oil	Germany
4.	Cooperative Union, Gulmi	Coffee	Japan, S. Korea.
5.	Natural Resource Industry	Essential Oil	
6.	Annapurna Organic	Coffee, Spices Honey	Japan , Canada
7.	Male Fashion	Essential Oil	Belgium
8.	HCPCL	Coffee	USA, Korea
9.	One World	Herbs	Europe
10.	Royal Everest Coffee Mills	Coffee	Japan, Europe
11.	Nepal Organic Coffee Products	Coffee	Nattional market
12.	CCUL, Lalitpur.	Coffee, Spices Honey	S. Korea, Germany
13.	CCUL, , Sindhu	Coffee	S. Korea, Japan
14.	Seven cooperatives in Jumla	Apple	KTM, Nepalgunj
15.	Sobogaard, Nepal	All products of Farm	

Chemical fertilizer consumption and government support in Nepal

The hills and mountain region, due to sloppy geography of land, are vulnerable to erosion. At present, farmers used 2.5–3 mt ha^{-1} organic manure for soil fertility management. National average use of chemical fertilizer is 30 kg ha^{-1} (Soil Management Directorate, 2013). Fertilizer used rate in Nepal is lower than the neighboring countries. ADS targeted to make double the present used rate of organic manure within the period of five years to increase soil fertility status (ADS, 2014). As of APP, the ADS also emphasized to increase chemical fertilizer used to increase the production. Chemical fertilizer demand in Nepal is supplied by importation. The provision of Government subsidy in chemical fertilizer is prevalent. For the fiscal year 2015-16 budget allocation for subsidy in 3, 00,000 mt chemical fertilizers is made (MOAD, 2015). This subsidy amount is about 40% of international price including transportation cost. Support to organic fertilizer company establishment and 50% subsidy package in organic fertilizer used. In addition provision for capital subsidy to fertilizer companies is made.

Chemical fertilizer use status

Year	Consumption (mt)
2008-09	81845
2009-10	110031
2010-11	144813
2011-12	176963
2012-13	231561
2013-14	298676

Source: MOAD, 2015 (unpublished data)

Pesticides use

Pesticide Act, 1991 and pesticide Regulation, 1993 are enacted for pesticide management. Government of Nepal has adopted the integrated pest management (IPM) as major plant protection strategy. Farmers are encouraged to search for alternative to chemical pesticides. The average use of chemical pesticides in Nepal is 396 g a.i. per ha (PPD, 2014). Rapid Bioassay for Pesticides Residues (RBPR) testing is initiated to ensure the food safety. Farmers Field School (FFS) approach is practiced to teach the farmers in pest management. Course curricula for different field crops, vegetable crops and fruit crops are developed. Government has given priority to produce and used the bio and botanical pesticides. Locally available botanicals are used in pest management since very beginning. It is estimated that over 300 spp of plants with pesticidal properties are available in Nepal. National IPM programme has tested and practice the used and promotion of bio and botanical pesticides through FFS (PPD, 2014).

Food safety programme initiated by National IPM Programme Nepal

National IPM programme is introduced as a major plant protection strategy in Nepal. It has started FFS approach for training farmers since 1997. Farmers trained from season long FFS are organized and mobilized in healthy crop production scheme. Where the trained farmers are registered, and inspire to produce healthy crops. The concept unlike truthful labeling is practiced in the scheme. Farmers healthy crop production green book is developed. The producer farmers whatever the inputs they used in the course of production are recorded in the green book. It is verified by designated technicians. The products are marketed in the outlet with the green book. It provides the basis for traceability and confidence over the products quality. Farmer's healthy crop production guidelines for 13 crops are developed. Trained farmers, production guidelines and farmers green book are found effective to ensure food safety.

Pesticide use trend in Nepal (tonne a.i)

Pesticides	**Year**				
	2012-13	**2011-12**	**2010-11**	**2009-10**	**2008-09**
Insecticides	138	114.72	96.12	61.62	105.81
Fungicides	163	166.81	183.89	129.57	203.39
Herbicides	100	53.48	46.69	15.68	11.12
Others	9	10.02	8.97	4.21	36.02
Total	410	345.03	335.67	211.08	356.34

Source: Pesticides Registration and Management Division, 2014

Hazardous effects of inorganic farming

Indiscriminate use of chemical pesticides actually after World War II leads to detrimental effects in life and environment as well. Unlike chemical pesticides injudious used of chemical fertilizers degrade the soil health. Low organic matter average 1% in Nepal (ADS, 2014), increased soil acidity are the major problem in Nepal. Adverse effect of pesticides – Residues, Resistance and Resurgence and pesticides poisoning and several accidents are encountered. A train from Panjab to Rajasthan is also known as Cancer train (Satyamewa Jayete, 2012). Such incidents seek alternatives to inorganic farming.

Soil fertility and fertilization

Soil fertility refers to the ability of soil to supply nutrients to the crop. The ability to supply nutrients is affected by their amounts in the soil and is also governed by several other chemical, physical and biological properties. Soil acidity is chemical factor of soil fertility which affects solubility or availability of plant nutrients and other chemical elements that affect the ability of plants to grow in soils. Physical factors include soil depth, water-holding capacity, drainage, aeration, tilth, temperature and nutrient-holding capacity. Biological factors include the presence of harmful organisms such as microorganisms that carry out mineralization of organic matter and nitrification of ammonium and that live in symbiosis with plants.

Soils do not have an unlimited capability to supply essential elements to crops. Therefore, fertilization is necessary to supply materials from outside to carry plant nutrients to soils. Organic fertilizers are naturally occurring materials of biological or mineral origin and are low in nutrient concentrations or solubility or have both properties. Organic fertilizers may be altered physically in processing for agricultural uses but chemical processing does not occur.

Common practices of organic fertilization include:

1. Green Manuring
2. Composting
3. Farm yard manure (FYM) used
4. Using slurry
5. Mulching
6. Used of vermicompost

Weaknesses

1. Production comparison with non-organic technology - Unit productivity of organic product is lower than the non-organic. So it is not possible to feed the growing population by organic agriculture.
2. Large and commercial agriculture is not possible with OA- inadequate/ low technology development

3. Organic production is not cost effective
4. No price discrimination over organic and non-organic products
5. Quality assurance
6. Market assurance for organic products

Positive and negative effects of organic fertilizers in agriculture

A. Advantages of organic fertilizers

1. Organic fertilizers commonly are mild, noncaustic materials, and if they can come in contact with a crop, the fertilizers likely will not burn or desiccate foliage or roots.
2. The slow release of nutrients makes them available for a longer period of time than water soluble chemical fertilizers, which may be leached with the downward movement of water
3. Use of organic fertilizers with high organic matter contents can improve the physical properties of soils in ways such as imparting higher water-holding capacity and better structure and good tilth or physical condition of soil for crop growth. Some of the organic matter of fertilizers is converted to humus in soil by a process known as huminification.
4. Organic materials are sources of many essential elements.
5. The use of organic fertilizers, such as composts, is a method of recycling materials that might otherwise be waste.

B. Disadvantages of organic fertilizers

1. Organic fertilizers that contain low concentrations of nutrients must be obtained and applied in large quantities to deliver sufficient nutrients to grow a crop. The materials may be bulky and difficult to apply to the soil.
2. Because of their slow release of nutrients, some organic fertilizers may not supply nutrients sufficiently rapidly or in large enough amounts to support the demands of a crop. The release rate may be too slow to provide nutrients to a crop that has been diagnosed as being nutrient-deficient. Poor solubility of the fertilizers may limit dispersion of the nutrients in the soil.

3. Although they may contain a multitude of elements, the concentration of nutrients in organic fertilizers may be too low to be of value to a crop. The supply of nutrients may not be balanced to meet the needs of crops. Good sources of organic fertilizers for P and K are scarce.
4. Even if they are raised on the farm, organic fertilizers usually more expensive than chemical fertilizers, with the exception the some of the slow-release chemical fertilizers may cost as much as organic fertilizers.

Conversion of conventional to organic farming

National Organic Programme in USA establishes transition periods for movement from conventional farming into organic farming for three years. Buffer zones must exist. In Nepal, the certifying agencies regularly inspect the field and for the first year of cultivation no certification is provided. From the second and third year, the agencies may provide organic certification if the product meet the given standards, where as in case of product from over three years of fallow land or forest products or honey bee products or animal products the conversion period is counted from the date of proposal approval (National Organic Agriculture Accreditation procedure, 2012).

These products have been certified as organic products by organic certification Nepal.

- Apple from Jumla
- Honey from Dadeldhura
- Coffee bean from Kaski and Palpa
- Rice from Chitwan
- Vegetables from Kathmandu
- Lentil from Rasuwa
- Tea from eastern part

Positive and Negative Effect of Organic Agriculture (as referred by Niggli *et al*., 2014)

A. Strengths

1. Multi-functionality - the most characteristic feature of organic agriculture produces both commodity and non-commodity outputs and addresses ethical

concerns like animal welfare and the livelihoods of farmers and farm workers (fair trade).

2. Bio-diversity on organic farms - Comparative biodiversity assessments on organic and conventional farms reveal 30 percent higher species diversity and a 50 percent greater abundance of flora and fauna in organic fields (Refering different scientists Urs Niggli et al 2014).

3. Lower negative environmental impacts: The high dependence of conventional farming on chemical fertilizers, herbicides, and pesticides has caused considerable environmental damage.

4. Stable soils – Less prone to erosion - Fertile soils with stable physical properties have become the top priority of sustainable agriculture.

5. Carbon sequestration: Organic farmers use different techniques for building soil fertility. The most effective ones are fertilization by animal manure, by composted harvest residues, and by leguminous plants as main and intermediate crops. Introducing grass and clover leys as feedstuff for ruminants into the rotation and diversifying the crop sequences, as well as reducing ploughing depth and frequency, also augment soil fertility. All these techniques increase carbon sequestration rates on organic fields.

6. Good nitrogen use efficiency Crop productivity has increased substantially through the use of heavy inputs of soluble fertilizers - mainly nitrogen - and synthetic pesticides. However, according to a meta-analysis in the United States (Erisman et al. 2008), only 17 percent of the 100 tonnes of industrial nitrogen annually applied on conventional farms is taken up by crops; the remainder is lost to the environment.

7. Adaptation to climate change As a result of climate change, agricultural production is expected to face less predictable weather conditions than those experienced during the last century.

B. Weaknesses

1. Yield gap

The fast-growing human population gives rise to the crucial question as to whether organic farming could feed the world. Two recently published scientific meta-analyses shed light on this important aspect: the overall yields of organic crops are estimated to be 25 percent (Seufert et al. 2012) lower than conventional ones, based on 316 comparisons, and 20 percent lower, based on 362 compare (referring De Ponti et al. 2012, Urs Niggli et al 2014).

2. Social, animal welfare and quality gaps

Organic production in developing and emerging countries is driven by the demand of the fast growing markets in Europe, United States and Asia. Therefore, exports prevail and domestic markets and self-supply are neglected.

3. Research gaps

Globally, US$ 49 billion is annually spent for food and farming research (Urs Niggli et al 2014). The research spending for knowledge, techniques, and tools that are highly specific to, and in compliance with, organic standards is probably far less than one percent of private and public Research and Development (R&D) budgets (Referring various writers Urs Niggli *et al* 2014).

Professional institutions with a capacity to assist farmers throughout the production, post-production and marketing processes are non-existent in many developing countries.

C. Opportunities

1. Reducing trade-offs between productivity and sustainability
2. Sufficiency in times of limited resources
3. Improved multi-actor cooperation
4. Active participation of farmers in co-innovation needed

D. Threats

Organic agriculture is still a niche production with globally only 0.9 percent of farm land under a certification system. However, many more farmers are organic by default and the agroecological farming movement, especially in Latin America and also in Europe with High Nature Value (HNV) farms, is much bigger. However, the organic sector is currently challenged to break out of its niche status. Already since 2009, the global area under organic certification has stagnated at 37 million hectares and constant growth rates have been noted only in

Europe (Willer and Lernoud 2014, Urs Niggli *et al* 2014). Currently, the markets for organic foods grow mainly in Europe and in the United States, and to a lesser extend also in the fast growing privileged classes of emerging and developing countries.

Scope of organic agriculture, future prospects and suggestions

Urban vs Rural Agriculture

Urban Agriculture (UA) is defined as agricultural (including livestock) production, processing, and distribution activities within and around cities and towns, whose main motivation is personal consumption and/or income generation, and which compete for scarce urban resources of land, water, energy, and labour that are in demand for other urban activities. UA includes small- and large-scale activities in horticulture, livestock keeping, fodder and milk production, aquaculture, and forestry - where several activities may be carried out within one enterprise (Urban Harvest).

Urban population is increasing in all the urban areas of Nepal. More satellite towns are established and older cities are getting more crowded. Within the period of 1960 to 2013 urban population is increased from 3.48 % to 17.88% (CBS, 2013). Traditional agricultural systems are changing. Farming in or around urban and peri urban areas is getting more sophisticated and focused. The urban and peri urban agriculture (UPA) covers a wide range of activities resulting in production, processing, preservation, marketing and consumption of food. People concern over food safety is increased. A market survey on organic products reveals that organic consumers are willing to pay 10-20% of more price to the organic products over inorganic if they are authenticated (Bhatta *et. al*., 2008). Together with this opportunities for capital transfer from urban to rural area is increased. In such circumstances organic agriculture provides a better prospects income generation and quality life.

Future prospectives for Nepal

- Food security at local level
- Traditional knowledge on organic management
- In hills and remote areas and non-commercial farmers do not used chemical farming

- Small farmers opportunity to export market
- Eco-tourism
- Crop diversification and local employment
- Democratic cooperatives
- Institutionalization of standards, harmonization, mutual recognition, research and studies at farmers level
- Supportive government policies
- Involvement of private sectors

Suggestions

- Make organic agriculture competitive
- Emphasize in selection of local potential varieties and breeds and their domestication
- Invest in research and development
- Organization-wide, cross-sectoral programme in organic agriculture is needed.
- Conserve and explore traditional technologies
- Consolidation of the scattered work on organic agriculture
- Increase linkage and coordination among stakeholders
- Promote compost manuring, green manuring, biological farming, cattle shade improvement, urine used
- Subsidy package for organic production
- Tie up the OA promotion programme with community health programme. (till now it is thinking only the programme of MOAD)
- Separate Organic Agriculture unit in MOAD Structure
- Strengthen internal quality control system of organic input
- Establish market outlet for organic products

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Status and Future Prospect of Organic Agriculture for Safe Food Security in Pakistan

Muhammad Riaz Chattha[1] and Muhammad Musa[2]

[1] Director (NIOA), National Agricultural Research Centre, Islamabad, Pakistan
Email: riaznarc@ yahoo.com

[2] Senior Program Specialist (Crops), SAARC Agriculture Centre, BARC Complex, Farmgate, Dhaka-1215, Bangladesh
Email: mum96@ hot.com

Summary

The organic farming is a new technique in farming, which basically, restricts the use of synthetic chemicals and GMO seeds. Organic farming will produce high quality fruits; vegetables and field crops with premium price and low input costs by using indigenous techniques; making compost and bio-pesticides to grow the crops; which also covers the concept of food security, quality issues, and concept of safe food, fair trade and organic food standards of different areas of the world.

Pakistan is facing severe energy crisis and high prices of chemical fertilizers in national market. The raw material like rock phosphate is depleting at faster rate. The high priced synthetic fertilizers are beyond the purchasing power of the poor farmers of the country. Hence, it is high time to introduce alternate farming technologies which are cost effective and sustainable both for productivity and soil fertility.

The small land holders of Pakistan are not able to apply heavy doses of fertilizers as well as pesticides. It is expected that 33 % of Pakistani farmers are already producing mixed organic. Now it is the need of the time to support such farmers technically and morally to use natural inputs like residues, compost and crop rotation, which are useful for land sustainability.

Chairman, PARC, Dr. Zafar Altaf established Directorate of organic farming on August 22, 2008 to help the small farmers. National Institute of Organic Agricultural (NIOA) deals with research and development of cost effective alternative technologies for sustainable farming system which is economical and suitable for all ecological zones of Pakistan;

building research based organic standards to establish organic certification system in Pakistan with the collaboration of IFOAM, and introduced plastic technology, bio-compost, and bio-pesticides by installing pilot-units at Bard-yard NARC and training activities; leading to sustainable agro ecosystem and better farming community across the country.

To develop the organic agriculture sector in Pakistan, the Government needs to develop appropriate policies; providing incentives for organic research and adoption. Promotion and practice of organic is not only important for Pakistan for maintaining of safety of its environment and ecology, it is also important in the global organic market context.

Country Profile

Pakistan is one of the blessed countries in the world having ample diversity in ecological and environmental aspects. Diverse environments coupled with varying landscapes provide comparative advantage for cultivation of crops, fruits and vegetables throughout the yea. These landscapes provide year round variability in terms of temperature and precipitation. Early vegetables and fruits can also be grown. Three crops of potato and tomato and two crops of rice can be grown per annum in different parts of the country. Most of the nuts and deciduous fruits are grown in the mountainous region, where fertilizers and pesticides are hardly used. The good examples are: walnut, pecans, pine nut, almonds, pistachio, mulberry, apricot, fig, etc. All these nuts and fruits are grown completely in organic environments and quality control systems can be developed for maintaining residue free soil and marketable products. The only intervention required is to tag these fruits as organically grown products to get premium price. Farmers can also be organized for value addition and processing and even they can be provided knowledge and skills for export.

There are some other fruits, which are also grown organically (Table 66). These include falsa and dates. Falsa can be used to produce juice concentrates for export. Dates in Baluchistan are normally grown organically. Why do not we process the quality dates and tag these as organic fruits to fetch premium price in the international market? Wild cumin normally named as black cumin is grown wild in the northern mountainous region. Even organic composts are never used as it is grown wild in the forests. It can be tagged as wild cumin to fetch premium price in the international market.

Recently, an American Company has contacted the Ministry of Food, Agriculture and Livestock for import of 50,000 bales of organic cotton from Pakistan. The Federal Secretary has chaired a meeting of cotton and organic farming experts for production of organic cotton in Pakistan. Experts have identified Baluchistan province as the potential area for growing organic cotton as the area is free of pest pressure and farmers are using very little pesticides compared to other parts of the country.

Districts of Nasirabad, Jafarabad, Kohlu, Khuzdar and Lasbela represent the potential areas for cultivation of organic cotton. During 1998-99, the production of cotton in Baluchistan was around 28,000 bales. Reducing the area under rice in Nasirabad and Jafarabad districts can easily increase it. The water saved from one acre of rice will be sufficient to grow 3 acres of organic cotton. Cotton is the most water efficient crop in terms of crop water requirement and water use efficiency.

Table 66: List of association/ organization working on organic farming in Pakistan

S. No.	**Organization Address**	**Area of Interest**	**Contact Person**	**Personal Contact No. Email Office Contact No.**
1	Hunza Organics, Lahore	Organic farming	Zahid Durrani	+92333434988 hunzaorganics@hotmail.com +92427667028
2	Rhoshni Associates, Lahore	Organic farming	Alexander Keune	+923034250456 roshni@gx.net +924235601062
3	Soon Valley Development Program, Soon Valley, Nowshehra, Khushab	Reweable energy organic farming sustainable	Mr.Gulbaz Afaqi	+923018603202 Soonvelley.developmentprogram@gmail.com -
4	Mountain Seathron Products , Hunza Nagar	Organic farming	Wazir Aman Rustam	+923449493607 - -
5	Sungi Development Foundation , Butgram	Organic	Shahid Nawaz Qureshi	+92997319316 - -
6	Dost Welfare	Organic farming	Dr. Parveen	+92915814181

	Foundation, Peshawar		Azam Khan	parveen@dostfoundation.org -
7	True Leaf Farms, Raiwind Lahore	Production of organic vegetables	Riaz Ahmad	+923218466688 truelefarms@gmail.com -
8	Department of Agriculture, Muzzarrarabad, AJK	Plant pathogist	Abdul Hafeez	- Hafeez444s@yahoo.com -
9	Lok Sanjh Foundation, Islamabad	Organic farming	Dr. Farzana Shahid	+92512255242 Lok-sanjh@yahoo.com -
10	Innovative Chamicals, Industrial Estate, Multan	Organic fertilizer	Sheraz Ahmad	+92300-8736262 - -
11	Ultimate Consultants, Tufail Road,Lhr.	Organic farming	Brig. Iftikhar Siddiqi	+923008490183 Ucl-pakistan@yahoo.com -
12	Grow Cure, Gulshan E Iqbal Karachi	Organic bioactivatore & minerals for increase	Syed Atif Ali Shah	+923212362361 growcure@gmil.com -
13	Foundation For Urban & Rural Depart, Qazi Arif, Taluka Mehar, District Dadu, Sindh, Pakistan	Organic farming	Qazi Wajid mahesar	+923123355111 - -
14	Jabran Farms, Chak No.28(South)Srgodha	Organic farming	Muhammad Saqib	+923226058376 - -
15	Pakistan Organic Farms, 112-Ycommercial Area DHA,Lahore	Trading in organic field crops	Muhammad Azhar	- info@pakif.com 92425731281-5
16	Resource Centre For Development, Fraraz House, D-237 Ghazikot-Township	Better livelihood through	Haudayatullahne akakhtar	- resourcecenre.pakistan@gmail.com +9222997303601
17	AMB Organics, Qazi Court, Boultan Market,Karachi	Manufacturing of bio-organic fertilizers	Ahmed M. Bangee	+923158246382 amborganics@bangee.org +9251261162223

18	Action Aid, H.8,H.31,Sector F-7/1, Islamabad	Organic farming ,food rights	Nasir Aziz	+923007162144 - -
19	Innovative Chemicals, 36-A, Industrial Estate, Multan.	Organic products	Sheraz Ahmad	092512856623 almas@shehersaaz.org.pk -
20	Shehrsaaz, H#755,St#24,2nd Floor G-9/A, Islamabad	Organic farming	Almas Saleem (Ms)	+92512856623 almas@shehersaqa.org.pk -
21	Pakistan Rural Institutional Organization For Socio-Eco-Growth dAnd Education (PRIME), Kohsar Town Bhara Kahu H#1,St#3,Islamabad	Organic farming	Mr. Naeem Iqbal	+92347748507 primekbr@gmail.com +923477348507
22	Gurmani Farms, H#7, Bosan Road, Multan	Organic mangoes production and marketing	Muhammad Gurmani	+9261786543 Web:http://yp.qincai.net/crop-798500.html -
23	Organic Producer , Mohalla Amin Abad,Karim Abad, Hunza POBOX, Alibad	Mountain herbs (tumuro plamating , sesbuckthorn, buckwheat salagit etc)	Shah Faqir	+92342297823 - -
24	Mountain Seabuck Thron&Dry Fruit Products, Wazir Aman & Family, Care De Glacier, Air Condition Bridge Kkh Gulkin Gojal, Hunaz Distt, Gb	Organic producer	Wazir Aman Rustam	+923449493607 subuckthronl@gmail.com 0923345129298 (Rawalpindi)
25	Mountain Areas Farmer Support Organization, Girls College Road , Near Ali Chowk, Skardu, Gilgit Baltistan	Organic farming	Ghulam Nabi Shigri	+923469209082 shairman@mountainfarmers.org 0925815450112
26	Bhombal Group, Old Rally Building ,Talpur Road,Karachi	Organic farming and certification	Tehsin S. Bhombal	+923332298883 ts@bhombal.com +922132436394-8

27	Tayyaba, Malir Area Karachi	Organic vegetables	Muzzamil Niazi	+923452005280 - -
28	Raza Farms, Raza Farms, Kabirwala(Khanewal)2-A-1,Ahbab Society, Sector G-111,Johar Town, Phase-2 Lahore 54770	Organic mango production	Asghar Raza Garzedi	0923435003500 smarsgri@gmail.com 0924235301400
29	Sindh Agriculture Development Association (SADA)umerkot,Sindh, Near Taluka Agric.Ext. Office Tharbazar, Umerkot	Sustainable agriculture	Muhammad Bux Kumbhar	+923332978960 Sada.agri@uhoss.com -
30	Shigar Town Management and Development Society , Abbruzi Higher Secondary School Siankhor, Shigar, Skardu	Kitchen gardening	Tehereh Sheerazie	092342252807 tsheerazie@gmail.com -

Concept and brief history and strategic importance of organic farming:

In the present times, more than 90% farming community of Pakistan is working on conventional agricultural methods started with the introduction of green revolution during the era of 60’s which resultantly gave better production of crops but unfortunately polluted the environment badly and contributed in contamination of human food along with underground water with the use of chemical inputs. Now-a-day, Pakistan is importing huge quantity of chemical inputs by spending billions of dollars annually which are causing a huge threat of poverty for the poor rural community on one hand and serious financial constraints to the economy of Pakistan on the other. Another alarming position is in the shape of severe climate change and its effect on the crops, land degradation, deforestation which can only be overcome by the introduction of organic agriculture in Pakistan. It is a false phenomenon that organic farming cannot feed the entire population by switching of present farming system to organic agricultural but with the passage of time by adapting the organic agriculture technologies the need of chemical inputs would be gradually minimized. The use of organic gardening products i.e. organic fertilizer, organic pesticides organic herbicides nutrients is a milestone which can reduce the huge amount of capital and would guarantee the better crop production for the sustainable livelihood of the human generations of Pakistan in future. Keeping in view the importance of organic farming, the Directorate of Organic Farming was established on September 22, 2008 and developed as National Institute of Organic Agriculture (NIOA) ON February 11, 2010 with the following objectives.

1. Development cost effective technology for alternate farming system which is economical and suitable for different eco-logical zones of Pakistan and also development of organic certification system in Pakistan
2. Test and adapt the alternate farming systems having different sizes and available resources
3. Translate research knowledge and outcomes into actionable input on large scale farming systems
4. Development of organic certification system in Pakistan

Present activities of National Institute of Organic Agriculture

1. Development of organic certification system in Pakistan
2. Preparation and field evaluation of organic products
3. Research and production of year round organic vegetables
4. Research on effects of climate change on organic vegetable and crops
5. Comparative study of organic products VS inorganic products
6. Tunnel farming under sustainable organic agriculture
7. Trainings to the internee/university students
8. Trainings to the extension officers; workers and farming community

Organic and inorganic area and types of organic and inorganic manures

The total geographical area of Pakistan is 79.6 million hectares. About 35% of the area is currently under cultivation. In 2005-06, total area under organic agriculture was 35,000 acres which increased to 150,000 acres (approxmately) by 2009-10 as reported by Hunza Organic, Noor Organic Taj Food and from others (Muhammad, 2010).

According to latest survey of Pakistan by NIOA, PARC scientists, the area under organic agriculture in Pakistan is about 1.51 million hectares while area under inorganic agriculture is 22.6 million hectare (Fig. 33).

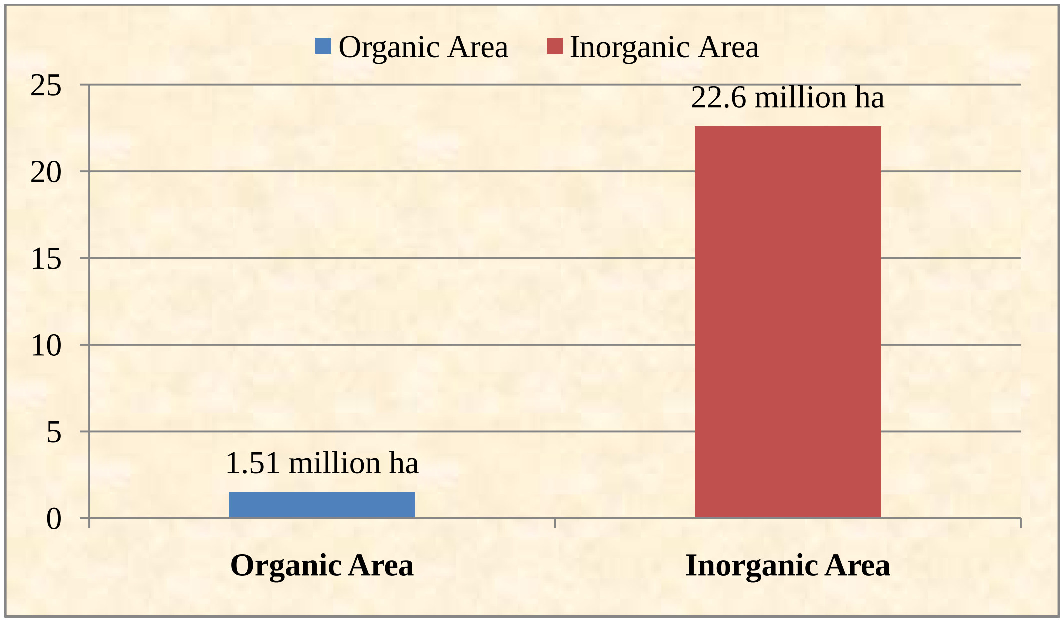

Fig. 33: Area under organic and inorganic agriculture

Different organic sources available for improving soil organic matter in Pakistan

There are a large number of organic sources available in the country to be used for improving the organic matter content of our soils (Table 67). Some of them are discussed here under.

A. Organic Sources

1. Farmyard manure

Farmyard manure is decomposed mixture of the dung and urine of cattle's and other livestock with the straw and litter used as bedding and residues from the fodder fed to them. It has been estimated that about 1.5 million tonnes of nutrients are available from farmyard manure in Pakistan. About 50 per cent of the dung in Pakistan remains uncollected. Out of collected animals dung about 50 per cent is used as fuel in the form of dried cake, locally called "Pathi". Whatever is collected for manuring is usually heaped on the ground surface with residues from fodder and other house sweepings. The nitrogen in the manure is subject to volatilization and leaching losses and the material that finally will be spread on the field may have low nitrogen content. The application of well-decomposed manure is more desirable than using fresh materials.

2. Poultry manure

Poultry manure has a higher nutrient or contents than livestock manure. According to the estimates the poultry manure available in the country can contribute about 101 thousand tonnes of nitrogen, 58 thousand tonnes of phosphorous and 26 thousand tonnes of potash.

3. Crop residues

Crop residues include straw, husk, leave, vegetable and fruit waste, grass cuttings, weeds, sawdust etc. In Pakistan, most of the crop residues such as wheat straw, sugarcane tops/ trash, cotton sticks, rice husk etc are used as fodder for animals and as a fuel. But other waste materials can be converted into useful compost manures by conserving and subjecting them to a controlled process of decomposition.

4. Green manure

Green manuring refers to the practice of growing crops, preferably legumes and ploughing them under, when they reach maximum production of green tops. Legumes are preferred as they have the ability to fix atmospheric nitrogen. The amount of N fixed varies from crop to crop and may be about 20-40 kg ha^{-1}. In Pakistan, Dhancha and Guara are suitable crops for green manuring.

5. Filter cake and silage

According to an estimate Pakistan sugar industry is producing about 1.2 million tonnes of filter cake every year, which is a rich source of organic matter, micro and macronutrients. Some sugar mills have molasses based distillery plants, which produce silage containing nutrients specially potassium. In case, all these materials are recycled by composting back to soil, it will also be a good source of essential plant nutrient for crop growth.

6. Slaughter house waste

Slaughter house wastes such as dried blood, meat meal, hoof and horn meal; have a high N content and are essentially concentrated organic manures, fairly quick acting, safe to use and effective on all crops. Slaughter houses are wide spread throughout Pakistan and largely their by-products are left outside, in one appraisal, it was shown that about 8000 tonnes blood meal could be produced annually for manorial use containing essential nutrients.

7. Other solid and liquid based materials

The other solid and liquid based materials available include sewage and sludge, fishpond effluent, city refuse and some waste of food processing industries. All these materials cannot be used directly as source of plant nutrients.

8. Compost

Composting is the process of decomposing (through the action of micro-organisms in the soil) plant residues in a heap or pit with a view to converting the nutrients contained in the residue in more readily available form.

In rural areas crop residues, stubbles, weeds, fallen leaves, remnants of fodder and green manure, etc. can be collected and stored in heap or pit. In this way, as the last pit is filled, the compost in the first pit is ready for application. Municipal/ industrial wastes comprising mainly town refuse and human excreta can also be composted. The preparation of urban compost on a large scale is being done in many countries. Some plants are also installed in Pakistan. Quite sophisticated machinery may be required for this purpose.

9. Biogas compost

This is a process by which organic material are biologically decomposed to yield energy in the form of combustible gases. The residual material provides valuable manure. Cattle dung which should be used for improving soil productivity is generally burnt as fuel. Biogas technology reconciles both these objectives: anaerobic decomposition of the cattle dung yield both fuel (biogas) and organic fertilizer (sludge). Biogas, popularly known as “gobargas”, is composed mainly of methane (CH4), about 60%; thus 1000 cubic feet biogas is equivalent to 600 cubic feet of natural gas, 5.2 gallons of gasoline and 4.6 gallons of diesel oil. A small family of four would require 150 cubic feet of biogas per day, for cooking and lighting an amount which can be generated from the family's night soil and the dung of three cows.

B. Inorganic Fertilizers

Nitrogenous fertilizers were introduced in Pakistan in 1952, phosphorus seven years later in 1959-60, and potassium another seven years later in 1966-67. Fertilizer use gained momentum after 1966-67, when high yielding varieties of cereal crops were introduced. Most fertilizers are used on irrigated crops. In rainfed areas use is still very low.The main types of fertilizers used in Pakistan are urea, DAP, NPK, Nitrophas, Ammonium Nitrate, Ammonium Sulphate, SSP, TSP, MOP, SOP (Table 67).

Table 67: organic and inorganic sources of nutrients

Organic Sources	**Inorganic Sources**
Farmyard manure	Urea
Poultry manure	DAP
Crop residues	NPK
Green manure	Nitrophas
Filter cake and silage	Ammonium Nitrate
Slaughter house waste	Ammonium Sulphate
Other solid and liquid based materials	SSP
Compost	TSP
Biogas compost	MOP
Biofertilizer	SOP

Principals of organic agriculture, Scope and Objectives

These principles are the roots from which Organic Agriculture grows and develops. They express the contribution that Organic Agriculture can make to the world. Composed as inter-connected ethical principles to inspire the organic movement -- in its full diversity, they guide our development of positions, programs and standards.

A. Principles of organic agriculture

1. Principle of health
2. Healthy soil, plants, animals, humans: a healthy planet
3. Principle of Ecology
4. Emulating and sustaining natural systems
5. Principle of Fairness
6. Equity, respect and justice for all living things
7. Principle of Care

Five Strategic Pillars of Organic Agriculture

- **Umbrella** **:** Stay informed, join the debate
- **Advocacy** **:** A voice for organic
- **Value chain** **:** Guaranteeing organic integrity
- **Programs** **:** Growing organic
- **Academy** **:** Tomorrow's organic leaders

B. Scope of organic agriculture

It is environmentally friendly; sustainable; healthy and can reduce many existing challenges that country is currently facing like shortage of power and water contamination. Organic farming is not only a production method but it is system that strengthens the social bondage and unity in a community. It also restores the respect between men-women on equality.

C. Objectives of organic agriculture

1. To document organic agriculture scenario and further possibilities in the country.
2. To find out the best possible ways for harvesting the maximum output from the sector on the basis of opportunities available in the country.
3. To bring awareness on dangers of conventional farming based on synthetic external inputs.

4. To promote regional cooperation and exchange of information.
5. To facilitate regional initiatives for cooperation.
6. To promote the global reorganization of the international standards as a long term goal.
7. To increase awareness of the need and opportunity for harmonization and equalance for organic trade.

Components of organic agriculture

Major components of organic farming are crop rotation, maintenance and enhancement of soil fertility through biological nitrogen fixation, addition of organic manure and use of soil microorganisms, crop residues, bio-pesticide, biogas slurry, waste etc. Vermiculture has become a major component in biological farming, which is found to be effective in enhancing the soil fertility and producing large numbers of horticultural crops in a sustainable manner. The various components of organic farming have been discussed in details below:

1. Crop rotation

It is a systematic arrangement for the growing of different crops in a more or less regular sequence on the same land covering a period of two years or more. The selection of optimal crop rotation is important for successful sustainable agriculture. Crop rotation is very important for Soil fertility management, weed, insect and disease control. Legumes are essential in any rotation and should be 30 to 50 percent of the land. A mixed cropping, pasture and livestock system is desirable or even essential for the success of sustainable agriculture.

2. Crop Residue

In Pakistan there is a great potential for utilization of crop residues/ straw of some of the major cereals and pulses. About 50% of the crop residues are utilized as animal fed, the rest could be very well utilized for recycling of nutrients. Adequate care is required to use the residues after proper composting with efficient microbial inoculants. While the incorporation of crop residues e.g. Wheat and Rice straw, as such or inoculated with fungal species has beneficial effects on crop yields, and is important in physical and chemical properties of soil.

3. Organic manure

The organic manure is derived from biological sources like plant, animal and human residues. Organic manure act in many ways enhance the crop growth and soil productivity. The direct effect of organic manure relates to the uptake of humic substances or its decomposition products affecting favorably the growth and yield of plants. Indirectly, it augments the beneficial soil microorganisms and their activities and thus increases the availability of major and minor plant nutrients.

a. **Bulky organic manure:** It generally contains fewer amounts of plant nutrients as compared to concentrated organic manure. It includes FYM, compost and Green manure.

   - **FYM:** It refers to the well-decomposed mixture of dung, urine, farm litter and left over or used up materials from roughages or fodder fed to the cattle. The waste material of cattle shed consisting of dung and urine soaked in the refuse is collected and placed in trenches about 6 m long, 2 m wide and 1 m deep. Each trench is filled up to a height of about 0.5 m above the ground level and plastered over with slurry cow dung and earth. The material is allowed to decompose undisturbed 3-4 months for anaerobic microorganism for completion of fermentation. FYM becomes ready to apply after 3-4 months. Well-rotted FYM contains 0.5% N, 0.2% P205 and 0.5% K2O.

   - **Compost:** Large quantities of waste material are available as vegetable refuse, farm litter, such as weeds, stubble, bhusa, sugarcane trash, sewage sludge and animal waste in houses and in areas like human and industrial refuse; therefore, excreta can be converted into useful compost manure by conserving and subjecting these to a controlled process of anaerobic decomposition. Compost is used in the same way as FYM and is good for application to all soils and all crops.

   - **Green manuring:** It is a practice of ploughing or turning into the soil undecomposed green plant tissues for the purpose of improving physical structure as well as fertility of the soil. From the time immemorial the turning in a green crop for improvement of the conditions of the soil has been a popular farming practice. Green Manuring, wherever feasible, is the principal supplementary means of adding organic matter to the soil. It consists of the growing of quick growing crop and ploughing it under to incorporate it into the soil. The green manure crop supplies organic matter as well as additional nitrogen, particularly if it is a legume crop, which has the ability to fix nitrogen from the air with the help of its rootnodule bacteria. A leguminous crop producing 25 tonnes of green matter per hectare will add about 60 to 90 kg of nitrogen when ploughed under. This amount would equal an application of 3 to 10 tonnes of FYM on the basis of organic matter and its nitrogen contribution. The green manure crops also exercise a protective action against erosion and leaching. The most commonly used green manuring crops are: Sunhemp (*Crotalaria juncea*), Dhaincha (*Sesbania aculeata*), Cluster bean (*Cyamopsis tetragonoloba*), Senji (*Melilotus parviflora*), Cowpea (*Vigna catjang, Vigna sinensis*), Berseem (*Trifolium alexandrium*).

- **Concentrated organic manure:** Concentrated organic manures are those materials that are organic in nature and contain higher percentage of essential plant nutrients such as nitrogen, phosphorous and potash, as compared to bulky organic manures. These concentrated manures are made from raw materials of animal or plant origin. The concentrated organic manures commonly used are oilcakes, blood meal, fishmeal, meat meal and horn and hoof meal.

4. Waste

a. Industrial waste: Among the industrial by products, spent wash from ditilisers and molasses and pressmud from sugar industry have good manurial value. It is important to use only well decomposed pressmud at 10 tonnes ha^{-1}. Addition of pressmud improves the soil fertility and enhances the activity of microbes. Coir waste is the by-product from coir industry and can be used as manure after proper decomposition.

b. Municipal and Sewage waste: It also forms an important component of organic waste. In Pakistan, the total municipal refuse is about 12 mt per annum containing about 0.5% N, 0.3% P_2O**5** and 0.3% K**2**O. Sewage sludge is available to an extent of 4 million tonnes per annum containing 3% N, 2% P and 0.3% K (Bharadwaj and Gaur, 1985). Sewage sludge particularly from industrialized cities is contaminated with heavy metals and these pose hazards to plants, animals and human beings. Separation of the toxic waste at the source will minimize the concentration of such elements in the sludge.

5. Biofertilizers

It has been observed that there is decline in crop yield due to continuous application of inorganic fertilizers. Therefore, increasing need is being felt to integrate nutrient supply with organic sources to restore the health of soil. Bio-fertilizer offers an economically attractive and ecologically sound means of reducing external inputs and improving the quality and quantity of internal sources. Bio-fertilizer is microorganism's culture capable of fixing atmospheric nitrogen when suitable crops are inoculated with them. The main inputs are microorganisms, which are capable of mobilizing nutritive elements from non-usable form to usable form through biological process. These are less expensive, eco-friendly and sustainable. The beneficial microorganisms in the soil that are greater significance to horticultural situations are biological nitrogen fixers, phosphate solubilisers and mycorrhizal fungi.

The Bio-fertilizers containing biological nitrogen fixing organism are of utmost importance in agriculture in view of the following advantages.

- They help in establishment and growth of crop plants and trees.
- They enhance biomass production and grain yields by 10-20%.
- They are useful in sustainable agriculture.
- They are suitable in organic farming.
- They play an important role in Agroforestry / silvipastoral systems.

Types of Biofertilizers

There are two types of bio-fertilizers.

1. Symbiotic N-fixation: Rhizobium culture of various strains which multiply in roots of suitable legumes and fix nitrogen symbiotically. Almost 50% demands of N are met by these microorganisms in legumes.

- **Rhizobium:** It is the most widely used bio-fertilizers, which colonizes the roots of specific legumes to form tumors like growths called rot nodules. It is these nodules that act as factories of ammonia production. The Rhizobium legume association can fix upto 100-300 kg N ha^{-1} in one crop season.

2. Asymbiotic N-fixation: This includes Azotobacter, Azospirillium, BGA, Azolla and Mycorrhizae, which also fixes atmospheric N in suitable soil medium.

They grow on decomposing soil organic matter and produce nitrogen compounds for their own growth and development, besides that they leave behind a significant amount of N in surroundings.

- **Azotobacter:** Application of Azotobactor has been found to increase the yields of wheat, rice, maize, pearl millet and sorghum by 0-30% over control. The beneficial effect of Azotobactor biofertilizers on cereals, millets, vegetables, cotton and sugarcane under both irrigated and rainfed field conditions have been substantiated and documented (Pandey and Sushil Kumar, 1989). Apart from nitrogen this organism is also capable of producing antibacterial and anti-fungal compounds, hormones and siderophores.

- **Azospirillium:** It is an important bacterium, which colonize the root zones and fix nitrogen in close association with plants. The crops which response to Azospirillum is maize, barley, oats, sorghum, pearl millet and forage crop. Azospirillum applications increase grain productivity of cereals by 5-20%, of millets by 30% and of fodder by over 50%.

- Blue Green Algae: The utilization of blue-green algae as biofertilizers for rice is very promising. Recent researches have shown that algae also help to reduce soil alkalinity and this opens up possibilities for bio-reclamation of such inhospitable environments.

- **Azolla:** A small floating fern, Azolla is commonly seen in low land fields and in shallow fresh water bodies. This fern harbours blue-green algae, anabaena azollae. The Azolla anabaena association is a live floating nitrogen factory using energy from photosynthesis to fix atmospheric nitrogen amounting to 100-150 kg N ha^{-1} $year^{-1}$ from about 40-64 tonnes of biomass (Hamdi, 1982; Singh, 1988).

- **Mycorrhizae:** Mycorrhizae are the symbiotic association of fungi with roots of Vascular plants. The main advantage of Mycorrhizae to the host plants lies in the extension of the penetration zone of the root fungus system in the soil, facilitating an increased phosphorous uptake. In many cases the Mycorrhizae have been shown to markedly improve the growth of plants. In Pakistan, the beneficial effects of Vascular-arbuscular Mycorrhizae (V AM) have been observed in fruit crops like citrus, papaya and litchi. Recent studies showed the possibility of domesticating Mycorrhizae in agricultural system (Hayman, 1982; Tilak, 1987).

6. Bio-pesticide

Bio-pesticides are natural plant products that belong to the so-called secondary metabolites, which include thousands of alkaloids, terpenoids, phenolics and minor secondary chemicals. These substances have usually no known function in photosynthesis, growth or other basic aspects of plant physiology; however, biopesticides control biological activity against insects, nematodes, fungi and other organisms is well documented.

Botanical insecticides are ecologically and environmentally safer generally affect the behaviour and physiology of insects rather than killing them. Among the botanical pesticides investigated. Neem (Azadirachta indica) has justifiably received the maximum attention. All parts of the Neem tree possess insecticidal property but seed kernel is most active.

Biopesticides and other preparations of plant origin used in agriculture seem to have a good scope especially in view of the environmental problems being faced with the synthetic agrochemical. Some of the commonly used botanical Insecticides are Nicotine, Pyrethrum, Rotenone, Subabilla, Ryanin, Quassia, Margosa, Acorus etc. Their used need to be promoted under the Integrated Pest management Programmes.

7. Vermicompost

It is organic manure produced by the activity of earthworms. It is a method of making compost with the use of earthworms that generally live in soil, eat biomass and excrete it in digested form. It is generally estimated that 1800 worms which is an ideal population for one sq. meter can feed on 80 tonnes of humus per year. These are rich in macro and micronutrients, vitamins, growth hormones and immobilized microflora. The average nutrient content of vermicompost is much higher than that of FYM. It contains 1.60% N, 5.04% P2O and 0.80% K2O with small quantities of micronutrients. Application of vermicompost facilitates easy availability of essential plant nutrients to crop.

Conclusion

A large fraction of farm by-products of plant and animal origin is utilized for non-farm use i. e. for fuel or other domestic purposes. Small and scattered lands holding of the large farming community compel them to leave the crop residue in the farm itself rather than recycle it for recycling. Lack of location specific technology to recycle organic waste and lack of awareness to recycle organic waste in agriculture are the main reason for its slow adoption even though is a native technique for the farmers which got lost during the period of Green Revolution. So, in order to popularize this eco-friendly farming practices like organic farming we have to give attention to strengthen the production of good quality organic manure, bio-pesticides, biofertilizers and green manuring crops, discourage the indiscriminate use of inorganic fertilizers and pesticides, development of pesticides of plant origin (such as Neem) and use of agents especially under integrated Pest Management system as well as steps to reduce hazardous chemical residues in seeds, fodder, food products and milk.

Approaches

- **Research Needs:** In several countries work is being conducted to identify specific areas where knowledge is lacking and future research is needed. Areas with increased research priorities are crop management by natural resources, agro-ecology, biodiversity, marketing, processing and quality assessment techniques, social and environmental impact of conversion to organic agriculture, how to keep organic production and processing free from genetic engineering; developing model organic farms at agricultural universities/ PARC establishments across the Pakistan.
- **Advisory Service:** The advisory service plays an important role in the transfer of scientific results into agricultural practice; ideally it should be the link between practice and research. Here the advisory service is partly integrated into the conventional advisory service. Development in terms of advisory service is needed in Pakistan; where only a few advisers are available and are mainly private consulting firms or advice through seminars of the producer organizations or exchange between farmers.
- **Technology Transfer:** The transfer of research results into agricultural practice or of the needs of practitioners into research is not organized in Pakistan. In Pakistan the *[NIOA] Nationl Institute of Organic Agriculture; needs to* unite farmers, advisers, researchers and ministry officials in order to coordinate the needs of organic farming.
- **Networks and Cooperation in Research:** Presently at numerous research stations, universities and institutes all over Pakistan, research on organic

agriculture is conducted. There is, however, a need for improvement of the communication between researchers as well as between researchers and practitioners, both at national and international level. Networks are a very efficient tool for stimulating research and disseminating results in the scientific community as well as among extensionists, in spite of the fact that many of the requirements are quite site specific. The International Federation of Organic Agriculture Movements was originally founded with the aim to coordinate research in organic agriculture in Pakistan. The norms of the IFOAM will be followed for two years to bring the organic awareness and management at their levels to become the certification body.

Country status of agriculture today including pesticide and fertilizer used [Organic; Inorganic cultivation system; Adoption of their environmental conditions]

Agriculture is an extremely important sector of Pakistan's economy. It plays a vital role and lays down the foundation for economic development and growth in this country. Agriculture contributes more than 21% to the Gross Domestic Product (GDP) and provides employment to 45 per cent of the total labor force of the country. It provides raw material to the industrial sector on one side and also is a market of industrial products on the other side. In the export earnings, direct as well as indirect share of agriculture is very high. Thus, it is prudent that agriculture plays a multidimensional role in the economy of Pakistan.

Almost 64% of the population of Pakistan resides in rural areas and earns its livelihood, directly or indirectly, from agricultural activities e.g. crop cultivation, livestock rearing, labor in agriculture, agriculture input supply, transportation of agricultural output to the market etc. Therefore, development of agriculture is synonymous to the development of the country.

In Pakistan, the most agricultural province is Punjab where wheat and cotton are grown. Mango orchards are mostly found in Sindh and Punjab provinces that make Pakistan the world's 4th largest producer of mangoes.

Fertilizer consumption has increased threefold during the past 30 years. It reached one million tonnes in 1980-81, two million tonnes in 1992-93 and three million tonnes in 2002-03 and about 4.5 million tonnes in 2013-14. Nitrogen accounts for 78% of the total nutrients, phosphate for 21% and potash for less than one percent. While the approximately 40565 tonnes pesticides were used in 2009-10.

Moreover development of awareness and implementation regarding organic [Pesticide & Fertilizers] IFOAM Norms are in progress.

Soil Fertility and Fertilization

In Pakistan, the soils are very poor in organic matter than the desirable level. A soil having 1.29 % C is considered to be sufficient in organic matter, but Pakistan soils are having less than that. In a survey conducted by Farooq-e-Azam it is reported that the range of soil carbon in Pakistan soils is 0.52 to 1.38% in different soil series. Most of them have less than 1%.

Reasons for low organic matter content of Pakistani soils

The low organic matter content of Pakistan soils can be attributed to the following reasons.

1. **Climatic conditions**: The mean annual temperature influences the processes of decomposition of organic matter. At high temperatures decomposition proceeds quickly. That is why high temperatures prevailing in the country coupled with low rainfall are conducive for a rapid decomposition and loss of organic matter.
2. **Soil orders**: The soils have been classified into 12 'orders'. The soil order plays key role in determining the potential of a soil to keep a certain level of organic matter. The largest indigenous soil orders are Aridisol and Entisol, which have the lowest organic matter content. Therefore, our soil has lesser capacity to hold higher organic matter content.
3. **Availability of easy-to-handle mineral fertilizers**: Before the advent of mineral fertilizers and green revolution, farmers used to replenish their soil by application of organic wastes. With the availability of easy-to-handle mineral fertilizers the farmers were able to get higher yields only with the application of mineral fertilizers. Thereby the use of organic wastes reduced drastically. The increasing prices of mineral fertilizers and soil degradation concerns have forced people to reconsider the organic sources in agriculture.
4. **The poor economic condition of our farmers** is another reason for less application of organic wastes. Almost no crop residues are left in the soil after harvest. The straw and other crop residues are used as fodder and animal dung is used as fuel. About 50 per cent of animal droppings are not collected, about

half of the collected is burnt as fuel and only one fourth is available for field application. Green manuring is not adopted by our farmers because it does not give short- term economic returns.

5. **Intensive tillage**: Another reason for lower organic matter content of our soil is the practice of intensive soil tillage. Soil tillage aerates soil and breaks up organic residues, making them accessible to microbial decomposition thereby reducing organic matter content of the soil. The slogan "Dab Kay Wah Tay Raj Kay Khah" (Plow more, earn more) is no more valid in modern agriculture.

Managing soil to improve organic matter

Organic matter in soil affects soil properties and processes and often one effect leads to another resulting in a complex chain of multiple benefits. For example, adding organic mulch to the soil surface encourages earthworm activity, which in turn produces burrows and bioprocess increasing infiltration of water and decreasing its loss as runoff which helps reduce pollution of streams and lakes.

There is a large contingent of organic sources available in the country to be used for improving organic matter content of our soils. Some of them are as under.

a. **Farmyard manure**: Farmyard manure is a decomposed mixture of dung and urine of livestock with straw and litter used as bedding and residues from the fodder. It has been estimated that about 1.5 million tonnes of nutrients are available from farmyard manure in the country. About 50 per cent of the dung remains uncollected. Out of collected animals dung about 50 per cent is used as fuel. Whatever is collected for manuring is usually heaped on the ground surface with residues from fodder and other house sweepings. The nitrogen in the manure is subject to volatilization and leaching losses and the material that finally will be spread on the field may have low nitrogen content. The application of well-decomposed manure is more desirable than using fresh materials.

b. **Poultry manure**: Poultry manure has a higher nutrient content than livestock manure. According to estimates the available poultry manure can contribute about 101,000 tonnes of nitrogen, 58,000 tonnes of phosphorous and 26,000 tonnes of potash.

c. **Crop residues**: Crop residues include straw, husk, leave, vegetable and fruit waste, grass cuttings, weeds, sawdust etc. Most of the crop residues such as wheat straw, sugarcane tops/ trash, cotton sticks, rice husk etc., are used as fodder and as fuel. But other waste materials can be converted into useful compost manures by conserving and subjecting them to a controlled process of decomposition.

d. **Green manure**: Green manuring refers to the practice of growing crops, preferably legumes and ploughing them under, when they reach maximum production of green tops. Legumes have the ability to fix atmospheric nitrogen. The amount of N fixed varies from crop to crop and may be about 20-40 kg ha^{-1}. Sun hemp, guar and dhancha are suitable crops for green manuring.

e. **Filter cake and silage**: Sugar industry produces around 1.2 million tonnes of filter cake every year, which is a rich source of organic matter, micro and macro nutrients. Some sugar mills have molasses based distillery plants, which produce silage containing nutrients specially potassium. In case, all these materials are recycled by composting back to soil, it will be a good source of essential plant nutrients for crop growth.

f. **Abattoir waste**: Slaughterhouse wastes such as dried blood, meat meal, hoof and horn meal have high nitrogen content and are essentially concentrated organic manures, safe to use and effective on all crops. From slaughterhouse waste about 8,000 tonnes blood meal could be produced annually for manorial use containing essential nutrients.

g. **Other materials**: Other solid and liquid based materials available include sewage and sludge, fishpond effluent, city refuse and some waste of food processing industries. All these materials are used as plant nutrients after proper processing and removal of heavy metals and undesirable materials.

h. **Compost**: Composting is the process of decomposing plant residues in a heap or pit with a view to converting the nutrients in the residue in more readily available form. In rural areas crop residues, stubbles, weeds, fallen leaves, remnants of fodder and green manure, etc. can be collected and stored in heap or pit to produce compost. Municipal/ industrial wastes comprising town refuse and human excreta can also be composted.

i. Biogas compost: This is a process by which organic materials are biologically decomposed to yield energy in the form of combustible gases. The residual material provides valuable manure. Cattle dung is generally burnt as fuel. Biogas technology reconciles both these objectives: anaerobic decomposition of cattle dung yields both fuel (biogas) and organic fertilizer (sludge). Biogas is composed mainly of methane (CH4), about 60 per cent. About 1000 cubic feet of biogas is equivalent to 600 cubic feet of natural gas, 5.2 gallons of gasoline and 4.6 gallons of diesel oil. A small family of four would require 150 cubic feet of biogas per day, for cooking and lighting an amount which can be generated from the family's night soil and the dung of three cows.

j. Strategies for improving organic matter content of soil: Fertilizers, which have all the nutrients in available form, can provide sufficient plant nutrient flow to the corps. Fertilizers are the quickest and surest way of boosting crop production but their cost and constraints frequently deter farmers from using them in recommended quantities and balanced proportions.

During a survey by the NFDC, it was found that 49% farmers use farm yard manure (FYM). Cultivation of sesbenia as green manure crop in normal as well as marginally salt effected soils is being practised by some farmers and its worth has proved in many studies. Among crop residues the practice of ploughing of cotton sticks is picking up among the farmers.

The Pakistan Agriculture Research Council (PARC), the National Institute of Biotechnology and Genetic Engineering (NIBGE) and provincial agricultural research institutes are carrying out work on biological fertilization. The PARC in collaboration with the Engro Chemical Pakistan Limited commercialized rhizobium specific for chickpea in the name of Biozot. NIBGE is also marketing its bio-fertilizer for rice. Provincial research institutes are also providing inoculums to farmers for leguminous and non-leguminous crops.

k. Zero/ minimum tillage system: Zero tillage is a system in which the soil is left undisturbed. The only soil disturbance is of a narrow band by soil engaging components of the planter or drill. Reduction in soil disturbance from conventional, highly disturbed tillage methods to minimum or zero tillage produces slower carbon losses and may even increase the amount of carbon stored in a soil. Other benefits of zero tillage to farmers include: Less labour, reduced machinery wear and tear, high soil moisture, improved soil tilth, reduced soil erosion and reduced production cost.

Weed control through chemicals is one of the drawbacks of this system. Because of being costly and environmentally hazardous, it is desirable to use some cheaper and environmentally safe chemicals. It is also possible that instead of keeping the field completely free of weeds, we can keep them to a safe threshold level and only till when weeds exceed threshold level. Increasing the cropping intensity is excellent way-out to reduce weeds.

However, under our conditions, minimum tillage system seems to be more promising than zero tillage. Cultivation can be done only whenever it is inevitable, for example at seedbed preparation or when weeds exceed the threshold level. This would also help reduce the use of chemicals for control of weeds and insects, thereby reducing the input costs and environmental concerns.

Conversion of conventional to organic farming

1. Organic farmers must meet strict IFOAM / EU standards for farming, production and processing practices, which are regulated by an inspection, certification and labeling scheme.
2. Organic food production in Europe is strictly regulated by an inspection, certification and labeling scheme. It is unlawful to call a food product 'organic' if it has not been inspected and certified by one of several organic control bodies (CBs).
3. If you want to diversify into organic food, you will need to undertake a fundamental change in your farming, production and processing practices. For example, organic farming strictly limits the use of artificial chemical fertilizers and pesticides - you would need to use natural methods of pest control, as well as using crop rotation to keep the soil healthy.
4. It can take up to three years to become certified as an organic producer as per European Community organic food and farming regulations.

Hazards of inorganic farming

1. Decline in soil productivity can be due to wind and water erosion of exposed topsoil; soil compaction; loss of soil organic matter, water holding capacity, and biological activity; and salinization of soils and irrigation water in irrigated farming areas. Desertification due to overgrazing is a growing problem.

2. Agriculture is the largest single non-point source of water pollutants including sediments, salts, fertilizers (nitrates and phosphorus), pesticides, and manures. Pesticides from every chemical class have been detected in groundwater and are commonly found in groundwater beneath agricultural areas; they are widespread in the nation's surface waters. Eutrophication and "dead zones" due to nutrient runoff affect many rivers, lakes, and oceans. Reduced water quality impacts agricultural production, drinking water supplies, and fishery production.
3. Water scarcity in many places is due to overuse of surface and ground water for irrigation with little concern for the natural cycle that maintains stable water availability.
4. Other environmental ills include over 400 insects and mite pests and more than 70 fungal pathogens that have become resistant to one or more pesticides; stresses on pollinator and other beneficial species through pesticide use; loss of wetlands and wildlife habitat; and reduced genetic diversity due to reliance on genetic uniformity in most crops and livestock breeds.
5. Agriculture's link to global climate change is just beginning to be appreciated. Destruction of tropical forests and other native vegetation for agricultural production has a role in elevated levels of carbon dioxide and other greenhouse gases. Recent studies have found that soils may be source or sink for greenhouse gases.
6. Economic and social problems associated with agriculture cannot be separated from external economic and social pressures as barriers to a sustainable and equitable food supply system.
7. Potential health hazards are tied to sub-therapeutic use of antibiotics in animal production, and pesticide and nitrate contamination of water and food. Farm workers are poisoned in fields, toxic residues are found in foods, and certain human and animal diseases have developed resistance to currently used antibiotics.

Positive and negative effects of organic and conventional farming on agriculture

Organic Farming	Conventional Farming
Application of green manure and compost and practice of crop rotation year after year maintains the fertility of soil.	Constant use of synthetic fertilizers, pesticides and fungicides, and non-practice of crop rotation reduces the fertility of soil.
Non-application of synthetic fertilizers, pesticides and fungicides in raising crop prevent the ground water table and other water resources from being polluted.	In conventional farming, synthetic fertilizers, pesticides and also fungicides are washed away by seepage and rain and pollute the ground water table as well as water resources.
Organic farming is labor intensive. It requires more labor per hectare.	Conventional farming requires less labor per hectare.
Organic farming is time consuming.	Conventional farming requires less time in producing the same quantity of crop as in organic farming.
Organic farming produce are costlier.	Conventional farming produces are cheaper than organic farming.
Organic farming produces lower yield per hectare as compared to conventional farming.	Conventional farming produces higher yield per hectare as compared to organic farming.
Skilled labor is required in organic farming.	Skilled labor is not required.

Farm waste recycling - Organic mulches

Preparation of bio-fertilizer/ compost having different formulations

Organic fertilizer was manufactured using the following are Ingredients.

- Rock phosphate
- Mud sulphur
- Gypsum
- FYM (Farm Yard Manure)

- Poultry waste

Total production since the establishment of biofertilizer plant at NARC 5897 bags (weighing 50 kg each) was manufactured. Out of these 4252 bags were used by NIOA, NARC, and IDPs and for demonstration purpose whereas 1645 bags were sold to private clients/ farms.

Organic mulches suppress weeds in several ways. First, they block seed germination stimuli by intercepting light, reducing soil temperature, and greatly dampening day–night temperature fluctuations. As a result, fewer weed seeds germinate under the mulch than in uncovered soil. Second, the mulch physically hinders emergence of those weeds that do germinate. If the mulch is thick enough to prevent light from reaching the trapped seedlings, they eventually die. Third, some mulch materials, such as grain straw and fresh-cut forages like sorghum-sudangrass, release natural substances that inhibit weed growth for several weeks after application, a process known as allelopathy. Finally, organic mulch can enhance crop growth and competitiveness against weeds by conserving soil moisture and moderating soil temperature.

Straw and other organic mulches effectively block emergence of most weeds germinating from seed, although grasses and large-seeded broadleaf weeds may require a greater thickness of material than small-seeded broadleaf weeds, which have more delicate seedlings. Perennial weeds arising from rootstocks, rhizomes, tubers, or other vegetative propagates can penetrate most organic mulches.

Weeds that have already emerged at the time of mulch application should be cultivated or hoed out before spreading mulch; simply laying the organic materials over established weeds is less effective. Once the weeds break through the mulch, they will enjoy the same mulching benefits as the crop, and will grow vigorously.

Scope of organic agriculture including organic manures produced

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, biological pest control, minimum tilth to be used to maintain soil productivity, to minimize the energy costs of production and transportation materials, to keep soil more fertile. Organic methods improve soil health, increase population of healthy worms, fungi and other soil organisms. Organic agriculture saves the land from losses due to erosion and soil degradation, improve soil fertility and enhances moisture conservation. Diverse varieties only be used under unfavorable conditions.

Organic farming is based on less input, better market demand due to having environmental and social concerns. It also based on local resources and technologies that provide farmer better independence and more control over their means of production. Environmental impacts of organic farming are.

- Improvement of soil biological activity
- Improvement of physical characteristics of soil
- Reducing nitrate leaching
- Increasing and improving wild life habitat

Organic farming objectives are to develop low capital; less labor intensive; high yielding,; better quality and healthy organic farming; Reducing the cost of production to minimum to achieve self sufficiency in all inputs.

It is recognized as a long-term solution to the problem caused by nitrate pollution. Organic agriculture in the beginnings shows lower yields than conventional cropping but as its input are lower than conventional agriculture and labor in Pakistan is cheap, in long when organic agricultural methods have improved soil characteristics, soil fauna and established worm activity and large production of vermi-compost the yields will surpass the conventional methods. Moreover, trend of adding organic compost is in progress and lots of peoples are involved in this business I our country.

Soil and crop management

The trend of soil analysis has been developed; farmers have started to add organic matter in their soils to manage the crops properly to increase the production under sustainable conditions as well as leguminous crops grown at NARC and around the country with the recommendation of NIOA scientists.

Compact soils with zero organic matter needs more compost and farmers have started to analyze their soils and adding organic manures to their soils for better crop management.

Preparation of organic matter, humus, sewage sludge and organic compost

Movement at municipality level has been started for the collection of waste from organic sources to produce good commercial compost for selling to farmers.

Maintenance of buffer zones

In organic agriculture, the buffer zones are maintained. Buffer zones are areas of land, adjacent to a water course or water body, kept in permanent vegetation. Buffers protect water quality by slowing the flow of water, thus facilitating the trapping of sediment, organic matter, nutrients and pesticides. The vegetation that forms an essential part of a buffer zone uses some of the trapped nutrients for growth and provides critical habitat for micro-organisms. Micro-organisms attached to the soil and vegetation in the buffer zone also use the nutrients and organic matter for their growth and reproduction, and in the process transform some contaminants into less harmful forms.

Split production and parallel production

Recommended throughout the organic agriculture, split production is distinguishable and parallel production is indistinguishable and prohibited.

Choice of crops and varieties

Developing awareness for cultivation of recommended verities i.e. Tomatoes, marrow vegetables, water melons, apricot, gram, and persimmon by practicing organic farming in all the field crops, which are demanded by clients/ customers.

Natural safe products for control of pest, disease, weeds, disease and growth management

To initiate a knowledge-based program, that is in short time could provide useful guidelines [IFOAM] to farmers wishing to adopt organic farming techniques, regarding natural and safe products (bio pesticides and bio fertilizers etc.) for crop management.

Post harvest management

Organic agriculture is a knowledge and research intensive subject, commercially driven by a global market and regulated by international standards of production. In order to benefit fully from the economic and environmental opportunities offered, there is a need to address the significant organic agriculture skills gap and IFOAM that exists in the region. The post harvest management should emphasis on following points.

- Approved Chemicals for Use in Organic Postharvest Systems
- Influence of Pre-harvest Factors on Postharvest Quality
- Microbial Food Safety Issues of Organic Foods Webinar
- Respiration and Ethylene and their Relationship to Postharvest Handling
- Tracking Your Produce For Your Business and Health Webinar

Quality of food and crop productivity under natural ecological system

- 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 farming has the potential to alleviate poverty and proves to be beneficial in a number of ways. It will result in improving status of living, better education, better health and more income resources of the farmers, so will have resultant social benefits. Organic food tends to have significantly higher levels of all 21 nutrients analyzed compared with conventional produce, which result to improve health of the consumers.

Processing: Handling and Packing

- Implementation of an Organic Handling Plan [IFOAM]
- May use mechanical or biological processing methods
- No commingling or contamination of organic products during processing or storage
- No use of GMOs or irradiation
- Must use proactive sanitation and facility pest management practices to prevent pest infestations
- Must take steps to protect organic products and packaging from contamination, if pesticides are used in the processing facility

- Must keep records of all pesticide applications
- Must not use packaging materials that contain fungicides, preservatives, or fumigants
- Must use organic minor agricultural ingredients in products labeled “organic”, unless such ingredients appear on section 205.606 of the National List and are not commercially available from organic sources
- Must use approved label claims for “100% organic” (100% organic ingredients, including processing aids), “organic” (at least 95% organic ingredients), “made with organic ingredients” (at least 70% organic ingredients) and proper use of the word “organic” in ingredient list (less than 70% organic ingredients)
- Must identify the name of the certifier of the final handling operation on the product's information panel
- Pakistan will establish consistent national standards for processing; handling and packing

South Asian organic farming trade/ market analysis

- In most Asian countries, the trade in organic agriculture has not been well tracked or measured. Many countries don't have tracking codes for organic trade since it represents a relatively small portion of agricultural trade. Estimates in the region typically put certified organic sales at less than one percent of a nation's agricultural sales. Of course, many organically grown but uncertified products enter local market channels without organic labeling and identification and these volumes or values, although likely to be considerably greater, are much more difficult to estimate.
- To expose staff [CB] to organic agriculture production, certification, import/ export trade, marketing and research methodologies in the Pakistan, staff from each province partner will visit the training course organized by the IFOAM. A one-week ‘Concepts of Organic Agriculture’ workshop will be arranged in each province and environmental science faculties of the partners with the basic principles of organic agriculture. It will include intensive class work, field trips and field work.

- Workshops and training sessions on curriculum development will be held in Islamabad. This will involve partners, participants from other [Heads of Educational Institutes] HEIs and other important stakeholders, such as future employers of organic agriculture graduates, government agencies for higher education, and government agencies in the agricultural sector. An outcome of the workshop is expected to be an outline common curriculum for organic agriculture in tertiary institutions, which will facilitate further teaching collaboration and exchanges. In addition, teaching materials including posters, slides, DVDs, and monographs will be developed. Access to markets will be a major issue in sustainability of organic agriculture.
- If there is a market pull for organic products, the sub-sector will expand. To develop the market, the issue of certification has to be resolved so that farmers can sell what they produce at premium prices. A workshop in Islamabad will be convened to impart such skills. An output at the end of the workshop will be a set of guidelines and organic standards for Pakistan.

Issues and scope of marketing organic produce

Issues and limitations the specific market is facing are the following.

- Consumers are unaware of the specific attributes that differentiate organic products from conventional ones, as well as certification standards.
- Producers are unwilling to become involved in organic agriculture either due to lack of information throughout production, post-harvest and marketing process or due to lack of financial support during the first stages of transformation farm from conventional to organic (papadopoulou, 1997).
- Marketing problems related to the supply, Distribution and promotion of the product exist. Consumers need either to contact organic producers directly of obtain the product from specialized retail outlets and a limited number of supermarkets.
- Prices are much higher than those of conventional products.

  In conclusion, the organic industry offers many opportunities despite the significant obstacles encountered. The main challenges for the time being are the establishment of the authenticity of the organic claim. However, before any of the above actions are taken, marketers should further analyze the behavior of consumers and find out all the constraints that prevent them from purchasing organic products. It is therefore imperative for a number of studies to be conducted in the field of organic products, in order to draw up the strategic plans, which will contribute to the successful widening of the market of organic products.

Government support and South Asian/ International cooperation on organic agriculture

To develop the organic agricultural sector in Pakistan, the Government needs to develop appropriate policies providing incentives for organic research and adoption. Promotion and practice of organic farming is not only important for this country for maintaining safety of its environment and ecology, it is also important in the global organic market context.

Organic agriculture is a knowledge and research intensive subject, commercially driven by a global market and regulated by international standards of production. In order to benefit fully from the economic and environmental opportunities offered, there is a need to address the significant organic agriculture skills gap that exists in the region. The "Institutional Capacity Building for Organic Agriculture in "Pakistan" project will establish a core of Network for Organic Research and Training and Demonstrations. The partners [NGO's/ Farmer communities] will train graduates, farmers, extension officers and civil society organizations to develop a viable organic agriculture sector. The project partners will also facilitate and undertake research that underpins organic production, embed organic agriculture into the curriculum and develop locally appropriate standards, regulations and technologies for organic production by developing [IFOAM, NOP, USDA] norms and standards.

Research and Development Institutes

Chairman, PARC, Dr. Zafar Altaf established Directorate of Organic farming on August 22, 2008 to help the small farmers. With the blessing of Allah, Directorate of Organic Farming progress leaps and bounds and introduced/ developed lot of innovative technologies like bio-fertilizers, bio-pesticides and bio-herbicides, moreover, In view of these innovations, Chairman, PARC upgraded the Directorate of Organic Farming as National Institute of Organic Agriculture. The institute is involved in identifying new production technology and disseminating new knowledge to the small farmers across the country.

- The project partners will together form the Network for Organic Research and Training, centered in PARC/NARC/NIOA, and supported by IFOAM, NO, USDA. The network will carry out a skills gap analysis to examine the opportunities and challenges for organic agriculture in each of the provinces. Through its activities the network will build relationships between the partners [NGO's/ Farmer communities] and allow them to share resources, regional experiences and knowledge. The network will also serve as a bridge between the regional partners and the international organic movement.
- To facilitate the sharing of skills and to encourage best practice in organic agricultural research and teaching, the project will promote an ambitious program of staff and research student mobility visits between partners within the region.

Legal Framework and policy of organic agriculture

Steps and Strategy: organic farming and certification system in Pakistan

Objective: To establish sustainable infrastructure for organic farming in Pakistan

Targets/ Goals:
1. Identification of potentials and use of appropriate tools to sensitize and activation**:**
2. Arrange resources (Local and foreign through PC1 and Donations - Grant Agreements)

S. No.	**Steps**	**Strategy**		
		Way forward	**Marketing**	**Promotion**
1	Organic farming sector development Identification of organic products **Agri produce:** **Living** Land - Halal animals	Notification of TWC by Ministry. As a first step use of Universities to introduce subject; establish model farms for research and provide accredited lab	Identification of groceries to sell the organic products stores, supermalls; Supply chain (from	• Media • Print • Seminars • Product display • Model Farms

	Aqua - Fishery **Non-living** Fruits and Vegetables Grains and Cereals Wild produce Mechanism of checking/ surveillance and accountability	facilities. Capacity building Identification of focal points in provinces and F.G. level Follow IFOAM guidelines. PGS	field to fork) Storage IFOAM Norms trust building	
2	Testing Labs	Notified Testing Labs	PARC/ Universities	
3	Identification and Registration of Products Producers Areas	PARC-NIOA		
4	Marketing and selling Organic in the national/ International Market. DocumentationNational Policy, Logo, Standard adoption (IFOAM) or development. Guidelines and broachers for growers Certification, International CBs already working Development/establishing of new local CBs	Linkage development NIOA-POFA/LETIS NIOA-PNAC Inspection System	Inspectors	

	Accreditation IFOAM/PNAC/Joint			
5	Capacity Building Trainings, Creating awareness, Seminars, workshops, broachers in local language (understandable for local farmer)	PARC-NIOA		
6	**Important Issues to be addressed** • Seed certification; • Land without chemical traces; • Mechanism of checking/ surveillance and accountability through use of internal control system (ICS); • Illiteracy, to maintain documentation and use of latest technology; • Environmental problems/ issues	PARC-NIOA		

Source: NPO Meeting 26 – 30 January 2015

Public perception and attitude on organic farming

To initiate a knowledge-based program, that in short time could provide useful guidelines to farmers wishing to adopt organic farming techniques. Trend towards organic farming is developing among the small farming communities.

Social and economic factors contribution to rural livelihood development food and nutrient security

To establish the market linkage of the organic products within existing markets by developing and implementing a model of grading, packing & certified labels of organic produce. The use of organic products i.e. organic fertilizer, organic pesticides, organic herbicides and micro nutrients is a milestone which can reduce the huge amount of capital and would guarantee the better crop production for the sustainable livelihood of the human generations in future.

Existing programmes/ approaches to promote organic agriculture

The esisting programmes working at National Institute of Organic Agriculture (NIOA) are following.

1. **Organic vegetable/ crop production**:

   Production of summer and winter vegetables

2. **Tunnel farming (off-season vegetables):**

   Cultivation of off-season organic vegetables i.e. tomato, cucumber and sweet pepper

3. **Organic product certification**:

   Formation of national working group on organic product certification for academia, researchers and stake holders

Organic Certification in Pakistan

Objectives

- Development of Organic Concepts
- Registration of Organic Farmers
- Organic Certification of interested farmers with the collaboration of International organizations
- To achieve the above objectives we got the membership of IFOAM

Approach

- Selection of five agriculture institutes in provinces of Pakistan with support from NIOA proposing to hold seminars/ meetings to identify organic farmers.
- Discuss marketing and policy constraints on the expansion of organic agriculture in Pakistan.

- Preliminary meeting that involves all our partners to plan details of the model farms.
- Our partners will be involved in planning, inviting representatives of the organic agriculture sector, publicity, advertizing, and encouraging stakeholders to attend the meetings. This approach leverages existing resources.

  Developing capacity building with relevant institutes on organic agriculture i.e. Extension; Universities; NGO's

Other relevant information

- Development of awareness IFOAM norms.
- Demonstration at organic model farms.
- Trust building and peer guaranteeing system.
- Development of market linkages.
- Selection of five agriculture institutes in provinces of Pakistan with support from NIOA proposing to hold seminars/ meetings to identify organic farmers.
- Discuss marketing and policy constraints on the expansion of organic agriculture in Pakistan.
- Preliminary meeting that involves all our partners to plan details of the model farms.
- Our partners will be involved in planning, inviting representatives of the organic agriculture sector, publicity, advertizing, and encouraging stakeholders to attend the meetings. This approach leverages existing resources.

  Certification protocols for Different products. (Honey; Gram and persimmon

SUCCESSFUL STORIES

1. Formulation of organic fertilizer

A plant installed at at NARC (Fig. 34) is manufacturing organic fertilizer using the following Ingredients

- Rock phosphate

- Mud sulphur
- Gypsum
- FYM (Farm Yard Manure)
- Poultry waste

Total production since the establishment of biofertilizer plant at NARC 5897 bags (weighing 50 kg each) was manufactured. Out of these 4252 bags were used by NIOA, NARC, and IDPs and for demonstration purpose whereas 1645 bags were sold to private clients/ farms.

Fig. 34: Machiney for preparation of bio-fertilizer

2. Formulation of micro-nutrient solution

The micronutrients solution was formulated using the following ingredients:

- Humic acid 10-15 g $litre^{-1}$
- K2SO4 15-20 g $litre^{-1}$
- MgSO4 15-20 g $litre^{-1}$
- FeSO4 15-20 g $litre^{-1}$

- $CuSO_4$ 15-20 g $litre^{-1}$
- $ZnSO_4$ 15-20 g $litre^{-1}$
- Boron 15-20 g $litre^{-1}$
- $MnSO_4$ 15-20 g $litre^{-1}$

The solution when applied as foliar spray enhanced plant growth and increased yield.

3. Different formulations of Bio-pesticide

A plant installed at at NARC (Fig. 35) is manufacturing Biopesticide using the following Ingredients.

- Green chilli (10%)
- Garlic (10%)
- Aak (10%)
- Surfactant (01%)
- Tara mera oil (06%)
- Organic emulsion (2.5%)
- Water (60.5%)

Fig. 35: Machiney for preparation of bio-pesticides

The above formulation has been reported as effective against sucking and chewing pests on vegetables and field crops.

4. Preparation of Bio-herbicide

A plant installed at at NARC (Fig. 36) is manufacturing bioherbicide from the extraction of following plants

- Heaven tree
- Chenopodium
- Mulberry
- Sorghum
- Euclyptus
- Corn gluten

Fig. 36: Machinery for preparation of of bioherbicide

5. Development of organic farming technologies

NIOA was initiated observational development research on vegetables, field crops and mushrooms besides some allied activities with some success are summarized below:

- Crops and vegetables production by using bio-fertilizer, humic acid and micro-nutrients at different stages.

- Judicious use of irrigation water by making furrows or ridge sowing at different stages according to prevailing conditions.
- Green manuring
- Organic mushroom production.
- Land use without degradation; hill farming, terracing, soil and water conservation techniques.

6. Tunnel Farming

Three different types of tunnels i.e. high tunnels, walk in tunnels and low tunnels were used for growing organic vegetables out of season and vegetable seedlings (Fig. 37). Raising vegetable seedlings under these tunnel structures resulted better remuneration.

Fig. 37: Off-season organic crops growing in high tunnell

7. Trainings

Detail on trainings imparted and knowledge transferred to different clients is given below:

- On-farm trainings provided to more than 5000 farmers, agricultural professionals and extension workers from different areas of Pakistan in various disciplines
- Advisory services to small farmers at private farms

- Imparted trainings to 24 internee students from different universities
- Disseminated knowledge through T.V channels, meetings, demonstrations, exhibitions and lectures (formal and in-formal)
- Media used; T.V channels, meetings, demonstrations, exhibitions and lectures (formal and in-formal)
- On farm trainings provide to more than 5000 farmers, agriculture professionals and extension workers from different areas of Pakistan in various disciplines
- Advisory services to small farmers at private farms
- Trainings imparted to 24 internee students from different universities
- Trainings to NGOs imparted to 170 participants (Table 68)

Table 68: Training to NGOs

Date	No. of participants	Area	Trainings imparted
31.05.12	40	AJKCDP, Muzaffarabad	- Kitchen gardening - Nursery raising - Plant protection techniques - Preparation and use of organic fertilizer - Capacity building and communication skills
08.10.12	50	Green Circle Organization, Islamabad	
06.11.12	25	ICIMOD, Pakistan	
05.05.13	30	Punjab Province	
31.05.13	25	ODO, Mansehra	

Conclusion

From the above discussion whereby we added pros and cons to the organic farming methods, it is very clear that the technique has lot of advantages and a few disadvantages that can be overcome by little effort from farmers’ side. So, Organic farming is no doubt best in its application, you just need to upgrade your knowledge to get maximum benefit out of it! Conventional agriculture has caused economic problems associated with over production of crops, increased costs of energy-based inputs and decreased farm incomes. It has also produced ecological problems such as poor organic matter in our soils, soil and water pollution and soil erosion. Organic Farming minimizes energy-based chemical inputs, produce good yields, increase farm profits and decrease environmental problems.

Way Forward and Recommendations

1. Research infrastructure should be strengthened.
2. Collaboration with international organizations to meet the future challenges of food security and better livelihood of human civilizations on sustainable basis.
3. Emergency positioning of scientific staff
4. Organic certification system
5. Organic vegetable production
6. Organic seed production
7. Functioning of bio-products units at NARC
8. Provision of sufficient budget.
9. Opportunities of projects for efficient use of professional skills.
10. Permanent training schedule should be devised.
11. The rules and regulations of organic farming should be formulated.
12. Countrywide surveys should be done for the collection of data related to organic farming community to established national organic forum

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An Introduction and Possibilities for a SAARC Regional Organic Standard using AROS

Kesang Tshomo
Program Coordinator, Department of Agriculture, MoAF, Thimphu, Bhutan

Background

Asia Regional Organic Standard, Global Organic Market Access (GOMA), is an Initiative of the Food and Agriculture Organization of the United Nations (FAO), Rome, International Federation of Organic Agriculture Movements (IFOAM), Bonn, and United Nations Conference on Trade and Development (UNCTAD), Geneva.

The AROS describes the requirements for organic production. It covers plant (including mushroom) production, collection of wild products and also the processing and labeling of products derived from these activities but excludes animals. This standard provides a mechanism to define the expectations for organic production. When complied with, it also enables producers to label their products as organic. The standard does not cover procedures for verification, such as inspection or certification of products.

The main purpose for the establishment of AROS was to facilitate equivalence between organic standards and certification programmes within and beyond the Asia region. It was also anticipated that AROS could be adapted to serve as the national standard for some of the individual countries in the region if they chose to use it. The Global Organic Market Access (GOMA) Working Group for Co-operation on Organic labeling and Trade for Asia agreed on a vision and objectives for AROS.

Vision

To be inclusive of all or most countries in the East, Southeast and South Asia regions and be based on common regional requirements, the standard can be adopted or adapted as a national standard, particularly by countries that have not yet developed and promulgated their own standard.

Objectives

- To facilitate intra and inter-regional market access of organic products in the Asian region;
- To promote regional cooperation and exchange of information and enhance private and public sector dialogues;
- To promote the global recognition of the regional standards as a long-term goal.

Therefore, the AROS is a harmonized Asia Regional Organic Standard (AROS) which was developed with participant members from 12 Asian countries including SAARC countries namely Bhutan, India, and Sri Lanka, as Asia Working Group for GOMA.

The AROS has been approved and listed in the IFOAM Family of standards as one of the standards recognized among the United Nation Forum of Sustainable Standards. This has also been referenced and discussed to be used by the ASEAN countries for their organic horticultural trade in the development of an ASEAN Standard for Organic Agriculture (ASOA). This is available for the SAARC to use as starting point for developing a regional organic standard instead of starting from scratch. To initiate the process SAARC could approach the UNFSS to support starting with a briefing of the regional countries of the status and way forward for a common standard and certification system.

The United National Forum on Sustainability Standards (UNFSS) has been created as an intergovernmental policy forum to provide information and analysis on voluntary sustainability standards with focus on developing countries to achieve their sustainable development goals. The UNFSS addresses the potential trade or development obstacles these standards may create, with analysis of organic, GAP and other sustainability standards in their country's context and i n implementing UNFSS recommendations. (UNFSS) offers such technical assistance to help with need based assessments and awareness and standards harmonization upon specific request from developing countries. They carry our regional briefings around the world. Such briefings have been held in Central America, East Asia, South-east Asia, and West Africa.

SAARC Secretariat could also request for such briefing for the SAARC member countries and prepare for collaborated development in the future.

AROS can be downloaded at http://www.goma-organic.org/regional-rojects/asia/.

Way Forward for a SAARC regional common organic standard

1. Request for briefing on regional group and common organic standard to UNFSS
2. Request UNFSS for technical support to facilitate procedures
3. Based on the common SAARC organic standard, SAC initiate for development of conformity assessment system, harmonization of system and accreditation for member countries
4. Training and capacity building in the common need areas and exchange technical expertise
5. Institute registration of organic inspectors for common standards so certification can be cheaper.
6. Promote recognition of SAARC organic mark among the regional market.

Conclusion

An assessment of the status of the organic standards and regulations was already done as a part of the process of the AROS and some of the key information are already available which could be accessed by the SAARC countries to develop and common regional standard and inspection and certification process so that organic trade in the region can grow much faster than is happening now so that a wider public can have access to organic food more easily and at a cheaper price so that the region may be healthier and more nutritionally secure.

Websites accessed

1. www.fao.org/docrep/015/an765e/an765e00.pdf
2. www.ifoam.bio/.../ifoam-projects-harmonization-and-equivalence-standards- itf-goma-unfss
3. unfss.org/
4. https://unfss.files.wordpress.com/.../intro-prest-unfss-launching-conference-21march-vers2.pdf
5. scanprogram.org/related-projects/unfss/

Evaluation of Bio-fertilizers on Cauliflower Production

Tashi Gyalmo

Research Officer, Horticulture Sector, RNR-RDC, Yusipang, Bhutan

Background

The centre resorted to undertake this research trial as such initiatives are felt mandatory if we are to achieve our nation's steadfast mission of going organic by the year 2020. It is also geared towards finding means of replacing our current trend of agricultural system, wherein we are using excessive chemical fertilizers in nourishing our plants while we are least bothered about the health of our soils. While many dwelling in the farming community have minimal or no knowledge on the beneficial soil microbes, it is also to be emphasized that farmers need to be educated on this aspect of maintaining soil health and the crucial role such microbes can play in agriculture. The need to stress on the maintenance of soil health which is a gateway to sustainable farming is also to be prioritized.

Objectives

- To address the increasing problems associated with the use of synthetic chemicals in agriculture through the use of bio-fertilizers.
- To find means of practicing sustainable agriculture by providing an ecological environment where all the microbial community could live in harmony wherein they can balance each other in their quest for food and space.

Materials and Methodology

Materials

FYM, Vermi-compost, Vermi-wash, Liquid manure, Compost tea, Heap compost, Buckets and jugs, Water, Cauliflower (Snow Mystic hybrid) seedlings (693), Spades, hand hoes, Bamboo pegs and metallic sheets, Paint and brush, Measuring tape and weighing balance, Plastic crates.

Methodology

Seven treatments i.e. FYM, vermi-compost, vermi-wash, liquid manure form biodigester tank, compost tea, heap compost and control were used (Table 69).

The solid bio-fertilizers were applied around the root zone while the liquid formulations were poured around the root zone of the crop on fortnightly interval except for FYM, which was stopped after its second application. In total, there were 6 applications in the entire crop period.

The RCBD experimental design was used to carry out the trial. Seven treatments including control and 3 replications were designed. The trial encompassed a total area of 105 m^2 with 21 plots of 5 sm^2 each. The seedlings were spaced at 30x45 cm, amounting to total plant strength of 693.

Fig. 38: Seedlings in the nursery Image   Fig. 39: Transplanting

Table 69: Treatments details, rate of application and interval of application

Sl. No.	Treatments	Rate of application	Application interval	Source
1	FYM	5 kg per bed	Fortnightly	Locally from private farms
2	Vermi-compost	3.5 kg per bed	Fortnightly	Locally prepared at RC-Yusipang
3	Vermi-wash	1L in 10L water per plot	Fortnightly	-do-
4	Liquid manure from Biodigester tank	1L in 10L water per plot	Fortnightly	-do-
5	Compost Tea	1L in 10L water per plot	Fortnightly	-do-
6	Heap compost	5 kg per bed	Fortnightly	-do-
7	Control	Without treatment	-	

Ten plants per plot were randomly selected and the curd weight was recorded. From the data, the average curd weight of the plots with same treatment was derived. Yield per hectare and the comparative yield advantage of the other treatments over the control plot were also worked out.

Result and Discussion

Compost tea and vermivash produced comparatively the highest yield than other treatments (Table 70). Accordingly, the comparative yield advantage of the different treatments over control was observed (Table 70). Treatments of compost tea and vermivash produced 50.90% and 23.70% more curd yield than control.

Conclusion

Compost tea and vermivash are best choice to use as bio-fertilizers for higher production of cauliflower. However, heap compost also gave comparatively good results. This can also be used if available.

Fig. 40: A glimpse of the cauliflower curds

Table 70: Comparison of yields between treatments

Sl. No.	Treatments	Curd weight (g)	Yield of curd (mt ha^{-1})	Comparative yield advantage of treatments over control (%)
T1	FYM	393.0	25.64	09.84
T2	Vermi-compost	376.7	24.55	05.19
T3	Vermi-wash	442.7	28.87	23.70
T4	Liquid manure	361.3	23.56	00.95
T5	Compost tea	540.0	35.22	50.90
T6	Heap compost	435.7	28.41	21.69
T7	Control	358.0	23.34	-

Evaluation of Bio-repellents on Pest Control in Cabbage

Tashi Gyalmo
Research Officer, Horticulture Sector, RNR-RDC, Yusipang, Bhutan

Background

Vegetable production during summer in the cooler regions and during winter in the warmer belts of the country is a sole activity contributing to the livelihood of many dwelling in farming community. Among many, the most important cash crop is cole crops which include cabbage, cauliflower and broccoli. Despite the challenge taken up by the farmers in enhancing production and opting to vegetable commercialization, they are always confronted with problems like the menace inflicted by pests and diseases. One rampant pest curtailing cole crop production is the infestation of Cabbage White Butterfly (*Pieris brassicae*). This has however led to the use of hazardous pesticides. Though the use is on a limited scale at the moment, it might lead to its indiscriminate use over the years. Then the danger of the pests developing resistance to the pesticides and the problem of pest resurgence coupled with the residual effect that it would leave on soil, and the corresponding environmental damage might ensue if we resort to its indiscriminate use. Therefore, a need to explore means of organic pest control is strongly felt. In line with this, an effort in studying the efficacy and the economics of using such locally prepared bio-repellents as well as the ease with which the materials can be obtained in the locality is a prerequisite step before recommending and or taking the technology to the farmers' field.

Objectives

- To identify the most suitable organic pest control measures keeping in view its efficacy, availability, economics and applicability in our local conditions against common and destructive pests.
- To explore eco-friendly measures of pest control that would contribute to sustainable agriculture.

Materials and Methodology

The trial was carried out in RCBD experimental design with 5 treatments including control and 3 replications. In total, there were 15 plots of 6 m^2 dimension each. The plants were indented at a spacing of 30x45 cm. The trial area of 90 m^2 encompassed a total plant population of 585. Five treatments viz.; Garlic brew, stinging nettle and cow urine extract, wood vinegar and Artemisia leaf extract including control were used (Image 3.4). The treatment application started a week after transplanting and continued on weekly basis. The method of application resorted to was foliar application with knapsack sprayer. A total of 9 applications were sprayed. It was stopped a week before harvesting.

The plants were visually inspected for the incidence of pests as well as the insect feeding damage on weekly basis simultaneously with the treatment application (Image 3.5). The total number of plants with insect feeding damage and total yield per plot were also recorded ultimately.

Results and Discussion

The crop reached its harvestable maturity in a span of 114 days after sowing. The details of the data are as illustrated in the Table 71. Yield advantages of 2.68-5.47% in bio-repellent treatments were observed over cover control.

Table 71: Average number of plants infested and Average Yield

Treatments	Nnumber of plants infested (per plot)	Yield (mt ha^{-1})	Yield advantage of treatments over control (%)
T1 (Garlic brew)	2.67	32.46	3.69
T2 (Stinging nettle and cow urine extract)	0.67	36.85	5.47
T3 (Wood vinegar)	6.00	33.27	4.02
T4 (Artemisia leaf extract)	2.00	29.96	2.68
T5 (Control)	7.00	29.64	-

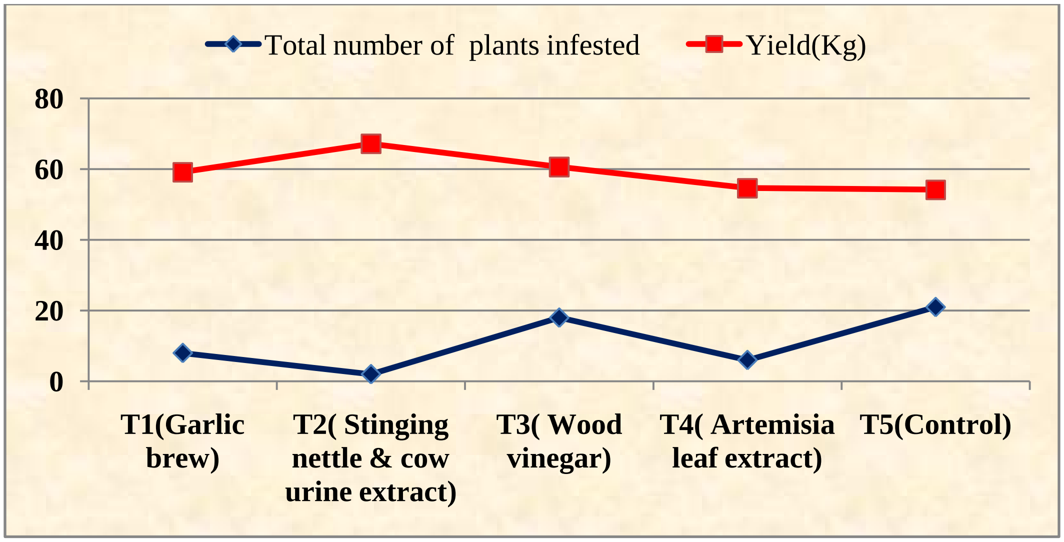


Fig. 41: Inverse relation between number of infested plants and yield

Total number of infested plants had inverse relation with the total yield (Fig. 41). Nnumber of plants infested was found to be lowest in treatment having stinging nettle and cow urine extract. Yield was recorded to be the highest in the same treatment. Highest rate of infestation by pests was recorded in control treatment. Consequently lowest yield in control was obtained.

Table 72: Pearson's Correlation

	Yield
No. of infested plants	-0.205

Pearson's correlation indicated that the number of plants infested and yield were negatively correlated at Pearson's correlation coefficient (r) of 20% (Table 72).

Table 73: ANOVA showing F-value

	Sum of squares	**df**	**Mean square**	**F**	**Significance**
Between Groups	88.00	4	22.000	8.049	0.004**
Within Groups	27.33	10	2.733		
	115.33	14			

Total number of infested plants was highly significantly at 0.01 significance level between the treatments (Table 73). However, the treatments had minimal influence over the yield per unit area among the treatments.

Conclusion

Combination of stinging nettle and cow urine extract proved to be the best treatment in warding off the commonly prevalent pests with only 2 plants with feeding damage in one of the replications, while 2 plots in the other 2 replications recorded zero infestation. The treatment also did well in producing heads of better quality and in nourishing plants for comparatively higher yields though significant variation was not observed in the yields among the treatments. In contrast, the highest rate of insect feeding damage of 21 and the corresponding decrease in the yield were observed in control.

Therefore, it can be suggested that the use of stinging nettle and cow urine extract be encouraged in our farming system. However, this conclusion is reached solely based on the trial data of only a single season and the reliability of the research findings is questionable until the results are reaffirmed by similar trials in the coming seasons.

One major drawback of such bio-formulations/ repellants is its limitation in their storability as the formulations should be applied within 2 days of its preparation. Further, the frequency of application might hamper its adoption by the farming community where labour scarcity is an issue.

Fig. 42: An overall view of the trial plot

Fig. 43: Nursery Raising; Line sowing of seeds in green house, dated 24.02.15

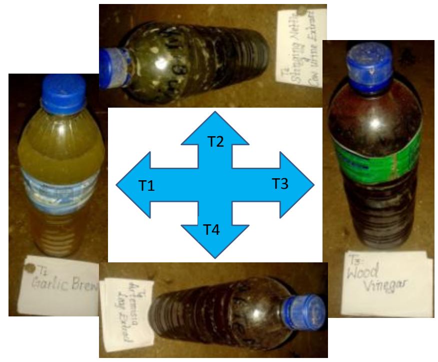


Fig. 44 (Left): Seedlings ready for transplanting (DOT: 08.04.2015)
Fig. 45 (Right): Treatments of the experiment

Fig. 46 (Left): Visual inspection of plants for insect feeding damage
Fig. 47 (Right): Pests observed during visual inspection

Fig. 48 (Left): A glimpse of the trial plot
Fig. 49 (Right): The harvested cabbage heads

Initiatives to Promote Organic Pest Management through Health and Environment Friendly Methods

Thinlay[1] and Phuntsho Lodey[2]

[1] Specialist, National Plant protection Centre, Semtokha

[2] Assistant Entomologist, NPPC, Semtokha

Estimated crop losses to pest

- Combined pre and post harvest losses to insects' ranges from 10-30%, to diseases about 15-30%, and to weeds about 10-15%.
- Loss figures are mostly based on farmers and researchers estimate.
- Experimental crop loss study has not been done.

Table 74: Major insect pests, diseases and weeds of major crops grown in Bhutan

Crops	Insect pests	Diseases	Common weeds
Rice	Stem borer, case worms, leaf folder	Brown spot, Blast, Sheath rot	*Potomegaton* (Shochum)
Potato	Tuber moth, aphids Red ants	Late blight, Viruses	*Cyperus spp. Digitaria spp, Ageratum conizoids, Ageratum Galinsoga, Fogopyrum, Chenopodium, Fumario parviflor and others*
Maize	Stem borer, Cut worm	Grey leaf spot, Turcicum blight	*Cyperus spp. Digitaria spp, Ageratum conizoids, Ageratum Galinsoga, Fogopyrum, Chenopodium, Fumario parviflor and others*
Vegetables/ Chillies	Cut worm, DBM, Aphids, Fruit borer, thrips and mites	Wilt/Blight, Rots viruses	*Cyperus spp. Digitaria spp, Ageratum conizoids, Ageratum Galinsoga, Fogopyrum, Chenopodium, Fumario*

			parviflor and others
Apple	Beetles, Weevils, scales Mites, Borers	Scab, PLF, Rust	*Cyperus spp. Digitaria spp, Ageratum conizoids, Ageratum Galinsoga, Fogopyrum, Chenopodium, Fumario parviflor and others*
Citrus	Trunk borer, Psyllids Fruit fly	Greening, Powdery mildew, Scab, Root rots	*Cyperus spp. Digitaria spp, Ageratum conizoids, Ageratum Galinsoga, Fogopyrum, Chenopodium, Fumario parviflor and others*

Initiatives

1. Policy initiatives
2. Technical Initiatives

Policy Initiative

- Since the inception of development activities in Bhutan in early 1960's plant protection service was one of the major focus for development in agriculture. During those days plant protection service was synonymous with use of pesticides.
- Pesticides were distributed free regardless of whether they were actually required, or used in pest control activities.
- From 1993 focus was shifted to the development of Integrated Pest Management and phasing out of toxic pesticides use.

Withdrawal of Subsidy on Pesticides

Withdrawal of subsidy on pesticides since 1990 in a phased manner is important policy decision taken to discipline farmers from misuse and overuse of pesticides. This had a positive impact on all sections of farmers and they have been very careful in placing demand for pesticides.

Year	% Withdrawal of subsidy*
1990-91	15
1991-92	30
1992-93	45
1993-94	60
1994-95	80
1995 onwards	100

Table 75: Impact of withdrawal of pesticide subsidy

Crop	Pre-subsidy withdrawal	Post-subsidy withdrawal
Potato	3-4	1-2 (during late blight outbreaks)
Maize	None	None
Rice	1-2 for control of blast disease	Only Herbicides used
Chili	-	None
Vegetables	1-2	Still used in cabbage/ cauliflower
Citrus	-	Bait spray
Apple	3-4	1-2 (to control scab and PLF diseases)

Prohibition and Disposal of toxic and unused pesticides

- WHO class 1a, 1b and 2a pesticides prohibited for use
- Banned chlorinated hydrocarbon, POPs, mercury and Arsenic based pesticides
- Disposed 32 MT of toxic and unused pesticides
- Introduced cash and carry system for pesticides

Table 76: Technical Initiatives to promote organic pest management

Crop	**Initiatives**	**Output to date**	**Institution involved / Collaborator**	**Remarks**
Rice	Resistance breeding since 1995-96 for the management of blast disease epidemics and annual monitoring of the disease through trap nurseries	Six resistant varieties released, annual monitoring data available	NPPC, IRRI, RDCs (Bajo, Yusipang, Bhur)	All resistant varieties widely cultivated
Maize	Resistance selection of CYMMIT maize lines since 2006 for managing GLS and TLB outbreaks	Two varieties in advanced stage of release	NPPC/ CYMMYT / RDC Wengkhar	Field demonstration and varieties provisionally released
Chili	Control of pod borer with NPV and Pheromones trap	Pheromones trap effective in reducing adult borer population, NPV not very effective in the field conditions	NPPC / Farmers	Timing of spray critical

Table 77: Other Initiatives to promote organic pest management

Crop	**Initiatives**	**Output to date**	**Collaborator**	**Remarks**
Chili	Management of chili blight disease through cultural practices (spacing, drainage, mulching, raised bed)	Successful in reducing disease but farmers reluctant to adopt	NPPC / Farmers	Labor intensive
Potato	Management of potato tuber moth by using *Artemisia* in the store	Adult moth repelled by the *Artemisia*	NPPC / Farmers	

Table 78: Initiatives to promote organic pest management

Crop	Initiatives	Output to date	Collaborator	Remarks
-	Training on bio-control agents and laboratory methods	Extension agents and NPPC staffs trained	Pest control Institute, Hyderbad, India	Proposed to set-up appropriate bio-control laboratory, but funding remains a major problem

Major Social and Technical Challenges in organic Pest Management

1. Farmer's Perception
2. Weeds in Rice and Potato
3. Availability of effective Bio-pesticides (Locally and regionally)
4. Organic solution for the control of chili blight, potato late blight, Citrus HLB disease
5. Farm Labor shortage

Chinese Citrus Fruit Fly (*Bactrocera minax*) Area-Wide Management

It is major pest of Citrus in Bhutan. It causes loss up to 70-80% fruit drop. Area-wide management is critical in managing such pests which can fly over long distances

2012: Prior to the initiation of the program

1. Fruit drop survey was carried out in Tsirang, Dagana and Sarpang.
2. Selected Kikorthang and Dunglagang, Tsirang Dzongkhag with contiguous area with high fruit fly infestation
3. Area-Wide Management Initiated since 2013

Major components of the program

- Farmers mobilization/ Group formation: coordinated control approach over a large area

- Farmers training
- Environmentally friendly control approaches: Protein bating & fruit drop collection
- Monitoring and evaluation of the program(fruit fly infestation level survey, monitoring fruit drop collection)
- Conducted research on attraction and effectiveness of the protein baits

Farmers' mobilization/ Group formation

Kikorthang and Dunglagang Geogs, Tsirang

Kikorthang	: 159;	farmers (22 groups)
Dunglagang	: 71;	farmers (11 groups)

Environmentally friendly control approaches: Protein bating and fruit drop collection

Protein Baiting

- Done weekly from Mid April, May, June and fortnightly in July (2013; 2014)
- Protein bait spraying: Protein source+ insecticides; fruit flies require protein for sexual maturation, hence, are highly attracted to protein
- protein attractant mixed with a small amount of insecticide; applied as spot treatment

Fruit Drop Collection

- Carried out from end of October till mid December
- Collected fruits dumped in pits and destroyed

Monitoring and evaluation of the program: Fruit fly Infestation surveys, monitoring, fruit drop collection

- Determination of fruit fly infestation levels through fruit sampling: 100 fruits on trees randomly sampled (10 fruits per tree per orchard)
- A total of 1000 fruits on trees sampled on each sampling period
- Sampling undertaken in treated and untreated

Monitoring of fruit drop collection: Farmers provided with record sheets to document information on fruit drop collection

- Determination of fruit fly infestation levels through fruit sampling: 100 fruits on trees randomly sampled (10 fruits per tree per orchard)
- A total of 1000 fruits on trees sampled on each sampling period
- Sampling undertaken in treated and untreated

Monitoring of fruit drop collection: Farmers provided with record sheets to document information on fruit drop collection

- Determination of sexual maturity of flies in Tsirang
- Fruit fly infestation levels significantly different in treated areas (AWM program sites) compared to the untreated sites
- Significantly higher number of fruits has been infested in untreated sites compared to the treated sites. Hence, the Area Wide fruit fly management program has achieved some level of success in reducing the fruit fly infestation levels

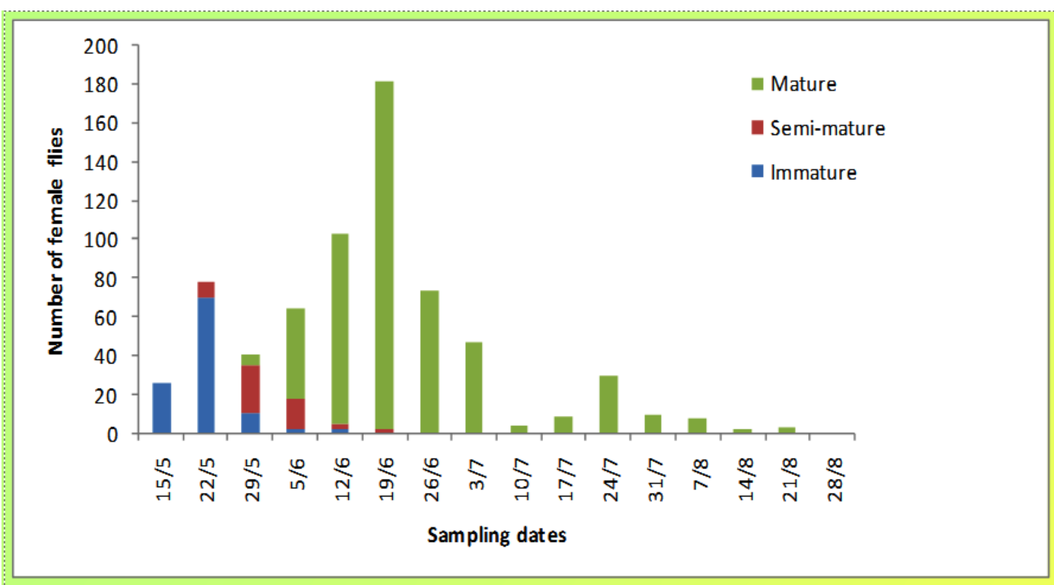


Figure 3. Seasonal ovarian development pattern of female *B. minax* flies, captured in PET bottle traps, in mandarin orchards in Tsirang, Bhutan in 2013

Fig. 50: Seasonal ovarian development pattern of female B. minax flies

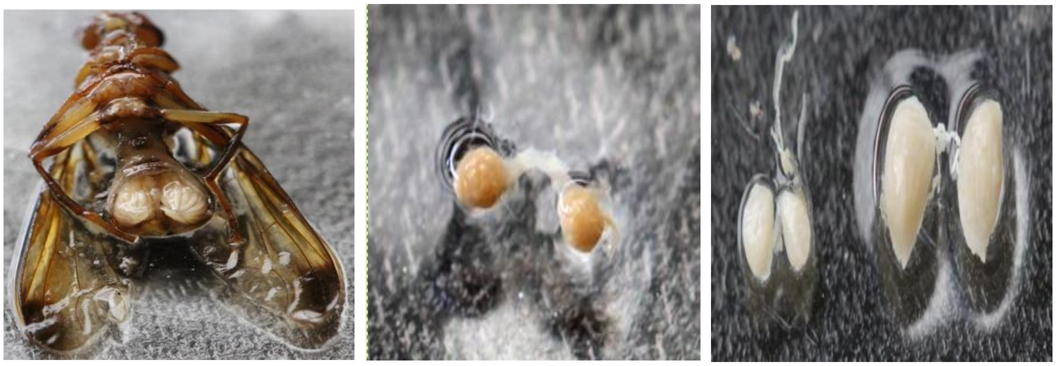


Fig. 51: Different stages of development of female B. minax flies

Table 79: Outcome of the baiting program (2014 sampling): Fruit fly infestation levels in treated and untreated areas

Treatments	Mean infestation levels	Standard Error mean
Treated area	17.75 a	2.44
Untreated area	58.75 b	3.55

Means followed by the same letter are not significantly different (t - test on log [x+1] transformed data: P = 0.05

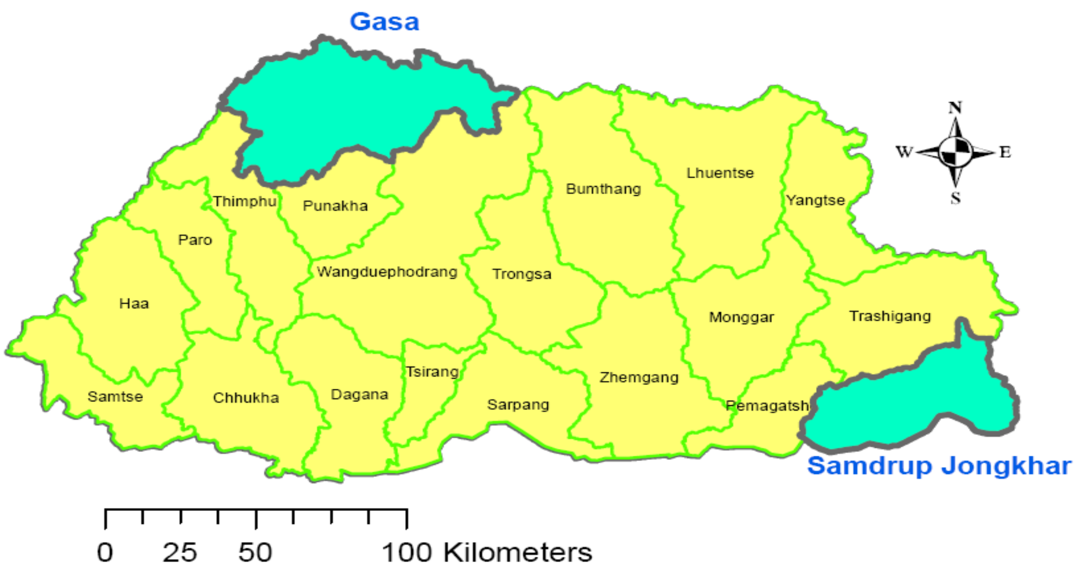
Conclusion

1. Farmers overall knowledge levels has greatly been improved over the program period.
2. Additional knowledge generated: Specifically on fruit fly emergence in Tsirang, sexual maturity, bait effectiveness and the response of the CFF to different baits.
3. AWM Program has been successful with fruit fly infestation level being significantly reduced in treated sites compared to untreated areas.

Organic Cropping Management and Soil Health

Yadunath Bajgai
RDC, Bajo, Bhutan

District-wide organic initiatives



Samdrup Jongkhar Initiative

- Ecologically friendly development
- Seeks to balance sustainable economic development with environmental conservation, cultural promotion, and good governance

Gasa – Another organic district

- Gasa is organic by choice
- Works closely with the Research Center in Bajo
- To increase yields while remaining organic.
- Research program was initiated in 2012 and
- Intends to increase vegetable production and marketing.126

- Imports rice but self sufficient in vegetable
- High altitude less pest and diseases

Garlic Production in Gasa

Table 80: Yield performance of garlic in Gasa

Village	Farmer	Crop-cut yield (kg)			Average yield per plot (kg)	Yield Kg/acre
		Sample I	Sample II	Sample III		
Khalio	1	1.4	1.2	1	1.2	809.4
	2	1.5	1.7	1.3	1.5	1011.8
	3	0.8	1.6	1.2	1.2	809.4
Damji	1	1.2	1.2	1.4	1.3	854.4
	2	1.4	1.2	1.1	1.2	831.9
	3	1.6	1.2	1.3	1.4	921.8
Yemina	1	1.3	1.2	1.1	1.2	809.4
	2	1.3	1.4	1.2	1.3	876.9
	3	0.9	1.5	1.3	1.2	831.9
		Average				861.9

Source: Annual Report 2013-14, RDC Bajo

Organic vs conventional

- Corn residue reduces weed biomass significantly
- Allelochemicals released during decomposition of residues
- Could we use such techniques to control weed in OA?

  Source: Bajgai *et al*, 2015

Economic performance of Toktokha farm

- Comparison organic and non-organic farms of 10 identical farms
- Area - 0.25 acres (0.5 langdo)
- 5 vegetables (radish, beans, mustard green, chilli and cabbage)
- two-sample t–test (equality of means tested

- Mean organic farms - 646.8 kg and net profit - Nu. 9,440.5
- Mean non-organic farms - 599.2 kg and the net profit - Nu. 10,052.10
- Mean quantity, production cost not different
- Mean net profit not different
- Yield of OA not lower than conventional
- No premium in market but there is premium over the imported food due used

Source: Zangpo and Sonam, 2014

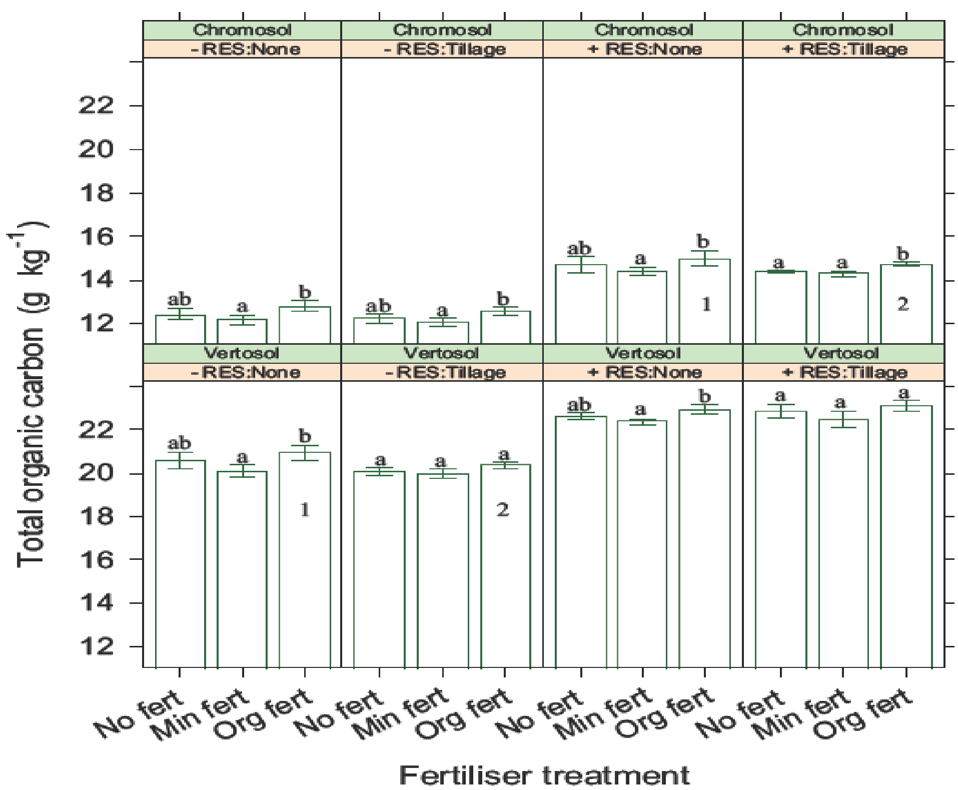


Fig. 52: Total organic carbon available under minral and organic fertilizer treatments

- Mineral fertilizer < No fertilizer
- Mineral fertilizer < Organic fertilizer
- No fertilizer and Organic fertilizer no difference

Source: Bajgai *et al*., 2014

Organic management – improves soil health

- Soil organic carbon% X 1.72 = SOM (Pribyl, 2010)
- Higher SOM content - reservoir of soil nutrients (Wells *et al.* 2000; Bajgai *et al*. 2014 and 2015)
- Increased soil aggregate stability (Maeder *et al*., 2002; Williams and Petticrew, 2009).
- Improved infiltration rate of water (Pimentel *et al*., 2005; Zeiger and Fohrer, 2009).
- Increased water holding capacity, more soil moisture for same quantity of soil (Lotter *et al.*, 2003; Pimentel *et al*., 2005).

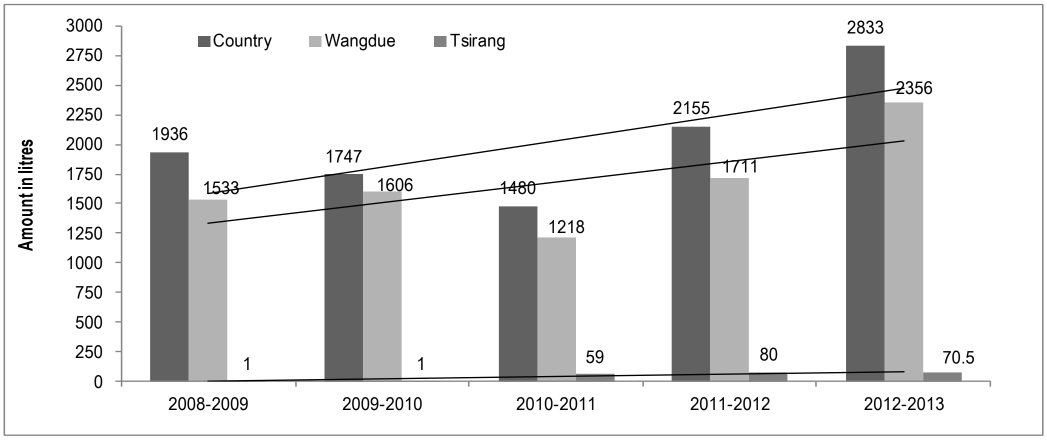
Fig. 53: Increased soil C and N

Fig. 54: Increased stability

Source: Andre Leu, 2011

Critical resource of organic agriculture lacking

- Lack of farm labour - Labour shortage has forced increased use of Glyphosate
- Restricts many farm activities that manual in nature like weeding
- Use of weedicide – butachlor in rice unavoidable



Source: Yeshi and Bajgai, 2014

Fig. 55: Amount of weedicides used during 2008-09 to 2012-13

Research needs

- Use of Butachlor in paddy not replaceable organic alternative
- Need to determine a sustainable alternative – biocontrol?
- Farmers unlikely to adopt organic unless problems are solved
- Soil fertility management – another challenge
- Alternative to common fertilizers - Urea and Suphala need to be developed
- Disadvantages of manures/ compost – larger volumes and lower in nutrient contents

Prospects

- Inaccessible and distant places - organic by default
- Conversion to organic easy due minimal/ non-use of chemicals
- Conservation of biodiversity and soil resources
- Help to eradicate poverty, promote gender equality and ensure better nutrition and health
- Opportunity for small holders to commercialize e.g. red rice

CONCEPT NOTE

Status and Future Prospect of Organic Agriculture for Safe Food Security in SAARC Countries

Background

The conventional agriculture of SAARC countries after the green revolution depended on chemical compounds that had a negative impact on soil, human health and the environment. Increasing global concern over the use of chemicals in agriculture is behind a growing trend of using organic methods of agricultural production. Organic Agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. It is considered to be a suitable agricultural production process to ensure harmonization between human welfare and sustainable development.

In recent years, some organic agricultural technologies have proven to be effective and accepted by the farmers in SAARC region. These include integrated rice–duck farming practices, organic vegetable production in sack, pheromone-trap for insect control, compost (kitchen waste, vermin-compost, pile compost, basket compost etc.) .

Until now, however, a domestic market that pays for organically produced food has not emerged and SAARC countries have not been able to benefit from the growing global organic market. The Asian countries together currently account for only 7% of the total global organic land, China and India being major contributors. To develop the organic agricultural sector in SAARC member countries, the Governments need to develop appropriate policies providing incentives for organic research and adoption. Promotion and practice of organic farming is not only important for SAARC member countries for maintaining safety of its environment and ecology, it is also important in the global organic market context.

SAARC member countries being a major agro-based populated country, the global organic industry will benefit from its participation in the international organic market.

Rationale

There is another growing concern called “food safety”. The food available in the market must be safe and healthy. The excessive, uncontrolled use of chemical fertilizer, pesticides, GMO seeds, use of contaminated water in food production and processing, unhealthy processing of food, use of toxic colours in food, giving high antibiotic and growth hormone to our chicken, cows and goats, etc., using formalin in fish, milk and fruits, using hazards chemicals to ripen fruits are very open and known food adulterations in our country. The consumers are panic and they are looking for safe food in affordable price.

Hunger Free World in SAARC region is promoting organic agriculture and a holistic lifestyle, sustainable with nature so that food production and harvesting system is present at grassroots. Only criticism will create panic but we need concrete actions on the ground as solution. If we take one bold step today then gradually many other will join together. We need a paradigm shift towards the organic and sustainable agriculture and a holistic sustainable lifestyle.

Organic farming is environment friendly, sustainable, healthy and can reduce many existing challenges that our countries are currently facing like shortage of power and water contamination. Organic farming is not only a production method but it is a system that strengthens the social bondage and unity in a community. It restores the respect between men-women on equality.

The project aims to increase household income from higher-value agricultural products sold in the market; improved nutrition due to higher-quality food consumed in the households; and a stronger base of agricultural and organizational knowledge and capabilities.

Benefits

These benefits include:

1. Ecological Sustainability

- Recycling nutrients instead of applying external inputs.
- Preventing the chemical pollution of soil, water and air.
- Promotion of biological diversity.
- Improving soil fertility and the buildup of humus.
- Preventing soil erosion and compaction.
- Promoting the use of renewable energies.

2. Social Sustainability

- Supporting sufficient production for subsistence and income earning for small farmers.
- Providing safe and healthy food.
- Supporting the adoption of good working conditions.

- Building on local knowledge and traditions.

3. Economic Sustainability

- Helping farmers achieve satisfactory and reliable yields.
- Providing a lower reliance on and associated cost for external inputs.
- Promoting crop diversification to improve income security.
- Promoting product value addition through quality improvement and on-farm processing.
- Promoting the adoption of efficient farming systems to improve overall profitability and competitiveness.

Goals

1. Employing long-term, ecological, systems-based organic management.
2. Assuring long-term, biologically-based soil fertility.
3. Avoiding/ minimizing synthetic inputs at all stages of the organic product chain and exposure of people and the environment to persistent, potentially harmful chemicals.
4. Minimizing pollution and degradation of the production/ processing unit and surrounding environment from production/ processing activities.
5. Excluding certain unproven, unnatural and harmful technologies from the system.
6. Avoiding pollution from surrounding environment.
7. Maintaining organic integrity throughout the supply chain.
8. Providing organic identity in the supply chain.

Objectives

1. To document organic agriculture scenario and further possibilities in member country
2. To find out the best possible ways for harvesting the maximum output from the sector on the basis of opportunities available in the SAARC member countries
3. To bring awareness on dangers of conventional farming based on synthetic external inputs.
4. To promote regional cooperation and exchange of information
5. To facilitate regional initiatives for cooperation,

6. To promote the global recognition of the regional standards as a long-term goal.
7. Increase awareness of the need and opportunity for harmonization and equivalence for organic trade

Country presentation outline

- Summary
- Country profile
- Concept, brief history and strategic importance of organic farming
- Organic & inorganic area, and types of organic & inorganic manure
- Principles of organic agriculture, Scope and Objectives
- Components of organic farming
- Country status of agriculture today, including pesticide and fertilizer (organic, inorganic, cultivation system, adoption of their environmental conditions) used
- Soil fertility and fertilization
- Conversion of conventional to organic farming
- Hazards of inorganic farming
- Positive and negative effects on agriculture
- Farm waste recycling, organic mulches etc
- Scope of organic Agriculture including organic manures produced etc.
- Soil and crop management
- Preparation of organic matter, humus, sewage sludge, organic compost etc
- Maintenance of buffer zone
- Split production and parallel production
- Choice of crops and varieties
- Natural safe products for control of pest, disease, weeds, diseases and growth management
- Post harvest management
- Quality of food and crop productivity under natural ecological systems
- Processing, Handling, Packaging

- South Asian organic farming and trade/ market analysis
- Issues and scope of marketing organic produce
- Government support and South Asian/ International cooperation on organic agriculture
- Research and Development Institutes
- Legal framework and policy of organic agriculture
- Public perception and attitude on organic farming
- Social and economic factors, contribution to rural livelihood development, food and nutrient security
- Existing programmes/ approaches to promote organic agriculture
- Any other relevant information
- Successful stories
- Conclusion
- Way forward and country recommendations
- References/ websites accessed

- **Support your data in form of graphs, tables and photographs as mentioned in ToR.**

Participants

One participant each from Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka will be invited to attend the consultative meeting.

Country Presentation

One participant having experience and adequate exposure from each country will submit a detailed country status report prior to the meeting and be requested to make power point presentation on the aspects related to prevailing organic agriculture in the respective country and further innovations to raise productivity and farm income.

Honorarium for the Focal Points

In addition to air fare, food and lodging, a modest honorarium will be provided to each of the focal point experts for his write-up and preparation of the country paper to be presented in the meeting.

Paper Presenters in the Regional Consultation Meeting

Country	Name and Designation	Address
A. Programme Organizer		
SAC	**Dr. Muhammad Musa** Senior Crop Specialist (Crops)	SAARC Agriculture Centre, BARC Complex, New Airport Road, Farmgate, Dhaka-1215, Bangladesh**.** **Email**: mum96@hotmail.com **Tel**: +880-2-8115353 **Cell**: +880-1778-945935, +92-300-6782882
B. Focal Point Experts from SAARC countries		
Bangladesh	**Dr. Muhammad Nazim Uddin** Scientific Officer	Olericulture Division Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh **Email**: nazim.hrc@bari.gov.bd nazim.68@gmail.com **Cell No.** +880-1552-440974,-1715-087383 **Fax**: +880-2-9261495
Bhutan	**Mrs. Kesang Tshomo** Program Coordinator	National Organic Programme Department of Agriculture, Ministry of Agriculture and Forests, Tashichhodzong Complex, Thimphu, Bhutan **Email**: ktshomo@moaf.gov.bt **Cell**: +975-17610467 **Phone**: +975-02-351079 **Fax**: +975-02-351695
India	**Natesan Ravisankar** Principal Scientist	ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut-250 110, Uttar Pradesh **Email**: agrosankar2002@yahoo.com.in

Country	Name and Designation	Address
		ifsofr@gmail.com **Cell:** +91-8755195404 **Fax**: +91-121-2888546
Maldives	**Rifaath Hassan** Assistant Director	Ministry of Fisheries and Agriculture Republic of Maldives **Email**: rifath.hassan@fishagri.gov.mv **Fax**: +960-3326558 **Cell:** +960-7995478
Nepal	**Dinesh Babu Tiwari** Senior Plant Protection Officer	Department of Agriculture, Nepal **Email**: dineshtiwari21@gmail.com
Pakistan	**Dr. Muhammad Riaz Chattha** Director (NIOA)	National Agricultural Research Centre, Islamabad, Pakistan **Email**: riaznarc@ yahoo.com **Cell**: +923005169583 **Phone**: +92519255361 **Fax**: +92519255034

C. Local Paper Presenters (Bhutan)

1. Dr. Thinlay, Plant Protection Specialist, Local technical presenter, National Plant Protection Centre, Department of Agriculture, MoAF, Thimphu, Bhutan.
2. Dr.Yadunath Bajgai, Principal Research Officer, Local technical presenter, RNR - Research and Development Centre, Bajo, Wangdue Phodrang, Bhutan.
3. Tashi Gyalmo, Research Officer, RNR - Research and Development Centre, Yusipang, Thimphu, Bhutan.

PROGRAM

Venue: Rochogpel Hotel

Date: 26-27th August 2015 (Wednesday-Thursday)

Jointly organized by: SAARC Agriculture Centre and Department of Agriculture, MOAF, Bhutan

DAY 1 (26th August 2015) : INAUGURAL AND TECHNICAL SESSION		
INAUGURAL SESSION		
09:00	Arrival of all the participants	
09:00-09:30	Registration	
09:30-09:35	Arrival of the Chief Guest	
09:35-09:45	Marchang – Traditional Opening	
09:45-09:55	Welcome address	Kesang Tshomo
09:55-10:15	Introduction about SAC Presentation: Synopsis based on country papers	Dr. M. Musa, Senior Program Specialist (Crops), SAARC Agriculture Centre, Dhaka, Bangladesh
10:10-10:20	Remarks	Director General, DOA
10:20-10:35	Opening Remarks by Chief Guest	Chief Guest
10:35-10:45	Vote of Thanks	Norden Lepcha
10:45-11:15	**Photo Session and Tea Break**	
TECHNICAL SESSION-I: Country presentation SAARC Countries		
Chairperson	**GB. Chettri, JD, DOA**	
Rapporteur	Leki Wangdi and Tenzin Drugyel	
11:15-11:30	Opening remarks by Session Chairperson	
11:30-12:00 (30 min.)	Country paper – Bangladesh and Discussion	Dr. Muhammad Nazin Uddin
12:00-12:30 (30 min.)	Country paper - Bhutan and Discussion	Mrs. Kesang Tshomo,
12:00-12:30 (30 min.)	Country paper - India and Discussion	Dr. N. Ravisanker
12:30-1:00 (30 min.)	Country paper - Maldives and Discussion	Ms. Rifaath Hassan

1:00-14:00	**LUNCH**	
14:00-14:05	Opening remarks by Session Chairperson	
14:05-14:35 (30 min.)	Country paper – Nepal and Discussion	Mr. Dinesh Babu Tiwari
14:35-15:05 (30 min.)	Country paper - Pakistan and Discussion	Dr. Muhammad Musa, SPS (Crops), SAC
15:05 –15:30 (25 min)	**TEA BREAK**	
15:30-16:00 (30 min.)	General discussions on the papers presented	
16:00-16:30	Concluding remarks by Session Chairperson	

DAY 2 (27th August 2015) : TECHNICAL AND CLOSING SESSION		
TECHNICAL SESSION-II: Special Invited Papers		
Chairperson	**GB. Chettri, JD, DOA**	
Rapporteur	Mr. Leki Wangdi and Mr. Tenzin Drugyel	
09:30-09:50 (20 min.)	Initiative to promote Organic Pest management in Bhutan	Dr. Thinley, Specialist, NPPC
09:50-10:10 (20 min.)	"Organic cropping management and soil health"	Dr. Yadhu, Bhujgai, RDC, Bajo
10:10-10:30 (20 min.)	Evaluation of bio-pesticides on pest control in cabbage	Ms. Tashi Gyelmo, Research Officer, RDC Yusipang
10:30-10:50 (20 min.)	Asian Regional Organic Standard, an introduction	Ms. Kesang Tshomo, NOP, MOAF
10:50-11:00	Concluding remarks by Session Chairperson	
TECHNICAL SESSION-III: Group work / Recommendations		
Chairperson	**GB. Chettri, JD, DOA**	
Facilitators	Dr. Musa, SPS (Crops), SAC	
11:00-11:10	Introduction of Group work by the Chairperson	
11:10-11:40 (30 min.)	Preparation of Recommendation	Focal Experts of SAARC Countries and all participants
11:40- 12:00	**TEA BREAK**	

12:00-12:40	Presentation, Discussion on Thematic Group Reports and Finalization of recommendations	Group Leader
12:40-13:40	**LUNCH** Concluding remarks by Session Chairperson	
13:40-14:00	Offering of Mementoes and Felicitations	Chairperson and Director SAC (facilitated by Kesang Tshomo
14:00-14:10	Vote of Thanks	Norden Lepcha
14:10- 14:30	**TEA BREAK**	
18:00- 11:00	**Closing Dinner**	

Proceedings of the Consultation Meeting

SAARC Regional Expert Consultation Meeting on "Status and future prospect of organic agriculture for safe food security in SAARC countries"

SAARC Agriculture Centre (SAC) in collaboration with the National Organic Programme, Department of Agriculture, Ministry of Agriculture and Forest, Bhutan organized an expert consultation meeting on "Status and future prospect of organic agriculture for safe food security in SAARC countries" during 26-27 August 2015 in Bhutan.

Renowned agricultural scientists from SAARC countries (Bangladesh, Bhutan, India, Nepal and Sri Lanka) participated in the meeting. Professionals from various agencies under the Ministry of Agriculture and Forest, Bhutan also participated in the event. This study was undertaken to make an assessment of the prevailing organic agriculture scenario and further possibilities in SAARC member countries, and find out the best possible ways for harvesting the maximum output from the sector based on opportunities available in the member countries. Recommendations were also drawn during last session of the meeting.

Mrs. Kesang Tshomo, Coordinator of the National Organic Program welcome the guests. Dr. M. Musa, SPS (Crops), SAC presented a brief note on activities of SAARC Agriculture Centre and synopsis based on country status reports during inaugural session. Hon'ble Director General, Mr. Nim Dorji, Department of Agriculture, Ministry of Agriculture graced the inaugural session as Chief Guest. He highlighted the importance of organic agriculture for food security and food safety in his opening remarks. He informed that less than 5% of the farmers used agrochemicals in their crops and 2% of farmers use agrochemicals in fruits and nut crops. He emphasized on establishing a network in development of collaborative action plans for the future. Norden Lepcha proposed the vote of thanks.

The technical sessions were chaired by Mr. G.B. Chettri, Joint Director, DoA, Bhutan. During technical sessions I, country status report on organic agriculture was presented by respective Focal Point Experts of participated countries. In session II on the second day, four invited papers were presented by local professionals. Each technical session was followed by discussion. Session chairperson conveyed the concluding remarks at the end of each session. In Session III, group discussion was made to prepare recommendations. Local professionals and experts from the SAARC countries drew series of recommendations. It was recommended that SAC Dhaka should initiate a plan to develop SAARC organic standard and certification systems in line with the existing policies and standards of SAARC nations. An information exchange system should be developed by SAC to share the information on research and development related to organic agriculture including the technologies, packages of practices and farm level success stories received from focal points nominated by GB members. The organic growers/ movement should be suitably supported with better incentives to enhance the percolation of organic farming in member nations. For this, conversion period should be crop- and area-specific depending on the nature of the crop and land use history. Adequate allocation of human, financial and physical resources to organic agricultural education in the form of degree, basic and applied infra-structure for research and development in all the countries was also recommended. Further, cross country capacity building program including training of researchers, extension functionaries, farmers and other relevant stakeholders among member nations should be developed and coordinated by SAC Dhaka. Country specific model should be prepared for safe and secure food. However, SAC Dhaka can synthesize the Indian model having the components of scientific organic agriculture in default organic areas and towards organic approach having integrated management with non-pesticide use for SAARC region. Inter-ministerial coordination among agriculture, health and environment is essential to promote organic agriculture. Free flow of organic commodities among the member countries should be allowed under SAARC organic standard. Periodic/ annual review of the progress over this recommendation will be made by SAC Dhaka and disseminate to member nations.

In concluding session, recommendations were finalized and presented for approval. Hon'ble Chief Guest, Dasho Secretary of the Ministry of Agriculture and Forests delivered their closing remarks. Then, certificates and mementos were offered to the participants. At the end, Norden Lepcha proposed the vote of thanks.

Glimpses of Regional Consultation Meeting

GROUP PHOTO: Chief Guest: Hon'ble Director General, Mr. Nim Dorji, DoA, MoAF, and other participants

TRADITIONAL OPENING - Marchang is being performed during inaugural session

TECHNICAL SESSION-I: A Focal Point Expert delivering his presentation

TECHNICAL SESSION-II: A Focal Point Expert delivering his presentation

TECHNICAL SESSION-III: Professionals preparing recommendations based on different issues related to organic agriculture

CLOSING SESSION: Hon'ble Chief Guest, Dasho Secretary of the Ministry of Agriculture and Forests delivering his closing remarks during concluding session

CLOSING SESSION: Dr. M. Musa, SPS (Crops), SAC receiving souvenir from Hon’ble Chief Guest, Dasho Secretary of the Ministry of Agriculture and Forests

CLOSING SESSION: Mr. G.B. Chettri, Joint Director, DoA, Bhutan receiving souvenir from Hon’ble Chief Guest, Dasho Secretary of the Ministry of Agriculture and Forests