

Organic Agriculture

(Concept, Scenario, Principals and Practices)

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Organic Agriculture Concept and Scenario

Introduction

Organic agriculture has grown out of the conscious efforts by inspired people to create the best possible relationship between the earth and men. Since its beginning the sphere surrounding organic agriculture has become considerably more complex. A major challenge today is certainly its entry into the policy making arena, its entry into anonymous global market and the transformation of organic products into commodities. During the last two decades, there has also been a significant sensitization of the global community towards environmental preservation and assuring of food quality. Ardent promoters of organic farming consider that it can meet both these demands and become the mean for complete development of rural areas. After almost a century of development organic agriculture is now being embraced by the mainstream and shows great promise commercially, socially and environmentally. While there is continuum of thought from earlier days to the present, the modern organic movement is radically different from its original form. It now has environmental sustainability at its core in addition to the founders concerns for healthy soil, healthy food and healthy people.

Concept of organic farming

Organic farming is very much native to this land. Whosoever tries to write a history of organic farming will have to refer India and China. The farmers of these two countries are farmers of 40 centuries and it is organic farming that sustained them. 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
- 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 (biofertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment.

As per the definition of the USDA study team on organic farming "*organic farming is a system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic*

waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection”.

In another definition FAO suggested that “*Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs”.*

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

The world of organic agriculture

As per the details released at BioFach 2010 at Nuremberg, the organic agriculture is developing rapidly, and statistical information is now available from 154 countries of the world. Its share of agricultural land and farms continues to grow in many countries. The main results of the latest global survey on certified organic farming are summarized below:

Growing area under certified organic agriculture

- 35 million hectares of agricultural land are managed organically by almost 1.4 million producers.
- The regions with the largest areas of organically managed agricultural land are Oceania (12.1 million hectares), Europe (8.2 million hectares) and Latin America (8.1 million hectares). The countries with the most organic agricultural land are Australia, Argentina and China.
- The highest shares of organically managed agricultural land are in the Falkland Islands (36.9 percent), Liechtenstein (29.8 percent) and Austria (15.9 percent).
- The countries with the highest numbers of producers are India (340'000 producers), Uganda (180'000) and Mexico (130'000). More than one third of organic producers are in Africa.
- On a global level, the organic agricultural land area increased in all regions, in total by almost three million hectares, or nine percent, compared to the data from 2007.
- Twenty-six percent (or 1.65 million hectares) more land under organic management was reported for Latin America, mainly due to strong growth in Argentina. In Europe the organic land increased by more than half a million hectares, in Asia by 0.4 million.
- About one-third of the world's organically managed agricultural land – 12 million hectares is located in developing countries. Most of this land is in Latin America, with Asia and Africa in second and third place. The countries with the largest area under organic management are Argentina, China and Brazil.
- 31 million hectares are organic wild collection areas and land for bee keeping. The majority of this land is in developing countries – in stark contrast to

agricultural land, of which two-thirds is in developed countries. Further organic areas include aquaculture areas (0.43 million hectares), forest (0.01 million hectares) and grazed non-agricultural land (0.32 million hectares).

Almost two-thirds of the agricultural land under organic management is grassland (22 million hectares). The cropped area (arable land and permanent crops) constitutes 8.2 million hectares, (up 10.4 percent from 2007), which represents a quarter of the organic agricultural land.

Continent wise growth –

- **Africa** - In Africa, there are almost than 900'000 hectares of certified organic agricultural land. This constitutes about 2.5 percent of the world's organic agricultural land. 470'000 producers were reported. The countries with the most organic land are Uganda (212'304 hectares), Tunisia (174'725 hectares), and Ethiopia (99'944 hectares).
- **Asia** - The total organic agricultural area in Asia is nearly 3.3 million hectares. This constitutes nine percent of the world's organic agricultural land. 400'000 producers were reported. The leading countries by area are China (1.9 million hectares) and India (1 million hectares). Timor Leste has the most organic agricultural area as a proportion of total agricultural land (seven percent). Organic wild collection areas play a major role in India and China, while Aquaculture is important in China, Bangladesh and Thailand.
- **Europe** - As of the end of 2008, 8.2 million hectares in Europe were managed organically by more than 220'000 farms. In the European Union, 7.5 million hectares were under organic management, with almost 200'000 organic farms. 1.7 percent of the European agricultural area and 4.3 percent of the agricultural area in the European Union is organic. Twenty-three percent of the world's organic land is in Europe.
- **Latin America** - In Latin America, 260'000 producers managed 8.1 million hectares of agricultural land organically in 2008. This constitutes 23 percent of the world's organic land. The leading countries are Argentina (4 million hectares), Brazil (1.8 million hectares), and Uruguay (930'965 hectares).
- **North America** - In North America, almost 2.5 million hectares are managed organically, representing approximately 0.6 percent of the total agricultural area. Currently the number of farms is 14'062. The major part of the organic land is in the U.S. (1.8 million hectares in 2008). Seven percent of the world's organic agricultural land is in North America. Despite tough economic times, U.S. sales of organic products, both food and non-food, reached 24.6 billion US dollars by the end of 2008, growing an impressive 17.1 percent over 2007 sales, according to the Organic Trade Association's 2009 Organic Industry Survey.
- **Oceania** - This region includes Australia, New Zealand, and island states like Fiji, Papua New Guinea, Tonga and Vanuatu. Altogether, there are 7'749 producers, managing more than 12.1 million hectares. This constitutes 2.8 percent of the agricultural land in the area and 35 percent of the world's organic land. Ninety-nine percent of the organically managed land in the region is in Australia (12 million hectares, 97 percent of which is extensive grazing land), followed by New Zealand (100'000 hectares), and Vanuatu (8'996 hectares).

Global market - According to Organic Monitor estimates, global sales reached 50.9 billion US dollars in 2008, doubling in value from 25 billion US dollars in 2003.

Consumer demand for organic products is concentrated in North America and Europe; these two regions comprise 97 percent of global revenues. Asia, Latin America and Australasia are important producers and exporters of organic foods. The financial crisis has had a negative impact on the global market for organic products; however, preliminary research finds that growth continued in 2009 in spite of the poor economic climate.

Standards and regulations - 2009 witnessed several major developments in the field of standards and regulations. The new EU regulation on organic production came into force as well as the Canadian organic standard. Furthermore, the Australian domestic organic standard was implemented. Canada and the U.S. concluded the world's first fully reciprocal agreement between regulated organic systems, and the EU introduced procedures for approving certification bodies from outside the EU. It is expected that these developments will ease trade in organic products and foster the future growth of the sector. The number of countries with organic standards has increased to 73, and there are 16 countries that are in the process of drafting legislation. In 2009, FAO, IFOAM and UNCTAD started the Global Organic Market Access (GOMA) project. The aim of GOMA is to facilitate equivalence, harmonization and other types of cooperation in order to simplify the process for trade flow of products among the various organic guarantee systems. There has been modest growth in the number of certification bodies. The total is 488, up from 481 in 2008. Most certification bodies are in the European Union, the United States, Japan, South Korea, China, Canada, and Brazil. A growing number of organic producers are certified through Participatory Guarantee Systems (PGS) across the world. PGS are locally focused quality assurance systems. It is estimated that around 10'000 small operators are involved in PGS world-wide. The leading countries with regards to PGS are located in the global South. Several organic standard setters have also developed draft standards for climate "add-ons" for organic certification, and it is expected that the use of carbon labeling by retailers will grow considerably in the future.

Organic farming and development support - Both private and public development initiatives have contributed considerably in the last 25 years to the growth of the organic sector in many countries of the world. Activities have related to, for instance, building up the capacities of different stakeholder groups in the organic sector, developing domestic and international markets, and developing local standards and legislations. One of the new initiative is the proposed Organic Research Centres Alliance (ORCA), hosted by FAO, which intends to internationally network and strengthen existing institutions with scientific credentials and empower them to become centers of excellence in trans-disciplinary organic agriculture research. International trade, an engine for growth can substantially contribute to poverty reduction in developing countries. The Trade, Climate Change and Environment Programme of the International Trade Centre (ITC) supports the organic sector through the provision of market information, training in standards compliance, and trade promotion; by supporting policies favorable to organic agriculture and trade; and by facilitating business contacts.

Organic Agriculture in India

Emergence

The growth of organic agriculture in India has three dimensions and is being adopted by farmers for different reasons. First category of organic farmers are those which are situated in no-input or low-input use zones, for them organic is a way of life and they are doing it as a tradition (may be under compulsion in the absence of resources needed for conventional high input intensive agriculture). Second category of farmers are those which have recently adopted the organic in the wake of ill effects of conventional agriculture, may be in the form of reduced soil fertility, food toxicity or increasing cost and diminishing returns. The third category comprised of farmers and enterprises which have systematically adopted the commercial organic agriculture to capture emerging market opportunities and premium prices. While majority of farmers in first category are traditional (or by default) organic they are not certified, second category farmers comprised of both certified and un-certified but majority of third category farmers are certified. These are the third category commercial farmers which are attracting most attention. The entire data available on organic agriculture today, relates to these commercial organic farmers

Growing area

Emerging from 42,000 ha under certified organic farming during 2003-04, the organic agriculture has grown almost 29 fold during the last 5 years. By March 2010 India has brought more than 4.48 million ha area under organic certification process. Out of this cultivated area accounts for 1.08 million ha while remaining 3.4 million ha is wild forest harvest collection area. Year wise growth of cultivated area under organic management is shown in Table 1. Overall status of organic production projects, processors, quantity produced, quantity exported and the value of export is given in Table 2, State wise details of total area and number of farmers under full organic, in-conversion and total under organic management (2009-10) are given in Table 3. Details in respect of important commodities produced during 2008-09 are given in Table 4.

Regulatory mechanism

For quality assurance the country has internationally acclaimed certification process in place for export, import and domestic markets. National Programme on Organic Production (NPOP) defines the regulatory mechanism and is regulated under two different acts for export and domestic markets. NPOP notified under Foreign Trade Development and Regulation Act (FTDR) looks after the export requirement. The NPOP notified under this act has already been granted equivalence by European Union and Sweden. USDA has also accepted the conformity assessment system of NPOP. Due to this, the product certified by any Indian accredited certification agency under NPOP can be exported to Europe, Sweden and USA without the requirement of re-certification. To look after the requirement of import and domestic market the same NPOP has been notified under Agriculture Produce Grading, Marking and Certification Act (APGMC). Regulatory body of NPOP under FTDR act is Agricultural and Processed Foods Export Development Authority (APEDA) under Ministry of Commerce and of NPOP under APGMC act is Agricultural Marketing Advisor (AMA) under Ministry of Agriculture. Accreditation of Certification and Inspection Agencies is being granted by a common National Accreditation Body (NAB). 18 accredited certification agencies are looking after the requirement of certification process. Out of

these 4 agencies are under public sector while remaining 14 are under private management.

Growing number of farmers and operators - Out of total 2099 operators, while processors account for 427 and individual farmers 753, majority of farmers i.e. 597,873 are small and marginal farmers covered by 919 grower groups. Out of the total organic producers in the world approximately half of them are in India. This is mainly because of small holdings with each producer.

Table – 1 Growth of area under organic management

S.No.	Years	Area under Organic management in Ha
1.	2003-04	42,000
2.	2004-05	76,000
3.	2005-06	1,73,000
4.	2006-07	5,38,000
5.	2007-08	8,65,000
6.	2008-09	12,07,000
7.	2009-10	10,85,648

Table 2 Overall status of organic production projects, processors, quantity produced, quantity exported and the value of export (Year 2008-09)

S.No.	Component	Quantum
1.	Area under Organic certification Process (ha) Full organic In-conversion Total	757978.71 327669.74 1085648.45
2.	No. of Farmers under Organic certification Process Full organic In-conversion Total	351297 246576 597873
3.	Number of operators	2099
4.	Number of processors	427
5.	Number of grower groups	919
6.	Number of exporters	253
7.	Total Production (MT)	1,811,111
8.	Total quantity exported (MT)	53,918
9.	Value of export in US \$	116.09 million
10.	Value of export in INR Rs.	591 crores INR

Table 3. Total area and total number of farmers under organic Certification process							
S.No.	States	Total Area in ha			Total No. of farmers		
		Organic	In-Conversion	Total	Organic	In Conversion	Total
1	Andhra Pradesh	10129.11	20838.12	30967.23	9046	22458	31504
2	Arunchal Pradesh	523.17	1374.33	1897.5	116	590	706
3	Asam	1598.18	3510.74	5108.92	479	2768	3247
4	Bihar	0	1096.3	1096.3	0	2111	2111
5	Chattisgarh	332.06	112.241	444.301	3	116	119
6	Delhi	77.3	190.4	267.7	4	66	70
7	Goa	5947.1	1443.67	7390.77	620	203	823
8	Gujrat	53596.95	16941.91	70538.86	19353	10213	29566
9	Haryana	3585.16	5387.59	8972.75	1794	3473	5267
10	Himachal Pradesh	437.09	139.01	576.1	346	833	1179
11	J & K	430.63	182.44	613.07	132	68	200
12	Jharkhand	0	0	0	0	0	0
13	Karnataka	16099.06	35369.398	51468.458	6061	26163	32224
14	Kerala	7352.67	7516.67	14869.34	6215	8857	15072
15	Manipur	1247.16	1924.15	3171.31	2066	2901	4967
16	Maharashtra	105172.62	45295.12	150467.74	44551	21098	65649
17	Madhya Pradesh	378572.26	61952.74	440525	151953	25072	177025
18	Mizoram	18002.27	9857.55	27859.82	14177	13878	28055
19	Meghalaya	1366.01	1677.1	3043.11	823	2685	3508
20	Nagaland	3091.3	6554.39	9645.69	3459	15639	19098
21	Orissa	79086.99	16653.92	95740.91	49523	12605	62128
22	Punjab	379.84	4883.77	5263.61	85	2992	3077
23	Rajasthan	29969.93	11157.99	41127.92	10204	7603	17807
24	Sikkim	2872.73	4521.49	7394.22	3130	4697	7827
25	Tripura	203.56	77.5	281.06	1	295	296
26	Tamilnadu	3199.44	3543.44	6742.88	206	3465	3671
27	Uttar Pradesh	8665.35	44879.88	53545.23	5518	26458	31976
28	Uttrakhand	16158.86	14906.75	31065.61	20695	26484	47179
29	West Bengal	9881.91	5681.14	15563.05	737	2785	3522
30	Other	0	0	0	0	0	0
	Total	757978.71	327669.749	1085648.459	351297	246576	597873

Table 4. Production of important commodities under organic management (Year 2008-09)

S.No.	Commodities	Quantity produced in MT		
		Organic	In-conversion	Total
1.	Rice	44335	32354	76690
2.	Wheat	6892	15364	22560
3.	Other cereals/ millets	67333	63985	131318
4.	Pulses	17560	16785	34345
5.	Oil seeds including Soybean	163185	59647	222832
6.	Cotton (raw seed cotton)	284832	86906	371740
7.	Spices	17419	20084	37504
8.	Tea/ coffee	16506	10838	27344
9.	Fruits and Vegetables	194505	538073	732579
10.	Herbal/ medicinal plants	129543	58767	188310
11.	Other miscellaneous crops	8001	25235	33236

Table 5 Estimates of area covered by different crops under organic management (Year 2008-09)

S.No.	Commodities	Area in ha		
		Organic	In-conversion	Total
1.	Paddy	18134.00	9766.00	27900.00
2.	Wheat	4056.00	7192.00	11248.00
3.	Other cereals/ millets	26184.00	37678.00	63862.00
4.	Pulses	12023.00	17617.00	29640.00
5.	Oil seeds including Soybean	91849.00	87307.00	179156.00
6.	Cotton	259699.00	93299.00	352998.00
7.	Spices	6507.00	23291.00	29798.00
8.	Tea/ coffee	12711.00	12465.00	25176.00
9.	Fruits and Vegetables	128879.00	41176.00	170055.00
10.	Herbal/ medicinal plants	32313.00	10690.00	43003.00
11.	Other miscellaneous crops	27995.00	28306.00	56301.00
12.	Crop details not available	19812.00	198110.00	217922.00
	Total area	640162	566897	1207059

Important features of Indian organic sector

With the phenomenal growth in area under organic management and growing demand for wild harvest products India has emerged as the single largest country with highest arable cultivated land under organic management. India has also achieved the status of single largest country in terms of total area under certified organic wild harvest collection.

With the production of more than 77,000 MT of organic cotton lint India had achieved the status of largest organic cotton grower in the world a year ago, with more than 50% of total world's organic cotton.

Future prospects

Although, commercial organic agriculture with its rigorous quality assurance system is a new market controlled, consumer-centric agriculture system world over, but it has grown almost 25-30% per year during last 10 years. In spite of recession fears the growth of organic is going unaffected. The movement started with developed world is gradually picking up in developing countries. But demand is still concentrated in developed and most affluent countries. Local demand for organic food is growing. India is poised for faster growth with growing domestic market. Success of organic movement in India depends upon the growth of its own domestic markets.

India has traditionally been a country of organic agriculture, but the growth of modern scientific, input intensive agriculture has pushed it to wall. But with the increasing awareness about the safety and quality of foods, long term sustainability of the system and accumulating evidences of being equally productive, the organic farming has emerged as an alternative system of farming which not only address the quality and sustainability concerns, but also ensures a debt free, profitable livelihood option.

The Principles of Organic Agriculture

To understand the motivation for organic farming, the practices being used and what we want to achieve, it is important to understand the guiding principles of organic agriculture. These principles encompass the fundamental goals and caveats that are considered important for producing high quality food, fiber and other goods in an environmentally sustainable way. The principles of organic agriculture have changed with the evolution of the movement and are now codified. The principles apply to agriculture in the broadest sense, including the way people tend soils, water, plants and animals in order to produce, prepare and distribute food and other goods. They concern the way people interact with living landscapes, relate to one another and shape the legacy of future generations. The principles of organic agriculture serve to inspire the organic movement in its full diversity. They are the roots from which organic agriculture grows and develops. They express the contribution that organic agriculture can make to the world and a vision to improve all agriculture in a global context. The Principles of Organic Agriculture serve to inspire the organic movement in its full diversity.

The International Federation for Organic Agriculture Movement's (IFOAM) definition of Organic agriculture is based on:

The principle of health
The principle of ecology
The principle of fairness and
The principle of care

Each principle is articulated through a statement followed by an explanation. The principles are to be used as a whole. They are composed as ethical principles to inspire action.

1. 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. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

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. Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

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. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products. This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being. Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs

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. This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and

traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

In totality organic agriculture aims at a sustainable production system based on natural processes. Key characteristics are that organic agriculture:

- relies primarily on local, renewable resources;
- makes efficient use of solar energy and the production potential of biological systems;
- maintains the fertility of the soil;
- maximises recycling of plant nutrients and organic matter;
- does not use organisms or substances foreign to nature (e.g. GMOs, chemical fertilisers or pesticides);
- maintains diversity in the production system as well as the agricultural landscape;
- gives farm animals life conditions that correspond to their ecological role and allow them a natural behaviour.

Organic agriculture is also a sustainable and environmentally friendly production method, which has particular advantages for small-scale farmers. Available evidence indicates the appropriateness of organic agriculture for small farmers in developing countries like India. Organic agriculture contributes to poverty alleviation and food security by a combination of many features, such as;

- increasing yields in low-input areas;
- conserving bio-diversity and nature resources on the farm and in the surrounding area;
- increasing income and/or reducing costs;
- producing safe and varied food;
- being sustainable in the long term.

The evaluations by IFAD in India and China (Giovannucci, 2005) reported that the income of participating farmers can increase substantially by adopting organic practices of farming. Certified production gives access to a premium market, or simply just better market access.

Organic Management

An Integrated approach

Growing Crops under Organic Management

Philosophy - Organic farming management is an integrated approach, where all aspects of farming systems are interlinked with each other and work for each other. A healthy biologically active soil is the source of crop nutrition, on-farm biodiversity controls pests, crop rotation and multiple cropping maintains the system's health and on-farm resource management with integration of cattle ensure productivity and sustainability. Organic management stresses on optimization of resource use and productivity, rather than maximization of productivity and over exploitation of resources on the cost of resources meant for future generations.

Management Principals - A living soil is the basis of organic farming. A live, healthy soil with proper cropping patterns, crop residue management and effective crop rotation can sustain optimum productivity over the years, without any loss in fertility. Organic farming envisages a comprehensive management approach to improve soil health, the ecosystem of the region and the quality of produce. It includes all agricultural systems that promote environmentally sound production of food and fibers. These systems take local soil fertility as a key to successful production, by respecting the natural capacity of plants, animals and the landscape; they aim to optimize quality in all aspects of agriculture and environment. A living soil can be maintained by continuous incorporation of crop and weed biomass, use of animal dung, urine-based manures (FYM, NADEP, vermicompost), biofertilisers and bioenhancers, special liquid formulations (like vermiwash, compost tea etc) during a crop's duration.

As a thumb rule, crop residues should be returned to the plot, directly or indirectly. Cattle droppings may be returned to the field as compost. As a strategy, the quantity of biomass removed for human food and fiber, cattle feed or firewood from an organic farm should be replaced with any other bio-waste on the farm. But it is important to account for it for preparing the balance sheet of nutrients for each crop being cultivated on the farm. In phosphorous-deficient and acidic soils, some quantity of mineral grade rock phosphate and lime can also be added either by direct application to the field or through addition to compost. The compost can be further enriched by incorporation of biofertilisers, microbial inoculants, etc. Special composts like biodynamic compost, cowpat pit compost, biodynamic preparations such as BD-500 and BD-501, special formulations like Panchgavya, Dashgavya, Biosol etc are also useful and ensure optimum productivity. Use of EM formulation has also been found effective in soil enrichment and compost making. For high nutrient demanding crops and for intermittent soil enrichment use of oilcakes, poultry manure, concentrated manures (mixture of oil cakes, poultry manure and rock phosphate) can also be an ideal low-cost option of manuring.

Important steps

While turning towards organic it is essential that the basic requirements of the system and the area are properly understood and long term strategies are addressed first. In most part of the country poor soil health due to loss of organic

matter and soil microbial load is a major problem. Reducing water availability and increasing temperature is further adding to the problems. Too much dependence on market for supply of inputs and energy has made the agriculture a cost intensive high input enterprise with diminishing returns. We need to address all these concerns and develop a system which is not only productive and low cost but also resource conserving and sustainable for centuries to come. To start with, following parameters need to be addressed in first stage

- Enrichment of soil
- Management of temperature
- Conservation of rain water
- Maximum harvesting of sun energy
- Self reliance in inputs
- Maintenance of natural cycles and life forms
- Integration of animals
- Maximum reliance on renewable energy sources, such as solar power and animal power

How to achieve

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.
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 & 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 bullock driven pumps, generator and other machine.

Developing organic farm

As organic management is an integrated approach, manipulation and adoption of one or few steps may not yield significant results. For optimization of productivity all the essential components need to be developed in a systematic manner. These steps include: (i) Habitat development, (ii) on-farm facilities for input production (iii) cropping sequence and combination planning, (iv) 3-4 year rotation plan and (vi) growing of crops suiting to the region, soil and climate.

Development of farm facilities and habitat

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.

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 tamarind (*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).

Major and minor plots should be separated by bunds about 1.5m wide and should be planted with Glyricidia, perennial Sesbania (jayanti), Leucaena leucocephala, cassia siamea, etc. The internal hedgerow should consist of perennial pigeon pea, Crotalaria, seasonal Sesbania, etc. Lops from these trees will provide enough quantity of biologically fixed nitrogen.

In between *Glyricidia/Sesbania* rows insert few plants of pesticidal value such as *Adathoda vesica*, *Vitax nigundo*, *Calotropis*, *Datura alba*, *Ipomea* (Besharam) etc. Surrounding the farm or garden, there should be hedgerows or a live fence of coppiced or pollarded, multipurpose, deep-rooted trees and shrubs and medicinal herbs such as *Adathoda vasica*, *Vitex negundo*, *Jatropha curcas*, etc. Ecological diversity is an essential component of any successful organic farming system.

Trees on utility space can be allowed to grow fully. Trees and bushes on farm bunds should be placed randomly at sufficient distance and pruned at repeated intervals. Glyricidia plants should be planted at close spacing on all major bunds and all around the farm. They will act not only as biological fence but also provide biologically fixed nitrogen to soil.

A 400 mt long Glyricidia strip can provide 22.5 kg N/ha per year from the year 3 and up to 77 Kg N/ha from year 7 under rainfed conditions. This can be 75-100% higher under irrigated conditions. Three to four harvests can be made under irrigated conditions and two harvests under unirrigated conditions. Never allow them to grow above 5.5 ft to avoid shading effect. Lopping is used as green leaf manure. Simply harvest them and incorporate in soil before sowing or use as mulch.

Conversion of soil to organic

Banning of chemicals- It is widely known fact that some biological processes of plants involved in acquiring nutrients such as nitrogen e.g. N₂ fixation are generally inhibited by adding Nitrogen fertilizer. Soil scientists 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.

Low input alternative - In first year simultaneously sow 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. Apply mixture of Compost and vermicompost (2:1) @ 2.5 ton per acre 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 lit per acre. Seedlings will emerge from this layer. If soil is poor in phosphorus then apply 300 kg of low grade mineral rock-phosphate along with the compost. Apply second dose of Jivamrut after 25-30 days of sowing with irrigation water or during rains.

To add to diversity 100 plants/ acre of marigold or Hibiscus subdarifa or any other suitable plant effective as trap crop/plant may be planted randomly through out the field. Few seedlings of vegetables such as chillies, tomato, brinjal, etc and rhizomes of turmeric, ginger etc can be planted randomly for home consumption.

Harvest the pods/ fruits and use remaining biomass for mulch. Collect the crop biomass at the end of strips in the form of heaps and drench with Jivamrut. Sow short duration leafy vegetables (such as fenugreek or spinach) in the space vacated by the first and second crop and mulch the surface with treated biomass. Harvest leafy vegetable and grains and incorporate remaining biomass in the soil at appropriate time.

In next season apply compost-vermicompost mixture @ 2.5 ton/ha and sow cereal crop with legume as inter or companion crop. After harvest use entire legume and remaining part of cereal crop as mulch. If irrigation facilities are there, take summer legume with some vegetable crop. Recycle entire residue as mulch. Use 3-4 application of liquid manure (such as Jivamruta) during each cropping season for soil application. Now the soil is ready for high value horticultural crops.

High input alternative – Incorporate 2.5-3.0 ton compost/ vermicompost or 1.5 ton of biodynamic compost, 500 kg crushed oil cakes, 500 kg rock phosphate, 100 kg neem cake, 5 kg Azotobacter and 5kg PSB biofertilizer or 4 kg consortia of customized cultures in soil through broadcasting or by drilling in furrows below the seeds. Sow 3-4 types of different crops in strips. 40% crop stand should be of legumes. Randomly plant 100-150 marigold and vegetable seedlings for increased diversity. After harvest incorporate entire residue in soil or use as mulch after sowing of the next crop. For second crop also use similar quantities of manures. Use liquid manure (Jivamruta) @ 200lit/acre 3-4 times during cropping season along with irrigation water. For increased productivity 2-3 sprays of vermiwash or vermiwash+cow urine or Panchgavya can also be provided.

In fruit orchards cultivate 3-4 types of legume mixtures as mixed or intercrop in inter spaces along with adequate quantity of manures (as specified above). After pod/ grain harvest mulch the entire soil surface with the left over biomass and drench the biomass with 2 applications of Jivamruta.

After about 12-18 months the soil will be ready for organic cultivation of any crop combination. For next two-three years, along with any crop incorporate legumes as inter or companion crops. Ensure that crop residue always have at least 30% residue from legumes. Also treat crop residue with liquid manure before incorporating into soil or using as mulch.

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. Deep rooted plants drew nutrient from deeper layer of soil and bring them to the surface of soil through their leaf fall. So the nutrients leached down to lower strata are further brought back to upper layer by these deep rooted plants. Also help in protecting soil from soil erosion. Farmers should select the crops combination according to their needs and season.

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 vegetable seedlings for home consumption and 100 plants/acre of marigold (Genda) 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.

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. 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. High nutrient demanding crops should always be followed by legume crops and returned back to soil. Some important benefits of crop rotations are:

- a. Not all plants have same nutritive needs
- b. Soil structure is improved through different types of roots
- c. Pest build up is avoided and
- d. Rotations help against the build up of weeds.

Under Network Project on Organic Farming (NPOF of ICAR) important cropping systems, which were found economically better or at par with conventional system at different experimental stations in the country are as follows:

- Soybean - Berseem/ Mustard/ chickpea at Raipur, Chattisgarh
- Tomato/ Cabbage – cauliflower – pea and maize – garlic at Bajaura, Himachal Pradesh
- Rice – wheat/ potato/ mustard/ lentil at Ranchi, Jharkhand
- Groundnut – rabi Sorghum, soybean – durum wheat, potato – chick pea, chillil+ Cotton and maize – chick pea at Dharwad, Karnataka
- Soybean – durum wheat/ mustard/ chick pea/ isabgol at Bhopal, M.P.
- Rice – durum wheat/ berseem, rice – potato – Okra and rice – garlic, sorghum – berseem, maize – berseem – maize + cowpea and sorghum + cluster bean – oats-cowpea at Ludhiana, Punjab
- Maize – cotton, chillies – onion and brinjal – sunflower at Coimbatore
- Sorghum – pea – okra at Modipuram, Uttar Pradesh

- Carrot/ rice (pre kharif) – rice (kharif), potato/rice (pre kharif) – rice (kharif), tomato/ rice (pre kharif) – rice (kharif), French bean/ rice (pre kharif) – rice (kharif) at Umiam, Meghalaya

Status of rich and live organic soil

A fertile and live organic soil ideally should have organic C between 0.8-1.5%. At any point of time it should have adequate quantity of dry, semi decomposed and fully decomposed organic matter for the use of micro-flora and fauna. Total microbial load (bacteria, fungi and actinomycetes) should be above 1×10^8 /gm of soil. There should be at least 3-5 earth worms/cubic ft of soil. There should be enough quantity of small life forms and insects such as ants etc.

Seed/ Planting material Treatment

In organic management, protection measures are used only in the case of problematic situations. Use of disease free seed stock and resistant varieties is the best option. There is no standard formulation or treatment methodology, available as on today, but farmers use different methods. Few of such innovative seed treating formulations are as follows:

- Hot water treatment at 53⁰C for 20-30 min.
- Cow urine or cow urine-termite mound soil paste
- Beejamrut
- Asphoetida 250gm in one lit. of water for 10 kg seed
- Turmeric rhizome powder mixed with cow urine
- Panchgavya extract
- Dashparni extract
- *Trichoderma viride* (4gm/kg seed) or *Pseudomonas fluorscens* (10gm/kg seed)
- Biofertilizers (Rhizobium/ Azotobacter +PSB)

Preparation of Beejamruta – Put 5 kg fresh cow dung in a cloth bag and suspend in a container filled with water to extract the soluble ingredients of dung. Suspend 50 g lime in 1 lit water separately. After 12 – 16 hours squeeze the bag to collect extract and add 5 lit cow urine, 50 gm virgin forest soil, lime water and 20 lit water. Incubate for 8-12 hours. Filter the contents. The filtrate is used for seed treatment.

Manuring and soil enrichment

During conversion period, soil fertility can be improved and maintained initially through use of organic inputs like well decomposed organic manure/ vermicompost, green manure and biofertilizers in appropriate quantity. These organic inputs are used for feeding the soil. Well fed healthy soil rich in microflora and microfauna takes care of the crop nutrient requirement. Plant biomass, FYM, Cattle dung manure, enriched compost, biodynamic compost, Cow-pat-pit compost and vermicompost are key sources of on-farm inputs. Among off-farm inputs, important components are non-edible oil cakes, poultry manure, biofertilizers, mineral grade rock phosphate and lime etc.

Lopping from Glyricidia and other plants grown on bunds, on-farm produced compost and vermicompost, animal dung and urine and crop residue should form the major source of nutrient and concentrated manures such as crushed oil cakes, poultry

manure, vegetable market waste compost and other novel preparations such as biodynamic formulations etc can be used in appropriate quantity. Use of high quantities of manures should be avoided. Changing crop rotations and multiple crops ensure better utilization of resources. Depending upon the type of crop and requirement of nutrients for different crops, the quantity of externally produced inputs is determined.

Application of liquid manure (for soil enrichment) is essential to maintain the activity of microorganisms and other life forms in the soil. 3-4 applications of liquid manure is essential for all types of crops. Vermiwash, compost tea, cow urine, Pachgavya and Biosol etc are excellent growth promoters when used as foliar spray. 3-5 sprays after 25-30 days of sowing ensure good productivity. Use of Biodynamic preparations, such as BD-500 and BD-501 as foliar spray has also been found to be effective in growth promotion.

Use of Biofertilizers and microbial cultures

Biofertilizers viz: Rhizobium, Azotobacter, Azospirillum, PSB and Pseudomonas etc have been found to be very effective tools of fertility management and biological nutrient mobilization. Recently customized consortia of such biofertilizer organisms, better adapted to local climatic conditions have also been developed and are available commercially. Efficiency of such microbial formulations is much higher under no-chemical use situations, therefore application of such inputs need to be ensured under all cropping situations.

Method of application:

Biofertilizers can be applied to different crops and plants by three different ways.

1. **Seed treatment** Suspend 200 gm each of nitrogen fixing and PSB in 300-400 ml of water and mix thoroughly. Pour this slurry on 10 to 12 kg of seed and mix by hands, till all the seeds are uniformly coated. Dry the treated seeds in shade and sow immediately. For acidic and alkaline soils it is always advisable to use 1 kg of slacked lime or gypsum powder respectively for coating the wet biofertilizer treated seeds.
2. **Seedling root dip treatment:** - Suspend 1 to 2 kg each of nitrogen fixing (*Azotobacter/Azospirillum*) and PSB into just sufficient quantity of water (5-10 lit depending upon the quantity of seedlings required to be planted in one acre). Dip the roots of seedlings in this suspension for 20-30 min before transplanting. In case of paddy make a sufficient size bed (2mt x 1.5mt x 0.15mt) in the field, fill it with 5 cm of water and suspend 2 kg each of *Azospirillum* and PSB and mix thoroughly. Now dip the roots of seedlings in this bed for 8-12 hours (overnight) and then transplant.
3. **Soil treatment:** - For soil treatment depending upon the total number of plants per acre 2-4 kg of *Azotobacter/Azospirillum* and 2-4 kg of PSB are required for one acre. Mix two types of biofertilizer in 2-4 liters of water separately and sprinkle this suspension on two separate heaps of 50-100 kg of compost. Mix the two heaps separately and leave for incubation overnight. After 12 hours, mix the two heaps together. For acidic soils mix 25 kg lime with this mixture. In plantation crops apply this mixture at the root zones by dibbling. In some field crops the mixture is broadcast evenly in the moist field and mixed with soil just before sowing. In sugarcane the biofertilizer manure is to be applied in furrows near the

root zone, after 30-40 days of planting and covered with soil. In potato it is to be applied after 20 days of planting or at the time of earthing-up operations. In case of sugarcane and potato, if setts/tubers are not treated with plant protection chemicals then biofertilizer compost mixture can be applied in furrows immediately before planting

Some important formulations for soil enrichment

Preparation of liquid manures

Many variants of liquid manures are being used by farmers of different states. Few important and widely used formulations are given below:

Sanjivak – Mix 100 kg cow dung, 100 lit cow urine and 500 gm jaggery in 300 lit of water in a 500-lit closed drum. Ferment for 10 days. Dilute with 20 times water and sprinkle in one acre either as soil spray or along with irrigation water.

Jivamrut – Mix cow dung 10 kg, cow urine 10 lit, Jaggery 2 kg, any pulse grain flour 2 kg and Live forest soil 1 kg in 200 lit water. Ferment for 5 to 7 days. Stir the solution regularly three times a day. Use in one acre with irrigation water.

Amritpani - Mix 10 kg cow dung with 500 gm honey and mix thoroughly to form a creamy paste. Add 250 gm of cow desi ghee and mix at high speed. Dilute with 200 lit water. Sprinkle this suspension in one acre over soil or with irrigation water. After 30 days apply second dose in between the row of plants or through irrigation water.

Panchgavya – Mix fresh cow dung 5 kg, cow urine 3 lit, cow milk 2 lit, curd 2 lit, cow butter oil 1 kg and ferment for 7 days with twice stirring per day. Dilute 3 lit of Panchgavya in 100 lit water and spray over soil. 20 lit panchgavya is needed per acre for soil application along with irrigation water.

Enriched Panchgavya (or Dashagavya) – Ingredients - cow dung 5 kg, cow urine 3 lit, cow milk 2 lit, curd 2 lit, cow deshi ghee 1 kg, sugarcane juice 3 lit, tender coconut water 3 lit, banana paste of 12 fruits and toddy or grape juice 2 lit. Mix cow dung and ghee in a container and ferment for 3 days with intermittent stirring. Add rest of the ingredients on the fourth day and ferment for 15 days with stirring twice daily. The formulation will be ready in 18 days. Sugarcane juice can be replaced with 500 g jaggery in 3 lits water. In case of non-availability of toddy or grape juice 100g yeast powder mixed with 100 g jaggery and 2 lit of warm water can also be used. For foliar spray 3-4 lit panchgavya is diluted with 100lit water. For soil application 50 lit panchgavya is sufficient for one ha. It can also be used for seed treatment.

Management of Temperature

Temperature in summer season is quite high and need to be managed. It can be achieved by keeping soil covered with biological mulch. Surface mulch has been reported to conserve soil moisture and improve water use efficiency (Hajare et al 1997). In the long term experiment at ICRISAT, it has been reported that mulch applied in this manner on the hottest day of summer (April 30) in 2002 the soil temperature at 5 and 10 cm depth in the mulch applied plots was 6.5 to 7.3° C lower than in control plot (Rupela et al 2005). Temperature control can also be achieved by

planting different types of trees like neem, amla, tamarind, gular, zizipus bushes, gliricidia on bunds.

Protection to all life forms

Practice of maintaining enough biomass and mulching with crop and weed residue will ensure the protection to all life forms in soil. Another important practice of banning the chemical fertilizers and pesticides in farming definitely helps in protecting the life forms in soil. For the survivability of different life forms the field must have dry organic matter as a food for small insects and small animals in soil, semi decomposed organic matter as food for earthworms and fully decomposed organic matter for micro organisms in the soil at all times. These insects, small animals, earthworms and microorganisms are the tireless natural employees of the soil, wherein small animals and insects feed on the larvae of pests and thus controlling the pest, earthworms makes the soil porous thus creating the more aerobic conditions in soil and also decompose the half digested organic residue and release locked nutrients into soil. Soil rich in organic carbon contain ample quantity of beneficial micro flora which plays an important role in recycling of nutrients and nitrogen fixation, phosphate solubilization and photosynthesis activity, cellulolytic activity. Therefore protection to all life forms in soil should be ensured at all time.

Pest management

As in organic farming management use of synthetic chemicals are prohibited, the pest management is done by: (i) cultural or agronomic (ii) mechanical (iii) biological or by (iv) organically acceptable botanical extract or some chemicals such as copper sulphate and soft soap etc.

Cultural alternative - Use of disease free seed or stock and resistant varieties are best preventive practice in organic pest management. Maintenance of biodiversity, effective crop rotation, multiple cropping, habitat manipulation and use of trap crops are also effective practices which can keep the population of pests below economical threshold limit (ETL).

Mechanical alternative - Removal of affected plants and plant parts, collection & destruction of egg masses and larvae, installation of bird perches, light traps, sticky colored plates and pheromone traps are most effective mechanical methods of pest control.

Biological alternative - Use of pest predators and pathogens has also proved to be effective method of keeping pest problem below ETL. Inundative release of *Trichogramma sp.* @ 40,000 to 50,000 eggs per hectare, *Chelonus blackburni* @15,000 to 20, 000 per hectare, *Apanteles sp.* @15,000 to 20,000 per ha and *Chrysoperla sp.* @ 5,000 per ha., after 15 days of sowing & others parasites & predators after 30 days of sowing, can also effectively control pest problem in organic farming .

Use of Biopesticides - *Trichoderma viride* or *T. harzianum* or *Pseudomonas fluorescence* formulation @ 4gm/kg seed either alone or in combination, manage most of the seed borne & soil borne diseases. There are other formulations viz. *Beauveria bassiana*, *Metarizium anisopliae*, *Numeria rileyi*, *Verticillium sp*, which are available in the market and can manage their specific host pest. *Bacillus*

thurengensis stenebrionis and *B.thurengensis sandigo* are effective against coleopterans as well as some other insect species. Bt. has been used in the management of diamond back moth on crucifers and vegetables @ 0.5-1.0 kg. formulation per ha.

Viral biopesticides of baculovirus group viz. granulosis viruses (GV) and nuclear polyhedrosis viruses provided a great scope in plant protection field. Spray of nuclear polyhedrosis viruses (NPV) of *Helicoverpa armigera* (H) or *Spodoptera litura* (S) @ 250 larval equivalents are very effective tools to manage the *Helicoverpa* sp. or *Spodoptera* sp. respectively.

Botanical pesticides

Many plants are known to have pesticidal properties and the extract of such plants or its refined forms can be used in the management of pests. Among various plants identified for the purpose, neem has been found to be most effective.

Neem (*Azadirachta indica*) – Neem has been found to be effective in the management of approximately 200 insects, pests and nematodes. Neem is very effective against grasshoppers, leaf hoppers, plant hoppers, aphids, jassids, and moth caterpillars. Neem extracts, are also very effective against beetle larvae, butterfly, moth and caterpillars such as Mexican bean beetle, Colorado potato beetle and diamondback moth. Neem is very effective against grasshoppers, leaf minor and leaf hoppers such as variegated grasshoppers, green rice leaf hopper and cotton jassids. Neem is fairly good in managing beetles, aphids and white flies, mealy bug, scale insects, adult bugs, fruit maggots and spider mites.

Some other pest control formulations

Many organic farmers and NGOs have developed large number of innovative formulations which are effectively used for control of various pests. Although none of these formulations have been subjected to scientific validation but their wide acceptance by farmers speak of their usefulness. Farmers can try these formulations, as they can be prepared on their own farm without the need of any purchases. Some of the popular formulations are listed below:

Cow urine – Cow urine diluted with water in ratio of 1: 20 and used as foliar spray is not only effective in the management of pathogens & insects, but also acts as effective growth promoter for the crop.

Fermented curd water – In some parts of central India fermented curd water (butter milk or *Chaach*) is also being used for the management of white fly, jassids aphids etc.

Dashparni extract – Crush neem leaves 5 kg, Vitex negundo leaves 2 kg, Aristolochia leaves 2 kg, papaya (*Carica Papaya*) 2 kg, *Tinospora cordifolia* leaves 2 kg, *Annona squamosa* (Custard apple) leaves 2 kg, *Pongamia pinnata* (Karanja) leaves 2 kg, *Ricinus communis* (Castor) leaves 2 kg, *Nerium indicum* 2 kg, *Calotropis procera* leaves 2 kg, Green chilly paste 2 kg, Garlic paste 250 gm, Cow dung 3 kg and Cow Urine 5 lit in 200 lit water ferment for one month. Shake regularly three times a day. Extract after crushing and filtering. The extract can be stored up to 6 months and is sufficient for one acre.

Neem-Cow urine extract - Crush 5 kg neem leaves in water, add 5lit cow urine and 2 kg cow dung, ferment for 24 hrs with intermittent stirring, filter squeeze the extract and dilute to 100 lit, use as foliar spray over one acre. Useful against sucking pests and mealy bugs.

Mixed leaves extract - Crush 3 kg neem leaves in 10 lit cow urine. Crush 2 kg custard apple leaf, 2 kg papaya leaf, 2kg pomegranate leaves, 2 kg guava leaves in water. Mix the two and boil 5 times at some interval till it becomes half. Keep for 24 hrs, then filter squeeze the extract. This can be stored in bottles for 6 months. Dilute 2-2.5 lit of this extract to 100 lit for 1 acre. Useful against sucking pests, pod/fruit borers.

Chilli-garlic extract - Crush 1 kg Ipomea (besharam) leaves, 500 gm hot chilli, 500 gm garlic and 5 kg neem leaves in 10 lit cow urine. Boil the suspension 5 times till it becomes half. Filter squeeze the extract. Store in glass or plastic bottles. 2-3 lit extract diluted to 100 lit is used for one acre. Useful against leaf roller, stem/fruit/pod borer

Broad spectrum formulation - 1 - In a copper container mix 3 kg fresh crushed neem leaves and 1 kg neem seed kernel powder with 10 lit of cow urine. Seal the container and allow the suspension to ferment for 10 days. After 10 days boil the suspension, till the volume is reduced to half. Ground 500 gm green chillies in 1 lit of water and keep overnight. In another container crush 250gm of garlic in water and keep overnight. Next day mix the boiled extract, chilli extract and garlic extract. Mix thoroughly and filter. This is a broad spectrum pesticide and can be used on all crops against wide variety of insects. Use 250 ml of this concentrate in 15 lit of water for spray.

Broad spectrum formulation - 2 Suspend 5 kg neem seed kernel powder, 1kg Karanj seed powder, 5 kg chopped leaves of besharam (*Ipomea* sp.) and 5kg chopped neem leaves in a 20lit drum. Add 10-12 lit of cow urine and fill the drum with water to make 150 lit. Seal the drum and allow it to ferment for 8-10 days. After 8 days mix the contents and distil in a distiller. Distillate will act as a good pesticide and growth promoter. Distillate obtained from 150lit liquid will be sufficient for one acre. Dilute in appropriate proportion and use as foliar spray. Distillate can be kept for few months without any loss in characteristics.

Some Other forms of Organic Management and Innovate Inputs

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 Steiner and subsequent practitioners.

The important components of biodynamic farming are as follows:

- a. Turning in plant materials such as green crops and straw
- b. Not using chemical fertilizers and pesticides
- c. Avoiding soil compaction by machinery or animals, particularly in wet weather
- d. 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)
- e. Fallowing the land by planting deep-rooting permanent pasture species or using green crops
- f. Use of preparations BD-500 and BD-501
- g. Compost made with preparations BD-502 – BD-507
- h. Liquid manure made with preparations BD-502 – BD-507
- i. 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 ethereal 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.

Biodynamic formulation-500 (BD-500)

As per the established norms of biodynamic process while cow-dung is full of astral and ethereal powers; the cow-horn shell has the potential to absorb astral powers. In this formulation the inherent potential of these two components is harvested in making a biologically active formulation.

- a. **Method of preparation** - Whip fresh cow dung to prepare a thick smooth paste. Fill the empty cow horn shells with this paste. Now place these horns in

the pit in upright position with the pointed closed end of horns facing upwards. Fill the pit with good fertile soil and compost mixture (25 : 1) till ground level. The soil of the pit is to be kept moist for all the time. If required sprinkle water at repeated intervals. As per the Indian moon calendar "*Kwar Navratra*" (October-November) is the most ideal period for placing the dung filled horns in pits. The horns are kept buried for approximately six months and are taken out during "*Chaitra Navratra*" (March-April). Dig out the horns at appropriate time and take out the BD-500 compost. The compost should be moist and should have a pleasing smell. Store the compost in earthen pots till its use. BD-500 can be used in any crop twice, first dose is to be applied a day before sowing and second dose after 20 days of seedling emergence. For best results it should be applied close to full moon days. BD-500 applied during low-moon or no-moon days will not be that effective.

- b. **Method of application** – Mix 30 gm of BD-500 in about 13 lit of rain or fresh tube-well water. Stir the solution with hand for one hour. Apply this suspension with the help of Knapsac sprayer on soil surface or as foliar spray. The best time of application is close to sunset. BD-500 application encourage the growth of beneficial microorganisms and earthworms, promote rooting process and harvest terrestrial forces for better crop growth and increased biological activity in the soil.

Biodynamic formulation 501 (BD-501)

In this formulation fine powder of quartz silica is filled in empty cow-horn shells and kept buried in soil for six months during hot summer season. Opposed to BD-500, the silica filled horns are buried during March-April (*Chaitra Navratra*) and taken out during Oct.-Nov. (*Kwar Navratra*). BD-501 is used as foliar spray and is known to be promoting photosynthetic activity of the plants, resulting into better growth of the plants and better quality of grains and fruits. 1gm BD-501 is sufficient for one acre. Mix 1gm BD-501 in 13 lit of water and mix by whirling for one hour. Apply this suspension in the field as fine mist spray. BD-501 should be applied in early morning hours when there is mild breeze. BD-501 is to be applied first at 3-4 leaf stage followed by two more application at an interval of 30 days. BD-501 also acts as prophylactic agent and helps in prevention of many fungal diseases such mildews and blights.

Other biodynamic preparation

Besides 500 and 501 there are seven other biodynamic preparations having numbers from 502 to 508, but as their method of preparations are difficult, they are not very popular in India and are not being used in large scale. Their methods of preparation in brief are as follows:

BD-502 – Moistened *yarrow* (*Achillea millefolium*) blossom gathered in spring, are packed into the bladder of deer stag or hart. The bladder is hung into the sun over the summer and buried into good soil over the winter. The contents, dug up in the spring, will aid the compost to regulate potassium and sulphur processes.

BD-503 – Chamomile blossoms (*Matricaria chamomilla*) gathered in the summer are moistened with chamomile tea and stuffed into the small intestine of a freshly butchered cow, made into little links of sausages and buried into good humus soil in the fall. The burial place should be close to melt water flow of snow after the winter. This preparation helps regulate the calcium processes of compost.

BD-504 – Stinging nettle (*Urtica dioica*) is buried in the soil for one full year, enclosed in a mantle of peat moss. It aids in humification of the compost.

BD-505 – Scrapings of the outer rind of Oak bark (*Quercus robur*) are placed in the skull cavity of a domestic animal such as sheep or goat and buried in fall in ground that has water percolations through it (such as below leaking drain pipe). The contents are used in the spring. This preparation works on calcium processes and contributes to making plants disease resistant.

BD-506 – Dried flowers of Dandelion (*Taraxacum officinale*) gathered in spring are moistened and folded into the mesentery (membrane that holds intestines) of a cow. This is buried in soil until the spring. It helps to regulate the silica processes in relation to the potassium processes.

BD-507 – Extract the juice of Valerian (*Valeriana officinalis*) flowers by squeezing. The juice is diluted in rain water and sprayed on the compost pile. This preparation regulates the phosphorus processes in the compost.

Although, the method of preparation of these compost BD formulations are difficult, but they are required in very small quantities and can be stored in glass containers for long periods. Once prepared can be used over large number of compost piles. A tea spoonful of each (502-507) will suffice for a normal garden compost pile of 3 m³. On a compost pile poke 5 holes of about 30-40cm deep and stuff each with tea spoonful of formulation 502 to 506. Formulation 507 is stirred in a bucket of water and uniformly spread over the entire compost pile.

BD-508 – Fresh tissue of horse tail plant (*Equisetum arvense*) is made into a tea by boiling with water for 20 min. Filtered tea can be stored in glass bottles and diluted at the time of use. This formulation is used as prophylactic agent against mildews, blights and other fungal disorders.

Cow-pat Pit (CPP)

Prepare a brick lined pit measuring 90 x 60 cm and 30 cm deep without any lining in the bottom. Mix 60 kg fresh cow dung with 200gm crushed and powdered egg shells and 300 gm basalt dust (or blue granite dust or bore well soil). Mix thoroughly to obtain smooth paste. Fill the mixture in to pit up to 12 cm height. Dig 5 holes in the paste and put one teaspoon full (3 gm each) of preparation 502 to 506 in each hole. Preparation 507 is mixed with water and half is poured in one hole and half sprinkled over the entire surface. Cover the surface with wet gunny bag.

After four weeks, aerate the dung by turning it with the help of a fork. Smooth out again and cover. Thereafter turn every week. CPP compost will be ready in 12 weeks time.

CPP can be used in various ways depending upon the requirement and crop/plants. Use 100 gm CPP/acre, mix with BD 500 or 501 and use as spray. CPP can be used as soil inoculant (@ 2 kg/acre) mixed with composts. CPP can also be used as foliar spray (@ 5kg/acre) right from the beginning of crop to up to fruit/pod formation stage with an interval of 7 to 15 days. CPP can also be used as paste on stem of fruit trees. CPP can also be used as inoculant to biodynamic composts in place of 502 to 507.

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 need 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 bioenhancer 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. Strength of various microorganisms detected in panchgavya are as follows:

i. Total fungi	38,800/ml
ii. Total bacteria	1,880,000/ml
iii. Lactobacillus	2,260,000/ml
iv. Total anaerobes	10,000/ml
v. Acid formers	360/ml
vi. Methanogens	250/ml

Physico-chemical studies have revealed that panchgavya possess almost all macro and micronutrients and growth hormones (IAA, GA) required for plant growth. Predominance of fermentative microorganisms such as yeasts and Lactobacillus helps improve the soil biological activity and promote the growth of other microorganisms. For foliar spray 3-4% panchgavya solution is quite effective. Four to five sprays ensure optimum growth and productivity: (a) two sprays before flowering at 15 days interval, (b) two sprays during flowering and pod setting at 10 days interval and (c) one spray during fruit/pod maturation. Application of panchgavya has been found to be very effective in many horticultural crops such as mango, guava, acid lime, banana, spice turmeric, flower-jasmine, medicinal plants like Coleus, Ashwagandha, vegetable like cucumber, spinach, okra, radish and grain crops such as maize, green gram and

sunflower. Panchgavya has also been found to be reducing nematode problem in terms of gall index and soil nematode population. As due to application of panchgavya a thin oily film is formed on the leaves and stem, it reduces evaporation losses and ensures better utilization of applied water.

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 have been incorporated in the package described above.

Jivamruta has been found to be rich in various beneficial microorganisms. As per the studies conducted by Bio Centre Bangalore the Jivamruta contains following microorganisms:

- Azospirillum 2×10^6
- PSM 2×10^6
- Pseudomonas 2×10^2
- Trichoderma 2×10^6
- Yeasts and moulds 2×10^7

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. This can be simply achieved through:

'Demystification of Science'

Prayog Pariwar has demonstrated that dissemination of relevant and often sophisticated science can be achieved in the local idioms of the common man. This can be very effective in bringing about a 'gray matter revolution'. With a new techniracy (technical literacy) for the management of soil, water, and canopy of leaves, it promises high yields with minimal external inputs and optimal harvesting of sunlight.

Understanding Natueco Farming Science

- Natueco Farming methods go beyond natural farming and organic farming.
- In natural farming, farming is done trusting nature through the empirical wisdom of ages. However, Natueco methods emphasize farming by knowing nature more and more through critical scientific inquiries and experiments. It is an ever growing, novel, unique, participatory tryst between man and nature.

Moreover, Natueco Farming in no way related to the present commercial techniques of farming.

- It has a new vision of infinite resource potentials in Nature and sunlight and promises **plenty for all** through harvesting all available resources by increasing the human activity.
- This depends on critical understanding of greening and recycling of biomass within the neighborhood to enrich the structure and fertility of soil in a calculated way.
- It promises record assured yields in a mathematic precision by understanding plant's geometry, cycles of growth and canopy (leaf area) management with little or no external inputs and ensuring optimum harvesting of sunlight.
- It visualizes that in the near future, the present money market system will have to give way to a new eco-economic system of Nature, i.e. energy market system.

Natueco Farming Step by Step

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:

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

Basic Principals of Natueco farming Harvesting the sun

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.

Five Stages in plant life

Every plant goes through five stages in its life: [1] Childhood [2] Puberty [3] Youth [4] Maturity and [5] Old age. These stages are of roughly equal duration and external interventions at specific stages are most important. (e.g. There is no use giving fertilizer dose when the plant has become old and is dying) Generally, plants can be classified as having a seasonal, short duration life span [90 to 130 days], medium life span of 4 – 5 years, or perennial long life span. For short duration life span, all 5 stages become very critical. For example, if sumptuous roots are not developed in the first 15-20 days [20% of lifespan] no amount of external inputs, thereafter will be useful or effective. Leaves and Branches also show these stages in their life cycles. Yellow, old leaves can only fall and cannot be rejuvenated. Old branches eventually become deadwood.

Medium for root zone

Generally, this is soil. However, one can do without it as in the case of hydroponics.

The main purpose of the medium is

- To give support to the plant and anchoring it by means of shoot root and feeder roots.
- To supply nutrients to the feeder roots.
- To provide moisture to the plant roots.
- To provide good air circulation to the roots.

It is always possible to prepare an ideal soil by human intervention. The soil also supports a whole range of life starting from microorganisms up to earthworms. The presence of these life forms provide essential benefits to the plant roots, in that they convert minerals found in nature into root-absorbable forms.

Plants manufacture their own food

Unlike animals, plants manufacture their own food. By means of photosynthesis, water and carbon dioxide, is converted into sugar: glucose, which is then converted to other forms of sugar, lignin, fats, etc. Plants produce 3 – 4g of dry mass/ square foot of photosynthesis area / per one sun-day of 8 – 10 hrs. From this: (i) 1g is used in plant metabolism (ii) 1g is used to build plant body, roots, stem, leaves, etc and (iii) 1g is either stored or used for producing fruits.

It is very useful and instructive to know, especially about the timings and places of storage of food/ energy and how to tap them at appropriate time. Without the knowledge of this the enzymes and hormones [Gibberilic acid, Indol acetic acid] may lead to a stage, where plants grow with luxurious growth but scarce fruiting.

Plant Biochemistry

Hormones are the messengers and enzymes are the catalysts of plant metabolism, hence their study is very useful for general understanding of plant physiology.

A family's requirement can be met in just 1000 m²

It is possible to create a microclimate within 10 Guntha (1 guntha = 1000sq.ft), which can meet one family's entire requirement, needed for respectable living.

Limited water supply

Assured supply of 1000 liters of water per day is a right of every family. With this as the only external input, prosperity can be built from within the neighborhood using the Prayog Pariwar methodology

Implementing Natueco Principle with Prayog Parivar Methodology

a) Soil Management - The first step of Natueco Farming is to develop the Nursery Soil using neighborhood resources. Nursery Soil consists of 50% biomass and 50% activated mineral topsoil by volume. The Biomass forms the organic part and the topsoil forms the inorganic part of the Nursery Soil. The Nursery soil provides support and delivers water and nutrients to the plant in the most efficient manner. To obtain high quality nursery soil, it is most important to build its organic part through biomass addition. The well composted organic part of the nursery soil is called HUMUS which contains ligno proteins. It is a black, light, and easily friable material that can be broken

into small fragments or crumbs. It has very good water holding capacity, twice its own weight. Generally, the weight of such material per liter of its volume in fine crumb form is about 400 grams. It has a peculiar black luster & we can see layers of dead colonies of the micro flora especially in well composted (humified) animal dung.

- b) Harvesting the Sun** - It is well known that the entire food chain is directly or indirectly depend upon sun energy, harvested by green plants through a process known as photosynthesis. Although one square meter of land surface usually receive 14,400 K. cal energy per day during bright sunny days, but only a small fraction of direct, total solar insolation is harvested by plants. The philosophy of Natueco culture emphasize on increasing the sun energy harvesting potential of plants, first by understanding the requirement of canopy index establishment, secondly by understanding the principal, that only the mature leaves of the plant are capable of doing optimum harvesting of sun and third by understanding the requirement of matching storage organs.

What is canopy index number – Canopy index number is calculated by accommodating overlapping leaves in multiple of 3 in one sq.ft. area. For example a plant, whose up to 3 overlapping leaves covers an area of 1 sq.ft., assigned Index No.1, with six overlapping leaves in 1 sq.ft., assigned Index No.2, with 9 overlapping leaves in 1 sq.ft. assigned Index No.3, with 12 overlapping leaves in 1 sq.ft., assigned Index No.4 and so on. Different plants have different leaf indices, generally between 5 and 10. Even the same plant can have different leaf indices as per its vigour.

Maximize Sun Harvesting - Critical studies by Prayog Parivar revealed many new findings, summerised below:

- i. To harvest optimum sunlight, the plant must build a canopy as per the index number of the crop, which is generally between 5 to 10. Thus if a plant's index number of leaves is 5, it means that, to harvest maximum sunlight from one sq.ft of area, this plant must have a canopy of 5 sq.ft. area.
- ii. Each plant needs specific area for its maximum growth. By multiplying this area required by the plant, by the index number of leaves, we can calculate the requirement of canopy area e.g. if a plant needs about one half sq.ft. area for its full spread and its leaf index is 5, then for optimum sun harvesting the plant must have a canopy of 2.5 sq.ft. (0.5 x 5).
- iii. Each plant must establish its optimum canopy spread at the earliest of its life cycle.
- iv. As only mature leaves are capable of doing optimum harvesting of the sun, the young emerging leaves and old dying leaves should be excluded from the point of view of calculation.
- v. There should be matching storage organ growth in plants at the time when optimum photosynthesis is taking place in the matured leaves.

3. Recycling Process

For optimum and continued growth of crops in the fields year after year, it is very much essential that recycling process carries on effectively. Three major components of this recycling process are (a) aerial component such as carbon

dioxide, oxygen and nitrogen (b) mineral elements from soil and (c) water. For optimum availability of all the essential nutrients, the fertility of the soil is very important. A good fertile soil maintains its fertility structure, only when the mineral part and the composted part of the soil are equal by volume. In Prayog Parivar's term such soils are called nursery soils. Thus in one cubic foot of nursery soil one half cubic foot soil will be of mineral part and the other one half of the well composted part of dead organic matter. Decomposition of dead organic matter first into compost and then finally into mineral matter and gases is the last part of the food chain of our ecosystem.

- (a) Among the aerial components, although one need not worry about carbon dioxide and oxygen, supply of nitrogen is partly ensured by good population of nitrogen fixing bacterial in fertile soil and partly is obtained from decomposition of degrading organic matter.
- (b) Entire quantity of mineral elements, need to come from soil reserve. Due care is needed to keep a balance in demand and supply of these nutrients by recycling partly the same crop residue and if needed from neighbourhood resources. Most of the nutrients absorbed by the plants are conserved in their leaves and twigs and only a small fraction goes in fruits and grains. To maintain the balance, the entire quantity of leaf and twigs etc. need to be recycled back and to compensate the loss of a small fraction of nutrients taken away in fruits and grains need to be compensated by small biomass /compost from other sources such as animal dung etc.
- (c) The water cycle is the cycle run by the nature, bringing water from the oceans to the lands and the mineral contents from the lands to the oceans. The evaporation of one litre of sea water requires 600 K cal of sun energy. The clouds so generated are transported to the lands by strong winds which eventually come down as rain. All life cycle on land depends on the supply of rain water and the life cycles in the oceans depend on the supply of nutrients carried through the water returning back to the seas or oceans. The Natueco culture cautions that in bringing one litre of rain water about 600 – 800 K cal of sun energy is involved, therefore we should not allow this precious water to be wasted as run-off, before it is fully utilized to optimize biomass production at every place. As per Prayog Parivar's estimate, the water required for producing one Kg biomass (on dry wt basis) is about 6000 gms. Only this much water is used in the production of 1 Kg carbohydrates. The remaining quantity of water supplied to the plant is used only temporarily and released in the environment, creating micro-climate of moisture conditions, favourable for its growth, as well as for the growth of the ecosystem.

d. Energy Pool and Energy Chain

The Nature's food chain starts with synthesis of carbohydrates in green plants, runs through various macro and micro consumers and ultimately ends into brown mass of decomposed organic matter, before releasing its mineral elements in air and soil. Although, this process is a natural process and runs without the involvement of human but man has accelerated the process to his advantage by bringing more land under cultivation, by using tools and the energy of drought animals. The use of animals in this sun harvesting is very important and must be exploited to its best, otherwise, it will be just wasted. The use of man-made energy tools might have accelerated the process, but has rendered the animal

energy useless which is going waste. In Prayog Parivar's vision all natural aspects, which can be incorporated in accelerating the biomass production need to be exploited to its optimum to harvest maximum richness of the nature.

Natueco summary

Prayog Parivar members conceived, practiced and mastered this new concept of Natueco culture. In their words while natural farming is done by trusting the nature, Natueco culture is done through understanding nature more & more. In this understanding harvesting of sun energy was given the prime importance, coupled with nursery soil build up through whole plant use. In this culture, if appropriate planning is done, then one family of five members can meet its entire requirements from just 10 gunthas of land (1000 m²). But for this one need to understand the Prayog Parivar's vision, his own initiatives, continuous innovations with latest scientific knowledge and once it is accomplished, this cultures promises "**Plenty for All**."

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.

Besides the practice of Agnihotra and the frugal distribution of Homa ash on beds and fields, a variety of further applications have also been recommended. Here are some examples:

Impregnation of Seeds and Bulbs - Before planting/sowing, seeds and bulbs are treated i.e., impregnated with a mixture of Agnihotra ash and cow urine. It is recommended to prepare a mixture of cow urine and water in a ratio of 50:50, to which up to 4 tablespoons of Agnihotra ash per 5 liters of solution are added and stirred. Seeds and bulbs should soak in this solution for 30-40 minutes. This strengthens the germinating plant and makes it more resistant to pests.

Like cow dung, cow urine has antibacterial effects and provides a protective coating around the seeds and bulbs. After this time of treatment, seeds are spread on filter paper, or other absorbent paper, to dry. They should be dry enough to spread, but moist enough so that the core of the seed doesn't dry out. Through the impregnation, germination is started-which would be ended if the seeds completely dried out. Bulbs may be planted immediately after being treated with the solution.

Fertilizers - In addition, plants can be fertilized with a mixture of Agnihotra ash, stinging nettles, and water. This special liquid fertilizer strengthens plants. The stinging nettles are fermented i.e. decomposed in the water for 7-14 days, depending on weather conditions and the amount of nettles needed. This mixture should then be diluted to a solution with a ratio of 1:9. In other words, 1 part stinging nettle solution is mixed with 9 parts water and filtered with a fine screen (sieve) into a spraying container or watering can.

Plant Nutrient Solution - To make an Agnihotra plant nutrient solution, up to 4 tablespoons of Agnihotra ash and up to 4 tablespoons of pulverized, dried cow dung are stirred in approximately 5 liters of water and then applied to plants. This may be repeated every 14 days, depending on how much it is needed.

Spray Solution - A nutrient solution to be sprayed can be made by mixing up to 4 tablespoons of Agnihotra ash with 5 liters of water. This spray solution is left standing for 3 days and then filtered through a fine screen before it is used to protect plants against pests and diseases. A spray solution can also be made from certain fern blossoms, in which approximately 150 grams of the blossoms, mixed with 2 liters of water and 2 tablespoons of Agnihotra ash, are left standing to ferment for 7-10 days. Filtered through a narrow-meshed screen and then finally distributed on the plants with a sprayer, this helps keep away pests such as snails.

Gloria Biosol an effective homa biofertilizer -

Gloria Biosol is a very effective bio-fertilizer which can be produced simply in Homa atmosphere. Biosol liquid can be used for foliar application to nourish plants and soil. Biosol is superior to vermiwash as it contains high numbers of beneficial microorganisms and energy of homa process. Agnihotra Ash has a significant positive effect on all the materials used and makes the Biosol rich in macronutrients.

Materials required to make the Biosol are:

- Fresh cow dung
- Vermicompost
- Cow urine
- Agnihotra ash
- Water

Materials are mixed in a large tank (200, 500 or 1000 litre). One copper Shree Yantra disc is placed in the tank. The tank is then sealed and kept for 20 to 30 days. After digestion is complete, the slurry can be removed. Biosol is used diluted with Agnihotra ash water solution in the ratio of 1:10. For one hectare of agricultural area, 200 liters of Biosol in solution are required. Biosol in solution can be sprayed on any type of crop at an interval of fifteen days. The application

of the Biosol solution should be made before sunrise or after sunset. If we preserve Biosol liquid in air tight cans it will last longer, say about six months. Left over solid Biosol which is having maximum macro nutrients should be mixed with any type of organic manure at a ratio of 1:5.

EM – Technology in organic farming

What is EM

EM or Effective Microorganisms is a consortium culture of different effective microbes commonly occurring in nature. Most important among them are : N₂-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.

Benefits of EM use

- Improve seed germination, seedling emergence, growth of plants, flowering, fruiting and ripening of grains and fruits.
- Improves photosynthetic potential.
- Increase tolerance in plants against pest attack.
- Improves physico-chemical and biological properties of soil.
- Help in control of soil borne pathogens.
- Interdependent biological activity of different EM organisms creates a congenial environment for growth and spread of soil's flora and fauna. They also promote the growth and colonization of VAM, which further help in plant growth promotion.
- Help in quick degradation of organic matter. With the use of EM the requirement of compost can be reduced or dispensed with. Just recycling of crop residue with EM can give similar results as with good compost. This saves lot of labour and space required for compost preparation.
- Improves soil biota and makes the soil soft and porous

How to use EM

Application of EM in agriculture involves four steps as follows:

- Procurement of primary EM- available in market
- Preparation of secondary EM – to be carried out by the farmer
- Appropriate dilution of the secondary EM solution
- Application to plants, soil and organic matter as spray

Preparation of secondary EM solution

Depending upon the requirement and its end use, various EM formulations have been developed. Even among one formulation depending upon the place and climatic conditions some variations have been incorporated and recommended by promoting institutes and agencies. Some of the widely used and popular formulations are described below. Water used in all formulations should be either rain water or fresh tube-well water. Tap water is not to be used.

1. EM-1 formulation- This formulation is used for seed treatment, soil enrichment and for spray in field after the emergence of seedlings.

- Dissolve 5 kg jaggary (chemical free) in about 100 lit of water

- Add 5 lit of EM
- Mix thoroughly and pour into a plastic carboy. Seal the carboy and allow to ferment for 7 days
- Dilute this solution in a ratio of 1:1000 and spray over soil or crop residue. For seed treatment soak the seeds in this diluted solution.

2. EM-5 for control of insects and pests –

- Dissolve 100gm of jaggary in 600 ml of water
- Add 100 ml each of natural vinegar, wine or brandy and EM
- Mix thoroughly and transfer the contents in a plastic bottle or carboy and seal the container.
- To increase the potency few cloves of garlic and chilly paste can also be added to this suspension before sealing the container.
- Allow the contents to ferment for 5-10 days under shade.
- Release the gas daily
- Within 10 days the EM solution will be ready for use. This can be stored up to 3 months at normal room temperature in a cool and dry place.
- Dilute the contents in a ratio of 1 : 1000 and apply as foliar spray with the help of a sprayer.

3. Fermented Plant Extract (FPE) – In this formulation fresh green weeds are fermented with EM to obtain a fermented plant extract.

- Grind 2.3 kg of fresh green weeds to a coarse paste.
- Dilute with 14 lit of water⁵⁹
- Dissolve 42 gm of jaggary in some water and mix with weed suspension.
- Add 420 ml of EM
- Transfer the contents to a plastic drum and with the help of a thick plastic sheet cover the drum and tie with a rope.
- The drum should be filled up to the top, leaving very little space for air.
- Fermentation and gas formation process will start slowly.
- Mix the contents at repeated intervals.
- Finished FPE having a pH of 3.5 with pleasing smell will be ready in 5-10 days time.
- Filter the solution through a cloth and collect the filtrate.
- For spraying on soil dilute the FPE in a ratio of 1 : 1000 with fresh water.
- For spraying on crops dilute FPE in a ratio of 1 : 500.
- Spraying should be done after germination of seeds in early morning hours once or twice a week.

4. EM-Bokashi – Bokashi is a type of compost prepared by fermentation of waste organic matter with the help of EM. Bokashi is mainly used for improving the fertility status of soil and for enhancing the degradation of crop residue.

- Collect sufficient quantity of different organic matter (such as rice bran, fish meal, animal waste etc) equivalent to 150 lit drum volume.
- Mix 150gm of jaggary and 50 ml of EM in 15 lit of water.
- Mix this solution with organic waste thoroughly in such a way that entire contents get uniformly moistened.

- Transfer the contents in a plastic bag and seal the bag.
- To ensure the anaerobic conditions put this bag into another polythene bag and seal
- Allow the contents to ferment for 3-4 days in a cool shade place
- Bokashi will be ready after 4 days.
- This can be used immediately.
- In plastic air tight bags Bokashi can be stored up to 6 months.

How to use Bokashi – Bokashi can be used directly as compost in poor fertility soils. It can also be used along with the crop residues. For 0.1 ha mix 100-150 kg Bokashi with sufficient quantity of finely chopped crop residue. Spread this mixture over 0.1 ha area and mixed with soil a day before sowing. Spraying of 5-10 lit of 1:500 diluted simple EM-solution over this mixture can further boost the degradation process. By using Bokashi+crop residue+EM-solution the requirement of compost can be dispensed with. This can save lot of labour, time and space required for compost process.

Application of EM formulations

At the time of land preparation – Dilute 5-10 lit of simple EM solution in 50-100 lit of water and sprinkle/spray over 0.1 ha of land, when soil is wet a day before sowing.

For seed treatment – Soak seeds for 5-6 hrs in 1 : 100 fold diluted EM solution and sow immediately.

As foliar/ soil spray – After seedling emergence, 1 : 1000 diluted EM solution or FPE should be sprayed at the rate of 500 lit per ha, 4-5 times at an interval of 7-10 days. In fast growing crops such as vegetables, spraying should be done twice a week. In transplanted crops 1 : 500 diluted FPE can be sprayed after 5 days of transplanting @ 750-1000 lit per ha.

For soil enrichment – For every 0.1 ha mix 100-150 kg Bokashi with crop residue and mix with soil just before sowing. Simple EM solution @ 5-10 lit can also be used as spray over this residue-Bokashi mix. Spraying the soil with 5-10 lit of FPE mixed in 500-1000 lit of water per ha also add to the fertility of the soil.

While sustaining soil and ecosystem health organic farming also promises high productivity

Introduction

Sustainability usefulness and suitability of conventional and organic systems vis-a-vis India's growing requirements has generated lot of debate in recent years. Although both the opponents and proponents seem to agree that organic farming practices improve soil fertility, but opponents always raise doubts over its sustainability and capability of meeting our overall food requirements in long term. To prove or disprove not much of information is available in literature. While there is voluminous data about the productive potential of conventional agriculture and effects of chemical inputs on soil fertility, little is known on the effects of organic farming practices. Long-term comparisons between the two systems require careful planning in large areas, preferably between the farms themselves, instead of the replicated plots. The two systems are based on two different philosophies. While the conventional system which relies on the addition of nutrients in chemical form as per the requirement of the crop and soil, independent from the fertility of the soil, can be managed and demonstrated in small plots, organic farming system relies on the inherent fertility of the soil and the overall management practices which are interdependent on each other to get desired results are developed over years. World over there are only a few studies, which has addressed these aspects in very judicious and scientific manner. Results of few such long experimented trials and discussed here.

Results of 21 year DOK trial

The DOK long term trial (D represents Biodynamic, O represents organic and K represents conventional) was taken up since 1978 as a collaborative work by Research Institute of Organic Farming (FiBL) and Swiss Federal Research Station for Agroecology and Agriculture (FAL-Reckenholz). The DOK long term trial – unique in its conception, compares the consequences of bio-organic, bio-dynamic, conventional (mineral fertilizers) and integrated (conventional + organic) farming systems in a randomized plot trial that has no other equivalent. Crops studied were: Potatoes, legume green manures, winter wheat with fodder intercrop, cabbage, barley, grass-clover, beet-root, soybean and maize. Salient features of the study are as follows:

1. **Productivity** – Yield in both the organic and biodynamic system were either at par or 1-5% lower than conventional. An average crop yield reduction of 20% was observed, compared to the integrated use of fertilizers and manures (manures used in these treatments were equivalent to the quantity used in organic plots and fertilizers were added as additional supplement).
2. **Nutrient balance** – The nitrogen balance was negative under all systems. Phosphorus in the conventional systems showed a surplus, whereas in the organic and biodynamic systems the P-balance was slightly negative. In potassium only mineral fertilized plots showed surplus, while it was negative in all systems. Interestingly the organic plots although, showed some negative balance in terms of P and K but it was having no impact on productivity and there were no deficiency symptoms at any point of time.
3. **Use of energy** – Organically grown crops use less fossil, energy than conventional crops.

- 4. Improvement in soil**– The use of organic matter had positive effect on the development and stability of soil structure. Carbon distribution among different particle size fractions was found to be 15-20% higher in soils provided with organic manures compared to non-manured soils. Percolation stability and soil aggregate stability was also found to be highly improved in systems provided with organic manures. Organic management promoted development of earthworms and above ground arthropods, thus improving the growth conditions of the crop. More abundant predators helped to control harmful organisms (pests). Total microbial biomass of microorganisms was 20-40% higher in organic systems than conventional system with manure and 60-80% higher than only mineral fertilization system. In soils of the organic systems, soil enzyme activities were markedly higher than in the conventional soils.

Results of 21 year trial at Rodale Institute FSI in Pennsylvania

Rodale Institute FSI in Kutztown, Pennsylvania is continuing with comparative studies on 6.1 ha of land since 1981. The experimental design include 3 cropping system (in main plot) with (a) conventional (b) animal manure and legume based organic (animal based organic) and (c) legume based organic. The main plots were 18x92 mt each split into three 8x92 mt sub plots, which allowed for same crop comparison in any one year.

- 1. Crop yields under normal rainfall years** - Corn grain yields averaged 4222, 4743 and 5903 kg/ha during the first five transitional years for organic animal (OA) Organic-legume (OL) and conventional (C) systems respectively. After this transitional period corn grain yields were similar for all system at 6431, 6368 and 6553 kg/ha for OA, OL and C systems respectively. Overall soybean yields from 1981 to 2001 (except 1999 when crop failed) were similar for all system.
- 2. Crop yields under drought condition** - Average corn yields in 5 dry years were significantly higher (28 to 34%) in the two organic system (6938 and 7235 kg/ha for OA and OL) compared with conventional system (5333 kg). During the extreme drought of 1999 the OA system had significantly higher corn yields (1511 kg/ha) than the other 2 systems. Soybean yields responded differently during the 1999 drought and were about 1800, 1400 to 900 kg/ha for OA, OL and C system.
- 3. Water percolation and retention** - Over 12 years period water volumes percolating through each system were 15% to 20% higher in OL and OA system respectively then the C System. This indicated an increased ground water recharge and reduced run-off in the organic systems. During 1995, 1996, 1998 and 1999 soil water content were measured of OL and C system. The measurements showed more water in the organically managed field then conventional system plots.
- 4. Energy inputs** - The energy inputs in corn for the OA and OL system were 28% and 32% less than those of conventional system. The energy inputs for soybean production were almost similar at 2.3, 2.3 and 2.1 million Kcal for OA, OL and C system respectively.
- 5. Economics** - The economic comparison made during 1991-2001 (without price premium for organic) for organic corn-soybean rotation and conventional corn-soybean system revealed that the net return for both rotation were similar. The annual net return for conventional system averaged about \$184 per ha, while the organic legume system for cash grain production averaged \$ 176 per ha.

The annual costs per ha for the conventional v/s organic rotations respectively were \$ 354 and \$ 281.

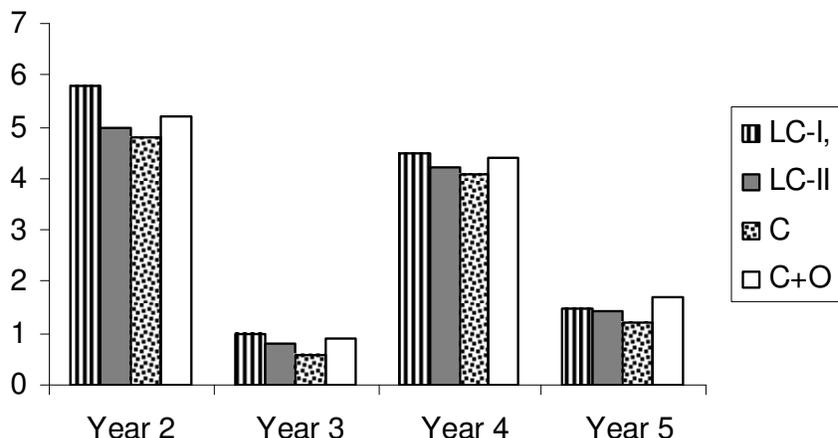
6. **Labor Cost** - The organic system requires 35% more labor, but because it is spread out over the growing season, the hired labor costs per ha are almost equal between the two systems.
7. **Profitability** - Over the 10 year period, organic corn (without price premium) was 25% more profitable than conventional corn (\$ 221 per ha verses \$ 178 per ha). This was possible because organic corn yields were only 3% less than the conventional yields (5843 kg/ha verses 6011 kg/ha) while costs were 15% less (\$351 per ha verses \$ 412 per ha)

Result of 7 year long-term field trial at ICRISAT in India

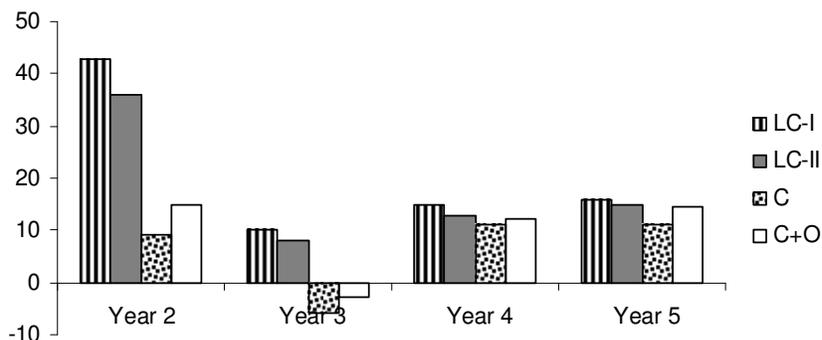
In India, although no such long term studies have been made, but large number of innovative farmers have developed various organic farming models, where comparable yields of different grains, legume, fiber, vegetable and fruit crops are being obtained consistently over years. To examine the possibility of such systems under Indian conditions a long term experiment was initiated at International Crops Research Institute for Semi Arid Tropics (ICRISAT) Patancheru, India since 1999, with four different system of crop husbandry: Low cost system-I based on rice straw (LC-I), Low cost system - II based on farm waste (LC-II), Conventional (C) and Integrated (C+O). As most of the Indian farmers are small and marginal and own few animals, the availability of manure in sufficient quality will not be there, the experiment was designed with less of animal manure and more of other organic matter.

1. **Crops growth and yield** - Six different crops (soybean, pigeon pea, maize, sorghum, cowpea and cotton) grown in last six years emerged well. Except the first year, in which LC1 and LC2 yielded 35-62% lower yields, the yields in other years, in LC1 and LC2 have been on a par with C or at most 14% lower than C+O. Most significant aspect for the farmers is the net income, which have been much higher in LC1 and LC2 than C (except the first year of transition). The differential has ranged between 1.3 and 4.6 times, showing that in economic terms, the low input strategy is proving to be much profitable.

Yield (total economic mass) t/ha



Net income (thousand rupees)



2. **Incidence of disease and insect pests** - In spite of high fear of collar rot by *Sclerotium rolfsii* and stem borer in the presence of high biomass in LC1, LC2 and C+O, the incidence of collar rot was virtually non-existent (at <5% mortality). *Helicoverpa armigera*, a major pest of pigeon pea and cotton was managed well with biological methods. Incidence of borer damage was also lower in LC1 and LC2 than in C+O. Aphids posed some problem in LC1 and LC2 in first three years, but the problem could be overcome with timely application of 1% soap spray. After that aphids were never a threat even when noticed on cotton, maize and pigeon pea. The other insects managed with 0.8% soap were mealy bugs and cow bugs. Population of natural enemies of insect pests was generally higher in the low cost system than C and C+O.
3. **Soil properties and Nutrient balance** - Here it is interesting to note that while LC1 and LC2 produced yields comparable to C, without receiving any chemical fertilizer they actually showed increase in the concentration of N and P compared with C. In years 3 and 4 this increase was 11-34% in total N and 11-16% in total P in LC1 and LC2, relatively more than in C. Among different soil biological properties, the soil respiration was more by 17-27% in organic plots than in C, microbial biomass carbon was 28-29% higher, microbial biomass nitrogen was 23-28% more and acid and alkaline phosphates were 5-13% higher compared to C.
4. **Balance sheet of nitrogen and phosphorus** - LC1 and LC2 which received plant biomass, compost and microorganism as their major source of crop nutrients ended up receiving substantially more N (27-52%) and more P (50-58%) than what was added to C (604 kg N/ha and 111 kg P/ha as fertilizers).
5. **Conclusion**- Six years experimenting with 4 crop husbandary systems reveal that maximization of yields can be achieved by the combined use of chemical fertilizers and organic inputs/practices (integrated agriculture), but this combination may not be affordable for small or marginal farmers in rainfed areas. The low cost biological (organic) approaches can be an attractive choice, particularly when their strategic application results in yield levels at par with conventional system. The low cost system discussed above not only yielded comparable results, but were 25% more profitable than conventional system. Pest and disease management was also effective and low cost with biological approaches. Soil fertility and soil nutrient balance was certainly on a significantly higher side in organic system and offer longer sustainability and suitability of the approaches under Indian conditions, typical of small and marginal farmers.

4 Years study under Network Project on Organic Farming (ICAR)

With the mandate to infuse scientifically validated organic farming approaches and to develop location/ region specific management protocols, four years ago, a “Network Project on Organic Farming” (NPOF) was initiated by Indian Council of Agricultural Research (ICAR) under Project Directorate of Cropping Systems Research, Modipuram. Thirteen research stations from all over the country are participating in the project. A brief summary of results and research highlights are presented here.

The experiments in the project have been designed mainly to evaluate the relative performance of location specific, important cropping systems under organic and conventional farming, and assess agronomic efficiency of different organic inputs especially organic manures and bio-agents. Cropping systems which are under evaluation involve cereal crops (mainly Basmati rice, durum and aestivum wheat, sorghum and maize), pulses and oil seeds (Chickpea, lentil, green gram, soybean, mustard and groundnut), spices (black pepper, ginger, turmeric, chillies, onion and garlic), fruit trees (mango), vegetables (potato, okra, baby corn, cowpea, peas, tomato and cauliflower), cotton, fodder crops (sorghum, maize, pearl millet, oat, cowpea and berseem) and medicinal plants (Isabgol and mentha) in location-specific cropping systems. The highlights of four years research are as follows:

1. Several region-specific cropping systems could be identified, which performed either better than or at par with conventional cropping, in terms of yield and economics.
2. In general, appreciable improvements in yield levels under organic system were noted over the previous years.
3. Improvement of different magnitudes was recorded in respect of soil organic carbon, available-P, available-K, bulk density, and microbial count under organic systems as compared to chemical farming. However, available-N content was, in general lower under organic systems.
4. An improvement in some of the quality parameters of ginger (oleoresin and oil content), turmeric (oil, oleoresin, starch and curcumin content), black pepper (oleoresin content), chillies (ascorbic acid content), cotton (ginning percentage), and vegetables (iron, manganese, zinc and copper content in tomato, French bean, cabbage, cauliflower, pea and garlic) was recorded.
5. Based on annual system productivity and net monetary returns, the best performing treatments were combinations of; non-edible oil cake (NEOC) + cow dung manure (CDM) + enriched compost (EC) at Raipur; farm yard manure (FYM) + NEOC at Ranchi; CDM – CDM + poultry manure (PM); EC + VC + green leaf manure (GLM) + neem cake (NC) at Dharwad; FYM + VC + NEOC at Jabalpur; FYM + crop residues (CR) + GLM in rice-red pumpkin and rice-cucumber, and VC + Glyricidia leaf manure in mango at Karjat; FYM + NEOC at Coimbatore; FYM + VC at Pantnagar; FYM + VC + CR – FYM at Ludhiana; EC + VC + NEOC at Modipuram; FYM(+RP) + VC at Bajaura; and FYM + VC + NC at Calicut.
6. Differences among different organic manures with respect to their effect on different soil parameters (available NPK, bulk density, pH, EC etc.) were not found to be considerable, in general.
7. Some of the non-chemical measures, tried at different centers; were quite effective in controlling major diseases/insect-pest/weeds and resulted in improvement in yields. For example:

- In rice-chickpea system a combination of soil application of mahua cake (100 kg/ha) + neem cake (100 kg/ha) + *Trichogramma japonicum* at tillering initiation + neem spray (0.5%) + use of bird perches in rice caused a significant reduction in incidence of stem borer and green leaf hoper, and in succeeding chickpea seed treatment with *Trichoderma* @ 5 g/kg seed + *Rhizobium* + HaNPV reduced pod borer incidence considerably and led to the highest yields.
- At Dharwad, a schedule of seedling dip with cow urine+dung slurry, botanical spray at 30 DAT, cow urine+5% NSKE spray at 45 DAT, panchagavya 3%+botanicals spray at 60 DAT, buttermilk (20%) + panchagavya 3% spray at 75 DAT, botanicals + buttermilk (20%) spray at 90 DAT, 5% NSKE + vermiwash spray at 110 DAT in chillies was found effective against fruit borer and leaf curl index in chillies.
- At Calicut, combined use of PGPR strains of IISR-6, IISR-8, IISR-13, IISR-51, IISR-151 and PB₂₁ & P₁AR₆ was found effective against rhizome rot and shoot borer in ginger and at Bajaura, spray of bhang (10% LAE) 2nd spray of Bt @ 1.0 kg/ha and 3rd spray with karvi (10% LAE) in tomato against fruit borer were found highly effective.
- For weed control, stale seed bed preparation followed by two hand weeding at 20 and 40 DAS in rice-wheat/lentil/mustard cropping systems at Pantnagar as well as at Ranchi; hand weeding twice in sunflower-cotton system at Coimbatore; and bed planting + spray of sorghum extract at 30 and 45 days after sowing in wheat at Ludhiana were found very effective.

Comparing Safety and Quality of Food in Conventional and Organic Farming

Introduction

With most things in the world people tend to have both, positive and negative opinion. Same is true with these two farming systems also. Both the opponents and proponents have their long list of myths and realities and dismiss each other's claims as not sustainable, insignificant, unfounded or misguided. In their long list some points are really of concern but some are exaggerated and some are sheer imagination, far away from reality. In this chapter an attempt has been made to analyze various myths created about and against the organic farming v/s conventional farming.

Menace of Pesticide Residues

Conventional agriculture has certainly led to very high toxic levels in our food. If we look in to the menace carefully we will find that these high levels may not due to the fault in technology, but mainly due to the continued use of persistent pesticides, faulty application, ignorance and greed of farmers to get better prices of their product. But for this also the technology has to share the blame. On the contrary organic products are safe and free from all types of toxic residues. The products grown in potential organic areas (where no pesticides are being used) have been found to be free of pesticide residues. In India studies conducted by various certification agencies indicate either no or very low levels (below detectable limits) of pesticides and other contaminants. In other countries also organic products have been found to be having very low levels of residues, which are coming mainly as drift from conventional farms.

Do organic products taste better?

Assessment of quality from taste point of view is difficult, as different persons have different standards depending upon their habits, liking and perception. In general there is no evidence of better taste in organic fruits and vegetables. In vegetables where high water content is preferred organic vegetable may rate lower. But this is again subjected to individual preference and may not hold well under all circumstances. But certainly the flavouring ingredients, oils and other taste giving ingredients have been found to be higher in organic products.

Does Organic Fruits and Vegetables Look Better in Physical Appearance

Shape, colour, volume and firmness are some of the important visual characters of quality. Lot of comparisons has been made to ascertain the fact. Most of the studies indicate that practically there are no detectable differences between organically and conventionally grown fruits and vegetables. While shape and colour are variety specific genetic characters, volume and firmness are dependent upon climate, environmental temperature and agricultural practices. Under similar circumstances, products of two systems were indistinguishable.

Does Organic Products Increase the Risk of Food Poisoning or Bacterial Infection?

Food poisoning is caused by the presence of pathogenic bacteria in food items. Prominent among such pathogenic bacteria are *Salmonella*, *Campylobacter*, *Taenia soleum*, *Citrobacter freundii* and *Escherichia coli* strain 0157. All these bacteria are prevalent in animal guts and in their excreta. As organic cultivation relies on higher use of manures it is assumed that they pose higher risk of contamination. After thorough evaluation and studies no such evidences have been found. Interestingly manures are recommended for all systems and conventional agriculture also promotes increased use of manures. Majority of the studies conclude that there is no risk of any food poisoning or bacterial infection through organic products. They are as safe as any other products produced by any other system.

Does Organic Products More Nutritious

To assess the claims of organic farming proponents that organically grown products are more nutritious, although very little studies have been done in India but lot of studies have been taken up in Britain, Europe and USA. Most of such studies when taken into account individually do not indicate any significant variations in quality, but some studies seem to show conclusive evidence one way or the other. But interestingly when the nutritional comparisons are piled up together and we ask the right questions, a different picture emerges which suggests that organically grown crops are more rich in some essential vitamins and minerals and has lower toxic components such as nitrates and heavy metals. Majority of the studies indicate significantly higher levels of vitamin-C, essential minerals such as iron, magnesium, phosphates and calcium. More than 90% of organic products have been found to be having low to very levels of free nitrates in saps. In conclusion it can be safely stated that there are enough indications to prove that organically grown products are superior in nutrients. Although, there may be dispute that how much superior and whether this quantity will have some significant impact on overall health scenario or not, but trends indicate their superiority over conventional products.

Threat of Mycotoxins/Phytotoxins in Organic Food

Certain moulds of fungi can produce phytotoxins which are harmful to human and animals. Some people have raised the concerns that as organic products are produced and stored without the use of fungicides, there are likely chances of such fungal contamination and resultant mycotoxins. All these concerns are sheer imaginations and there is not even a single study to substantiate the claim or concern. The infestation and phytotoxin levels reported by US Food and Drug Administration are far below the acceptable norms and do not pose any threat to human and animals. There is no evidence to suggest that consumption of organic foods has caused any mycotoxin/phytotoxin toxicity. On the contrary the every-day food stuffs like orange juices, nutmeg, coffee and tea etc have far higher levels of phytotoxins and our bodies are adapt at dealing with all such natural products, therefore, it can be concluded that organic products do not pose any threat of mycotoxin or phytotoxin toxicity and on this issue they are at par with non-organic products.

Organic Certification

Organic certification

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

- Avoidance of synthetic chemical inputs (e.g. fertilizer, pesticides, antibiotics, food additives, etc) and genetically modified organisms;
- Use of farmland that has been free from chemicals for a number of years (often, three or more);
- Keeping detailed written production and sales records (audit trail);
- Maintaining strict physical separation of organic products from non-certified products;
- Undergoing periodic on-site inspections.

Purpose of certification

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

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

The certification process

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

- **Study** the organic standards, which cover in specific detail what is and is not allowed for every aspect of farming, including storage, transport and sale.
- **Compliance** - farm facilities and production methods must comply with the standards, which may involve modifying facilities, sourcing and changing suppliers, etc.
- **Documentation** - extensive paperwork is required, detailed farm history and current set-up, and usually including results of soil and water tests.
- **Planning** - a written annual production plan must be submitted, detailing everything from seed to sale: seed sources, field and crop locations, fertilization and pest control activities, harvest methods, storage locations, etc.
- **Inspection** - annual on-farm inspections are required, with a physical tour, examination of records, and an oral interview.
- **Fee** – A fee is to be paid by the grower to the certification body for annual surveillance and for facilitating a mark which is acceptable in the market as symbol of quality.

- **Record-keeping** - written, day-to-day farming and marketing records, covering all activities, must be available for inspection at any time. In addition, short-notice or surprise inspections can be made, and specific tests (e.g. soil, water, plant tissue analysis) may be requested. For first-time farm certification, the soil must meet basic requirements of being free from use of prohibited substances (synthetic chemicals, etc) for a number of years. A conventional farm must adhere to organic standards for this period, often, three years. This is known as being in *transition*. Transitional crops are not considered fully organic. A farm already growing without chemicals may be certified without this delay.

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

Certification system in India

In India, there are two accreditation systems for authorizing Certification and Inspection agencies for organic certification. National Programme on organic Production (NPOP) promoted by Ministry of Commerce is the core programme which governs and defines the standards and implementing procedures. 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 NPOP notified under APGMC act and controlled by Agriculture Marketing Advisor, Directorate of Marketing and Inspection looks after domestic certification. Currently 20 certification agencies have been authorized to undertake certification process Details of the system are available at www.apeda.com/npop. 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 NOP.

National Programme on Organic Production

National Program on Organic Production (NPOP) was launched during 2001 under the Foreign Trade & Development Act (FTDR Act). The document 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.

Scope

The NPOP shall, among others, include: (i) Policies for development and certification of organic products, (ii) National standards for organic products and processes, (iii) Accreditation of programmes to be operated by Inspection and Certification Agencies and (iv) Certification of organic products

Operational Structure:

National Steering Committee for National Programme for Organic Production, is the apex policy making body and operates the entire programme through National

Accreditation Body (NAB), Technical Committee (TC) and Evaluation Committee (EC).

Agricultural and Processed Food Products Export Development Authority (APEDA) is the secretariat and implementation office for NPOP for export while Agriculture Marketing Advisor, Directorate of Marketing and Inspection, Department of Agriculture and Cooperation is the secretariat and implementation office for NPOP for domestic certification.

National Standards for Organic Production (NSOP)

National Standards for Organic Production are grouped under following six categories:

- 1) Conversion
- 2) Crop production
- 3) Animal husbandry
- 4) Food processing and handling
- 5) Labeling
- 6) Storage and transport

Standard requirements for crop production, food processing and handling are listed below:

1. Conversion Requirements

The time between the start of organic management and cultivation of crops or animal husbandry is known as the conversion period. All standard requirements should be met during conversion period. Full conversion period is not required where organic farming practices are already in use.

2. Crop Production

2.1 Choice of crops and varieties – All seeds and planting materials should be certified organic. If certified organic seed or planting material is not available then chemically untreated conventional material can be used. Use of genetically engineered seeds, pollen, transgenic plants are not allowed.

2.2 Duration of conversion period – The minimum conversion period for plant products, produced annually is 12 months prior to the start of the production cycle. For perennial plants (excluding pastures and meadows) the conversion period is 18 months from the date of starting organic management. Depending upon the past use of the land and ecological situations, the certification agency can extend or reduce the minimum conversion period.

2.4 Fertilization policy – Biodegradable material of plant or animal origin produced on organic farms should form the basis of the fertilization policy. Fertilization management should minimize nutrient losses, avoid accumulation of heavy metals and maintain the soil pH. Emphasis should be given to generate and use own on-farm organic fertilizers. Brought in fertilizers of biological origin should be supplementary and not a replacement. Over manuring should be avoided. Manures containing human excreta should not be used on vegetation for human consumption.

2.5 Pest disease and weed management including growth regulators – Weeds, pests and diseases should be controlled preferably by preventive cultural

techniques. Botanical pesticides prepared at farm from local plants, animals and microorganisms are allowed. Use of synthetic chemicals such as fungicides, insecticides, herbicides, synthetic growth regulators and dyes are prohibited. Use of genetically engineered organisms or products is prohibited.

2.7 Soil and Water conservation – Soil and water resources should be handled in a sustainable manner to avoid erosion, salination, excessive and improper use of water and the pollution of surface and ground water. Cleaning of land by burning (e.g. slash and burn and straw burning) should be restricted. Clearing of primary forest for agriculture (jhuming or shifting cultivation) is strictly prohibited.

3 Collection of non-cultivated material of plant origin and honey – Wild harvested products shall only be certified organic, if derived from a stable and sustainable growth environment and the harvesting shall not exceed the sustainable yield of the ecosystem and should not threaten the existence of plant or animal species. The collection area should not be exposed to prohibited substances and should be at an appropriate distance from conventional farming, human habitation, and places of pollution and contamination.

4. Food processing and handling

General principles - Organic products shall be protected from co-mingling with non-organic products, and shall be adequately identified through the whole process. Certification programme shall regulate the means and measures to be allowed or recommended for decontamination, clearing or disinfection of all facilities where organic products are kept, handled, processed or stored. Besides storage at ambient temperature the following special conditions of storage are permitted.

Controlled atmosphere, cooling, freezing, drying and humidity regulation.

Pest and disease control – For pest management and control following measures shall be used in order of priority

Preventive methods such as disruption, and elimination of habitat and access to facilities. Other methods of pest control are:

Mechanical, physical and biological methods

Permitted pesticidal substances as per the standards and

Other substances used in traps.

Irradiation is prohibited. Direct or indirect contact between organic products and prohibited substances (such as pesticides) should not be there.

5. Packaging

Material used for packaging shall be ecofriendly. Unnecessary packaging material should be avoided. Recycling and reusable systems should be used. Packaging material should be biodegradable. Material used for packaging shall not contaminate the food.

6. Labelling

When the full standard requirements are met, the product can be sold as “Organic”. On proper certification by certification agency “India Organic” logo can also be used on the product.

7. Storage and transport

Products integrity should be maintained during storage and transportation of organic products. Organic products must be protected from co-mingling with non-organic products and must be protected all times from contact with the materials and substances not permitted for use in organic farming.

Grower Group Certification System

This system is based on the internal quality system and shall apply to producer groups, farmer’s cooperatives, contract production and small scale processing units. The producers in the group must apply similar production systems and the farms should be in geographical proximity.

Constitution of group

The group should have a legal status or constitution of the organization and shall be presented by an organizational chart.

Internal quality system

Group certification is based on the concept of an Internal Quality System comprising of the following: -

- Implementation of the internal control system
- Internal standards
- Risk assessment.

An external inspection and certification body should be identified for conducting annual inspection of the individual group / unit. The external inspection agency shall evaluate by checking the IQS documentation, staff qualifications and re-inspecting some farms.

Developing IQS

The following are the minimum requirements for setting up an IQS for grower groups:

- Development of Internal Control System (ICS)
- Identification of producer groups
- Creation of awareness about group certification
- Identification of qualified personnel for maintaining the internal control system
- Give necessary training in production and IQS development
- Preparation of IQS manual containing policies and procedures
- Implementation of the policies and procedures
- Review and improvement of the IQS document for maintaining a harmonized IQS.

The system is operated through following workers

1. Internal quality system manager (IQS Manager)
2. Internal inspectors
3. Approval manager / committee

4. Field officers
5. Purchase officers
6. Warehouse manager
7. Processing manager (in case of processing unit)

Internal standards

The internal standards shall be prepared in local language by the IQS manager for the region of operations under the framework of NPOP standards. If the farmers are illiterate, the internal standards shall contain illustrations in the text for better understanding.

Conflict of interest

The IQS personnel shall not have any conflict of interest that might hinder the work. All possible conflicts shall be declared in a written statement. In such cases, the IQS shall ensure that alternative solutions are found.

Scope of certification

The certification shall be granted to the group with reference to the regulations / standards adopted by the group.

Procedure for implementation of ICS

1. **Registration of members** - All members of the group will be formally (legally) registered under a single entity.
2. **Provision of documents to the members of the grower group** - Each member of the grower group will be supplied with docket in local languages, which will contain – Copy of IQS manual, Internal standards document, NPOP document, Definition of the production unit, .. Farm Entrance Form, Field records, Written contract, Annual farm inspection checklist and Information on training programmes and provision of advisory services

Internal inspections

At least two inspections of the group (one in growing season of each crop) shall be carried out by the internal inspector and will be documented. The inspection will be carried out in presence of the member or his representative and must include a visit of the whole farm, storage of inputs, harvested products, post harvest handling and animal husbandry. In case of non-compliance, the results will be reported to the IQS manager and all measures should be taken according to the internal sanction procedures.

External inspections

The external Inspection and Certification Agency will re-inspect some of the farms for the evaluation of the grower group for efficient internal control system for compliance with the NPOP Standards. The sampling plan for inspection shall be based on the inspector's perception of risk.

Yield estimates

Yields will be estimated for each crop for individual farmer in the group. This activity should be carried out especially during harvesting and should be counter-checked with the estimates during buying.

Certification Procedure in brief

- Application is made to the certification agency in the prescribed format with necessary farm and process details
- Screening of application by certification agency and if necessary further details/clarification sought
- Cost estimate comprising of certification charge, inspection charge, travel cost, reporting cost, laboratory charges etc is sent for acceptance
- Acceptance of cost by the grower/producer
- Signing of agreement between grower/producer and certification agency
- Certification agency seeks cropping/production/cultivation /processing plan and supply a copy of the standards to the grower/producer to follow
- Certification agency raises an invoice and asks the producer to release 50% of the certification cost in advance
- Grower/producer pays the fee
- Inspection schedule is worked out
- Inspection is carried out at one or more than one occasion
- If required unannounced inspection can also be done. In case of doubt the inspection team can also draw plant/soil/raw material/input/product sample for laboratory analysis.
- Inspection report/(s) submitted to the certification committee
- Certification agency asks for final payment
- Final payment is made
- Certification is granted
- Grower/producer releases the stock for sale with Certification Mark (India Organic Logo)

Conditions for Products used in fertilization and soil conditioning in organic farming

Items	Conditions for use
Material from plant and animal origin	
<p>Matter produced on an organic farm unit</p> <ul style="list-style-type: none"> • Farmyard and poultry manure, slurry, urine • Crop residues and green manure • Straw and other mulches • Composts and Vermicompost 	<p>Permitted Permitted Permitted Permitted</p>
<p>Matter produced outside the organic farm unit</p> <ul style="list-style-type: none"> • Blood meal, meat meal, bone meal and feather meal without preservatives • Compost made from plant residues and animal excrement • Farmyard manure, slurry, urine • Fish and fish products without preservatives • Guano • Human excrement • Wood, bark, sawdust, wood shavings, wood ash, wood charcoal • Straw, animal charcoal, compost and spent mushroom and vermiculate substances • Compost from organic household • Compost from plant residues • Sea weed and sea weed products 	<p>Restricted Restricted Restricted Restricted Restricted Restricted Restricted Restricted Restricted Restricted Restricted</p>
<p>By products from the industries</p> <ul style="list-style-type: none"> • By-products from the food and textile industries of biodegradable material of microbial, plant or animal origin without any synthetic additives • By products from oil palm, coconut and cocoa (including fruit bunch, palm oil mill effluent, cocoa peat and empty cocoa pods. • By-products of industries processing ingredients from organic agriculture • Extracts from mushroom, Chlorella, Fermented product from <i>Aspergillus</i>, natural acids (vinegar) 	<p>Restricted Restricted Restricted Restricted</p>
Mineral Origin	
<ul style="list-style-type: none"> • Basic slag • Calcareous and magnesium rock • Lime, limestone, gypsum • Calcified sea weed • Calcium chloride • Mineral potassium with low chlorine content (e.g. sulphate of potash, kainite, sylvinit, patenkali) • Natural phosphates (rock phosphate) 	<p>Restricted Restricted Permitted Permitted Permitted Restricted Restricted</p>

<ul style="list-style-type: none"> • Trace elements • Sulphur • Clay (bentonite, perlite, zeolite) 	<p>Permitted Permitted Permitted</p>
Microbiological origin	
<ul style="list-style-type: none"> • Bacterial preparations (biofertilizers) • Biodynamic preparations • Plant preparations and botanical extracts 	<p>Permitted Permitted Permitted</p>

Conditions for Products used in Plant pest and disease control

Items	Conditions for use
Material from plant and animal origin	
<ul style="list-style-type: none"> • Plant based repellents (Neem preparations from <i>Azadirachta indica</i>) • Algal preparations (gelatin) • Casein • Extracts from mushroom, chlorella, fermented products from <i>Aspergillus</i> • Propolis • Beeswax, Natural acids (vinegar), plant oils, Quassia • Rotenone from <i>Derris elliptica</i>, <i>Lonchocarpus</i>, <i>Tephrosia</i> spp. • Tobacco tea (pure nicotine is prohibited) • Preparation from <i>Ryania</i> species 	<p>Permitted Permitted Permitted Permitted Restricted Permitted Restricted Restricted Restricted</p>
Mineral origin	
<ul style="list-style-type: none"> • Chlorides of lime/soda • Burgundy mixture • Clay (bentonite, perlite, vermiculite, zeolite) • Copper salts/ inorganic salts (Bordeaux mix, copper hydroxide, copper oxychloride) • Quick lime 	<p>Restricted Restricted Permitted Not allowed Restricted</p>
Mineral origin	
<ul style="list-style-type: none"> • Diatomaceous earth • Light mineral oils • Permanganate of potash 	<p>Permitted Restricted Restricted</p>
Insects origin	
<ul style="list-style-type: none"> • Release of parasites, predators of insect pests • Sterilized insects • Sterilized insect males 	<p>Restricted Restricted Not allowed</p>
Microorganisms used for biological pest control	
<ul style="list-style-type: none"> • Viral, fungal and bacterial preparations (biopesticides) 	<p>Restricted</p>

Items	Conditions for use
Others	
<ul style="list-style-type: none"> • Carbon dioxide and nitrogen gas • Soft soap, soda, sulphur dioxide • Homeopathic and ayurvedic preparations • Herbal and biodynamic preparations • Sea salt and salty water • Ethyl alcohol 	Permitted Permitted Permitted Permitted Permitted Not allowed
Traps, barriers and repellants	
<ul style="list-style-type: none"> • Physical methods (e.g. chromatic traps, mechanical traps) • Mulches, nets • Pheromones – in traps and dispensers only 	Permitted Permitted Permitted

Accredited Inspection and Certification agencies

IMO Control Pvt. Ltd.

Mr. Umesh Chandrasekhar
Director
No. 1314, Double Road
Indiranagar 2nd Stage
Bangalore-560 038.(Karnataka)
Phone No.: 080-25285883, 25201546
Fax: 080-25272185 Email:
imoind@vsnl.com

Indian Organic Certification Agency

(INDOCERT) Mr. Mathew Sebastian
Executive Director Thottumugham P.O.
Aluva-683 105 Cochin, (Kerala)
Telefax:0484-2630908-09/2620943
Email:Mathew.Sebastian@indocert.org

Lacon Quality Certification

Pvt. Ltd Mr. Bobby Issac Director
Chenathra, Theepany, Thiruvalla - 689
101.(Kerala) Telefax: 0469 2606447
Email: laconindia@sancharnet.in

Natural Organic Certification Agency

Mr. Sanjay Deshmukh, CEO
Chhatrapati House Ground Floor
Near P. N. Gadgil Showroom
Pune-411 038 (Maharashtra)
Phone No.: 020-25457869, 56218063
Fax: 020-2539-0096
Email: contact@nocaindia.com

OneCert Asia Agri Certification

Pvt. Ltd. Mr. Sandeep Bhargava
Chief Executive Officer
Agrasen Farm, Vatika Road,
Vatika P.O., Off Tonk,
Jaipur-303 905, (Rajasthan)
Phone No. : - 0141-2770342
Telefax No: - 0141-2771101
Email: info@onecertasia.in

Bureau Veritas Certification India Pvt.

Ltd. (Formerly known as BVQI (India)
Pvt. Ltd.) Mr. R. K. Sharma Director
Marwah Centre, 6th Floor Opp. Ansa
Industrial Estate
Krishanlal Marwah Marg Off Saki-Vihar
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(Maharashtra) Phone No.: 022-
56956300, 56956311
Fax No. 022-56956302 / 10
Email: scsinfo@in.bureauveritas.com

ECOCERT India Pvt. Ltd

Dr. Selvam Daniel(C.R.)
Sector-3, S-6/3 & 4, Gut No. 102
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(Maharashtra)
Phone No.: 0240-2377120, 2376949
Fax No.: 0240-2376866
Email: ecocert@sancharnet.in

SGS India Pvt. Ltd.

Dr Manish Pande
Divisional Manager – Food, Retail
& CSRS250 Udyog Vihar Phase – IV
Gurgaon – 122 015 (Haryana)
Phone No.: 0124-2399990-98
Fax No.: 0124-2399764
Email: namit_mutreja@sgs.com

Control Union Certifications (Formerly

known as Skal International (India))
Mr. Dirk Teichert Managing Director
“Summer Ville”
8th Floor 33rd – 14th Road Junction
Off Linking Road, Khar (West)
Mumbai –400052 (Maharashtra)
Phone 022-67255396/97/98/99
Fax 022-67255394/95
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controlunion@vsnl.com

Uttaranchal State Organic Certification Agency (USOCA)

Director 12/II Vasant Vihar
Dehradun-248 006 (Uttaranchal)
Phone No.: 0135-2760861
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Email: uss_opca@rediffmail.com

APOF Organic Certification Agency

(AOCA) Mr. K. Dorairaj
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#3, 1st floor, 9th cross, 5th main,
Jayamahala Extn, Bangalore – 560046
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Rajasthan Organic Certification Agency (ROCA)

3rd Floor, Pant Krishi Bhawan, Janpath,
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Vedic Organic Certification Agency

Plot No. 55, Ushodaya Enclave,
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Hyderabad – 500 050
Mobile No.: 09290450666,
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ISCOP (Indian Society for Certification of Organic Products)

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