People's Manual on Organic Manures and Bio-Fertilizers

Radha Hollabhar

JANHIT FOUNDATION

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JANHIT FOUNDATION

Janhit Foundation is an independent, not-for-profit non-governmental organization, actively engaged in the promotion of human welfare through environmental protection since 1998.

Key areas of work include

- Groundwater quality protection for human health
- Provision of safe drinking water to marginalized communities
- Protection of river water quality for aquatic ecosystems
- Enhancement of available water resources through water conservation measures
- Promotion of sustainable agriculture by organic farming methods
- Environmental education and empowerment of local communities

Janhit Foundation undertakes this work through scientific research, campaigns, advocacy and grassroots level community involvement.

As a public interest organization, Janhit Foundation focuses on strengthening local communities through their active participation in decision making, to achieve sustainable development. We believe that environmental degradation can only be addressed adequately if local people are empowered in decision making at all levels and have control over resources.

To achieve our goals, we work in partnership with government, non-governmental, national and international organizations on environment and human rights issues.

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Preface

Agriculture is the first settled activity of humankind. Women and men, working the land, learnt to identify the food crops to grow, experimented to produce varieties that had high yields, that were moisture prudent, and that were resistant to diseases and pests. They learnt the relationships between various life forms, between plants and animals, and how each needed the other in order to survive and thrive. They learnt that planting selected crops together would minimize disease and pest attacks. Over thousands of years, they perfected the art of ensuring food throughout the year, without harming the earth and the life on her.

Today, both the earth and the farmer are facing severe threat. The farmer's science – people's science – has been downgraded as "ignorance", "tradition", "old-fashioned" and "unproductive". Working in laboratories, so-called plant scientists are devising new varieties of seed such as hybrids and genetically engineered seeds, new chemicals, and new techniques to make agriculture "productive". Farmers have become consumers of these new technologies, rather than independent innovators.

Globalization of the new agricultural technologies and inputs has pushed the farmer into deep debt. Agriculture is no more production of food; it has become production for the market. And, in a situation where the market means more than survival, soil, water, seeds and lives are being sacrificed. Thousands of farmers have committed suicide in India in the last ten years, driven to debt by the new agricultural technologies. Lakhs of farmers are trapped in debt and poverty. The combination of new seeds and chemicals has mined the earth of all its fertility and its water: the soil is degraded and water is scarce. Thousands of varieties of plants, animals, worms, insects and micro-organisms have become extinct. In addition, chemicals in the food and water are leading to numerous dangerous diseases.

The time has now come to reclaim the earth and the independence of the farmer. If the earth and farmers have to survive, and to grow healthy, nutritious food, we need to abandon the destructive new technologies that are driving us to the edge of extinction. We need to re-learn the ways of our ancients to foster the earth and all life on it, to produce enough food for every person on the planet.

Radha Hollabhar

Section I

WHY USE ORGANIC FERTILISERS?

I. Failure of The Green Revolution

Food is essential for survival. Today, in India, millions of people go hungry to bed. Why is India not being able to feed its hungry people? The hunger of India's people is not related to under-production of food. The country produces adequate food to meet the needs of each of its citizens. However, numerous policies related to structural adjustment policies and globalization, are alienating people from their lands, and leading them into poverty, reducing their ability to access food.

The farmers of India have always produced enough food for the people of their country. Many people claim that the Green Revolution increased productivity and prevented famines. But, while the Green Revolution did increase production of wheat and rice to some extent, it has had severe consequences.

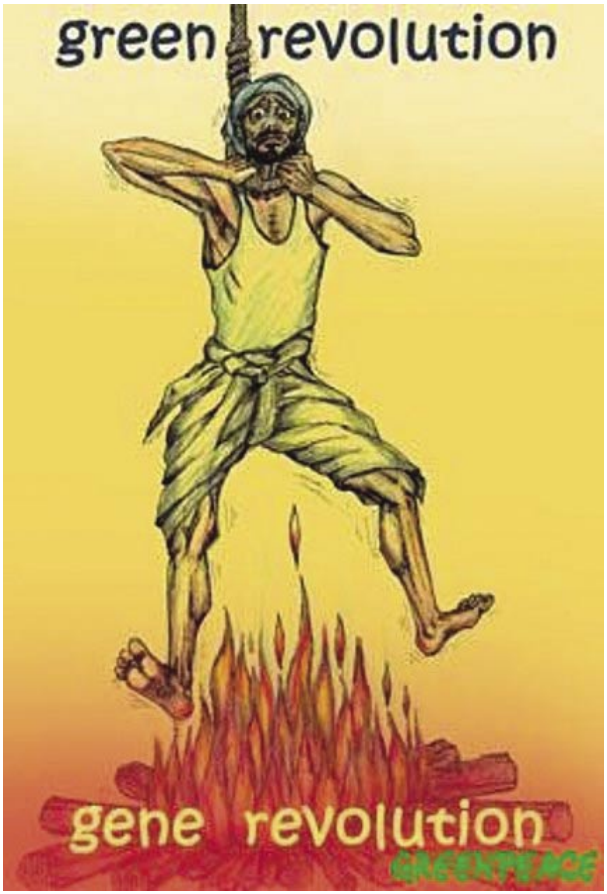
Because of the Green Revolution, India's food security became dependent on wheat and rice in Punjab and Haryana. Earlier, people of various states consumed locally growing crops such millet, pulses, oilseeds, as staples. If one crop failed, there were other crops. If all the crops failed in one region, only that region was affected by hunger. Today, the entire country depends upon the rice and wheat produced by Punjab and Haryana. If crops fail in this region, the entire country is threatened by hunger.

The Green Revolution deepened farmers' debts. The seeds of the new technology gave high yields only if they were given chemical fertilizers. Farmers were forced to take loans to buy the seeds, fertilizers and pesticides. As the yields were never as high as promised, the price received was never high enough to repay the loans.

And more loans had to be taken for the next planting season. In the last decades, tens of thousands of farmers have committed suicide because they could not pay back their debts.

Chemical fertilizers have also caused water depletion and groundwater pollution. Plants need water in order to absorb their food. Chemical fertilizers require excessive amounts of water. This has led to a drastic fall in groundwater levels. Chemicals also contaminate sources of drinking water.

Both chemical fertilizers and chemical pesticides are present in our soil, our water, our food, and even in our bodies today. These chemicals are associated with numerous diseases that affect the brain, the reproductive system, the immune system, the digestive system – in fact, our entire bodily functions. People are increasingly falling prey to diseases like cancer.



The Green Revolution has led to the extinction of numerous agricultural species. Chemicals in the soil destroy life forms vital to food production. Chemical pesticides cannot differentiate between pests and their predators and thus kill indiscriminately. When farmers practice monoculture farming, many species including those best suited for the soil and climate become extinct through non-use. Again, the concept of monoculture tends to treat native varieties as weeds and destroys them, even though many of the plants being destroyed may have been used as food or medicine.

II. Problems Caused by Chemical Fertilizers

The use of chemical fertilizers causes the following additional problems:

I. Nitrate pollution:

Nitrogen is applied to the soil as urea (which quickly turns to ammonium), ammonium nitrate, or a combination of ammonium and nitrate. About 40-60 percent of applied nitrogen is lost by volatilization, run off, de-nitrification and leaching. The nitrate that is leached causes a lot of visible and invisible hazardous effects.

Visible effects:

Plants become succulent and of dark green color. This makes them more susceptible to pests and diseases. Eg. paddy in most of the paddy growing regions.

Nitrates increase the growth, weaken the stem and cause crops like paddy to lodge, leading to reduced quality and quantity of the seed

Invisible effects:

Pollution of ground water by nitrates: Excess nitrate moves below the root zone or into the groundwater (once the groundwater becoming polluted it remains so for extended periods of time). Drinking such water can cause a disease called "*Methemoglobinemia",* where nitrite (the reduced form of nitrate) interferes with the oxygen-carrying capacity of the blood.

Japanese encephalitis (JE): Excess use of urea in rice fields promotes the growth and spread of vectors causing this human disease, which is often fatal. Children between the age groups of 4 and 14 years are mainly affected.

Nitrosomine illness is caused by the presence of secondary amines, which cause cancer in humans.

Feroxyl nitrates, alkyl nitrates, vapors of HNO_3 and nitrate aerosols cause *respiratory illness*

HNO_3 can also lead to acid rains causing lot of *damage to ecosystem and buildings.*

Nitrate oxide produced by de-nitrification *damages the stratospheric ozone layer.*

Eutrophication:

Eutrophication happens when the surface water of lakes, reservoirs, and streams is enriched with nutrients. Algae and higher aquatic plants proliferate and accumulate in excessive quantities, degrading water quality.

Soil acidification and alkalization:

- Chemical fertilizers increase the acidity or alkalinity of the soil, causing imbalance in nutrient availability to crops and effecting activities of beneficial microorganisms.
- Iron, aluminum and manganese toxicities in acidic soil and sodium toxicity in alkali soils affect the availability of other nutrients and deteriorate fertility and productivity of soils.
- The continuous application of 'P' fertilizers can result in the buildup of trace metal contaminants such as arsenic and cadmium, which are contained in the fertilizer.
- Excessive application of potassic fertilizers decrease vitamin C (ascorbic acid) and carotene content in vegetable and fruits.
- Use of phosphates such as DAP causes leaching of zinc, leading to zinc deficiency in soil, animals and humans. This deficiency in animals and humans can cause numerous health problems.
- Excessive application of chemical fertilizers leads to malnutrition due to degradation of carbohydrates and proteins both qualitatively and quantitatively.
- Excessive application of chemical fertilizers affects physical properties of soil such as infiltration, soil aeration, soil structure and bulk density, etc.

It is clear that the Green Revolution is not a sustainable agricultural technology that can continue to feed the world indefinitely.

III. Key Characteristics of Organic Farming

Organic farming, which relies on nature and natural process, is both sustainable and can feed the people with healthy and nutritious food. Soil fertility is increased by crop rotation, mixed cropping, large scale application of animal or Farm Yard Manure (FYM), compost, crop residues, green manuring, vermicompost, bio-fertilizers, and through the use of bio-pesticides and biological control of pests and diseases.

Key characteristics

- Organic farming protects the long-term fertility of soils by increasing the organic content in the soil and increasing microbial activity.
- It creates nitrogen self-sufficiency with legumes, and effectively recycles organic matter including crop residues and livestock waste.
- For weed, disease and pest control, it relies primarily on crop rotations, natural predators, diversity, organic manuring, resistant varieties, bio-pesticides and biological intervention;
- It involves the extensive management of livestock, and takes into consideration the needs and welfare of livestock, including their nutrition, health, and breeding.
- Careful attention is paid to the impact of the farming system on the wider environment and the conservation of wildlife and natural habitats.

Benefits of organic farming

- It helps to maintain a healthy environment by reducing the level of pollution.
- It improves human and animal health by reducing the level of residue in the product.

- It helps to maintain high levels of agricultural production in a sustainable manner.
- It reduces risk of crop failure.
- It reduces production costs.
- It improves soil health.
- It makes efficient use of natural resources while conserving them for future generations.
- It reduces consumption of fossil fuels.

Basic steps of organic farming

The basic steps of organic farming are enshrined in the following five principles:

1. Conversion of land management from chemical-based management to organic management.
2. Management of the entire surrounding system, including biodiversity, to ensure that the system is sustainable.
3. Crop production using organic methods of making nutrients available such as
   a. crop rotation, intercropping, mixed cropping, polycropping or multiple cropping
   b. recycling of organic matter through residue management
   c. green manure cropping
   d. biological inputs
   e. judicious use of water
4. Conversion in concept of weeds – these often include plants that often have medicinal and other uses in organic farming. Management of pests by using physical, cultural and biological control system.
5. Integration of livestock in the farming system.

Section II

KEEPING SOIL FERTILE THE NATURAL WAY

IV. Soil: A Living Resource

Soil covers most of the landmass on earth. When plant stalks, roots and manure are recycled into the soil, the organic content of the soil increases. This helps to improve both the quality of the soil and its water holding capacity, and increase the biomass in it. The biomass in the soil regulates the nutrient cycle and conveys nutrients to plants.

Soil is a living system, home to millions of microbes, bacteria, algae, fungi, ants, earthworms, and other organisms. Fertile soil, in which things can grow easily, has a large number of living organisms in it. Dead, inert soil is that in which nothing can grow, not even the organisms that live in the soil. Thus, the organic content of the soil is an indicator of its fertility. It also indicates the carbon and nitrogen content in the soil, both of which are necessary for healthy plant growth and adequate food production.

To find out if soil is healthy, it is tested for microbial biomass, their enzyme activity, and the presence of various organisms that help to make soil a living resource by working on dead plants and organic matter to decompose it and release the nutrients so that they can be easily absorbed by plants.

Table 1: Indicators of Soil Quality

Physical Properties	Chemical Properties	Biological Properties
Bulk density Rooting depth Water infiltration rate Water-holding capacity Aggregate stability	pH Electrical conductivity Carbon-exchange capacity Organic matter Mineralizable nitrogen Exchangeable potassium Exchangeable calcium	Microbial biomass carbon Microbial biomass nitrogen Earthworms Enzymes Ability to suppress disease

Source: Mitchell J et al, Soil Management and Soil Quality for Organic Crops, Vegetable Research and Information Centre, California

Adding organic matter to the soil improves its physical, chemical and biological qualities. Organic matter improves soil structure, allows water to percolate, increases its water holding capacity, provides essential nutrients, and encourages organisms that assist plant growth to multiply in sufficient numbers.

Physical properties of soil

Soils, whose fertility has been improved naturally, do not *crust*, while soils where chemicals have been used start crusting. When this happens, it means that the soil is losing its structure and indicates that it will soon lose its ability to retain water. This may lead to soil erosion. Adding organic biomass to the soil helps it to retain both its structure as well as its capacity to hold water.

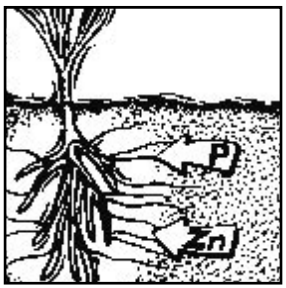
The soil of an organic farm is usually of a darker *color* than neighboring farms where chemicals are used. This darkness is due to the presence of organic matter, which allows the soil to absorb water, and contains microbes and other organisms. Organic farms usually have more clay in the soil. Clay helps in holding five times more water than sandy soil. Of course, if the soil is entirely of clay, it can become waterlogged. To prevent this, it is important to ensure that there is enough organic matter in the soil. This will lead to an increase in microorganisms as well as earthworms and other organisms, which make the soil porous.

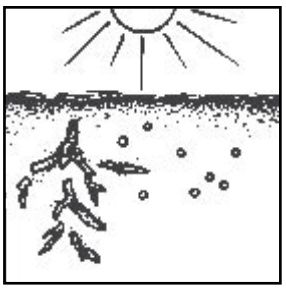
Farms where chemicals are used usually have *dense* soils that have no room for accumulation of either air or water. In contrast, the soil of an organic farm has enough pore space for air and water, both of which are essential for optimal plant growth.

Soils can be either *acidic* or *alkaline.* This is shown by the pH value – a scale of 1-14, where 7 is neutral. The lower the value, the more acidic is the soil. Nitrogen absorption requires a pH of 5.5 or more, and the absorption of phosphorus requires a pH value of 5 to 7. A good balance is between 5.5 and 6.2.

Microorganisms

The most important group of microorganisms in the soil are VAM fungi or Vesicular Arbuscular Mycorrhizae, which are not visible to the naked eye. Unlike other many other fungi, they do not cause disease. In fact, they are vital to plant health, and live in a harmonious relationship with plant roots. They extend their own hyphae (root like structures) to penetrate plant roots, and transport nutrients that the plant cannot reach by itself. Nutrients like phosphorus and zinc move very slowly through the soil. So when the plant roots exhaust the supply present near them, they can suffer, because it can take a long time before minerals are replaced. As the hyphae of VAM can reach much further distances, they help bring these nutrients to the plant root.





VAM fungi also help hold soil particles together. When the plant dies, they live as spores on the dead roots, which grow again in the presence of adequate moisture.

They also help in preventing several plant diseases.

There are about 150 species of VAM fungi, which are thought to have occupied the same soil habitats for millions of years, adapting slowly over time. There is evidence that monocultures severely disturb their habitats, leading to their extinction in the soil.

Earthworms

Earthworms have been keeping soil healthy for millions of years. There are more than 4400 named species of earthworms on the planet.

Earthworms have been divided into three categories:

- *Epigeic* (surface living). These deeply pigmented worms live on organic litter or loose topsoil that is rich in organic matter. They efficiently fragment leaf litter. As they cannot dig, they do not affect soil structure.
- *Anecic* (living in vertical burrows from surface to sometimes 1.7 meters or more below the ground). They come to the surface to feed on green decaying litter mixed with the soil of the upper layer. They may also produce surface casts, depending upon the bulk density of the soil. They are large and less pigmented than epigeic worms.
- *Endogeic* (living in lateral burrow systems). They rarely come to the surface, and derive nutrition from the organically rich soil that they ingest.

The first two varieties are used in the vermicomposting process.

It is important to note that local varieties of earthworms must be used. There is a trend today to use epigeic varieties imported from abroad, particularly from the US. While these earthworms are extremely efficient, it is important to remember that they have the potential to multiply fast (given the good nutrition), and to drive local varieties to extinction. Local varieties are specifically suited to the local environment, are hardier, and thus need less care and nurturing.

How earthworms help

Earthworms help maintain soil fertility in three ways:

Biological. The earthworm is essential to converting dead organic matter into rich humus. It pulls down organic matter from the surface to either consume it or to plug its burrow, where it shreds the leaf, partially digests it, and then mingles it with the soil. Worm casts in fact are rich source of humus, as they contain 40% more humus than the top 6" of soil, in which the worm lives.

Chemical. Besides organic matter, the worm also ingests soil and tiny stones, which are ground and digested in the stomach, and which it expels in the form of worm casts. These worm casts make the nutrients more easily available to plants. Studies in the US have shown that worm casts are 5 times richer in available nitrogen, 7 times in available phosphates and 11 times in phosphates than the surrounding top 6 inches of soil. Thus, the more the worms, the more fertile the soil.

Physical. By burrowing, the worm creates passages for both air and water to travel and reach the roots of the plant.

The presence of earthworms is affected by numerous environmental factors. Chemical fertilizers, sprays, and dusts can destroy the earthworm population in the soil. Chemical nitrogenous fertilizers create highly acidic conditions, which can kill the worms. Applications of DDT, lead, and superphosphates can lead to their extinction. In addition, as they accumulate the pesticides and heavy metals in their body, they can cause the deaths of birds, frogs and other creatures that feed on them.

Keeping soil healthy the natural way involves:

- Minimum tillage
- Proper crop rotation, intercropping, mixed cropping and multiple cropping
- Green manure cropping
- Use of well-decomposed manure and organic matter
- Mulching
- Use of bio-fertilizers.

V. Composting

Composting can be called the last process in the Wheel of Life.

The Wheel of Life

“In the soft warm bosom of a compost heap, a transformation from life to death and back again is taking place. Life leaves the plants of yesterday, but in death, these leaves and stalks pass on their vitality to the next generation...”

Composting has been called the “Wheel of Life” because it signifies the process by which matter is born, dies, and then, through decay and decomposition, is made available again to new life. This process has been going on since the beginning of life on earth; it has, in fact, made possible life on earth. Microorganisms in the soil decomposed and digested leaves that fell on the forest floor as well as various forms of dead animal life and turned them into nutrients for newer plant life. These plants, and their fruits formed the food for man, insect, bird and beast. In nature, there is no waste. All life contributes to making the earth continuously fertile for new life.

Where???

Take illustration 1st page from Art and Science of Compost and liquid manures.

Agriculture has disrupted many of these natural processes by which life returns to earth. Chemical agriculture has disrupted them further. Compost is the way to return the gifts of the soil and to revive its fertility. Compost makes use of all organic matter that is available on the farm to create fertilizer.

Care should be taken that the right temperatures are maintained, so that the decomposition is complete and pests and disease carrying organisms are destroyed. The manure should be completely dry before use.

The composting process removes the fetid smell from the organic matter, making it easy to handle and sweet smelling. It also increases its nitrogen content, while it reduces the bulk.

As plants can only use organic matter while it is still in the process of decaying, even finished compost is only partly decayed. It continues to breakdown in the soil, providing food for microorganisms and other creatures, which in turn, convert it into easily accessible nutrients for plants.

Livestock and compost

Labour can go waste, but never manure, sings the farmer from Rajasthan.

At the heart of composting is animal dung. Livestock is essential to an organic farm. In India particularly, livestock has been the main source of fertility. Cattle were often penned in fields to fertilize them. For instance, farmers often fought with one another over where nomads would graze their cattle, because 1000 sheep and goats penned in 1.32 acres of land for five or six nights could provide the soil with enough fertility to last six to seven years. The nomad owners of livestock were greeted with milk, sugar and wheat, and often given cash payments too.

> *Ghusuri kara, gal gobara, mainsi muta, bila re e sabu huai khata*
> Pigs rolling side to side, cow's dung, buffalo's urine, all these make good manure
>
> - Oriya song

While buffalo dung, pig dung, goat and sheep dung, camel dung, horse dung and chicken litter can be used for composting, traditionally cow dung has been the dung of choice. Cow dung and cow urine have been idealized in Indian farming tradition.

The Indian cows are economical vis-à-vis the cross breeds if we take into account the costs of their feed and upkeep as also the number of lactations that they produce during their lifetime. Calculating the value of cow dung and urine for bio-fertilizers and bullock power for agriculture and transportation it appears that crossbreeds are of little use. From the economic angle, the indigenous cows are undoubtedly much more beneficial than the crossbreeds and thus need to be conserved on a priority basis.

Composting

The nutrient value of farmyard manure increased by 50% to 100% by composting. There are two ways of composting:

Anaerobic – where the compost is put into pits dug out in the ground, layers being added every day till it is full, then covered, and left for six months to a year. This does not allow full microbial activity, and therefore the composting is not complete.

Aerobic – this involves decomposing the organic material in the presence of oxygen. It is quicker, and contains more nutrients.

- Compost allows the soil to retain more plant nutrients over a longer period.
- It supplies part of the 16 essential elements needed by the plants.
- It helps reduce the adverse effects of excessive alkalinity, acidity, or the excessive use of chemical fertilizer.
- It makes soil easier to cultivate.
- It helps keep the soil cool in summer and warm in winter.
- It aids in preventing soil erosion by keeping the soil covered.
- It helps in controlling the growth of weeds in the garden.

There are many methods of aerobic composting, such as the Indore technique, the Bangalore technique, etc.

A good, general method of composting:

Pile onto a flat concrete or stone platform on the ground, or in a well-ventilated shallow brick tank above ground level, the following:

- Layers of organic waste material such as crop residues,
- Garbage from cities and rural area and agro-industries (bagasse, etc.),
- Farmyard wastes, etc.

Finish the layering in one go. Ensure that the pile has a moisture content of about 60%. Turn the material over every 5 to 10 days. Protect the pile from rain, by building a shelter over it. In about three to four months, the pile produces a good compost with about 1-2% nitrogen, about 50-60% organic carbon and essential macro and micronutrients. The final composition depends upon what has been put into the pile. To improve its quality, you can either spray cow dung slurry, or jaggery and water on it, and add azetobacter, and other nitrogen and phosphorus solubilizing bacteria to it.

For this section, illustrations can be taken from Navdanya's Principles of organic farming: Renewing the Earth's Harvest.

Who is this illustration?

Indore Method

A pit, 9ft. x 5ft. x 3ft. is dug, and filled with farm wastes up to a height of 3 inches. Over this, slurry of cow dung and cow urine is spread, till it is 2 inches high. The process is repeated until the pit is almost full. Finally, the whole pile is plastered with a 2-4 inch layer of soil and dung, to prevent moisture loss. The inside temperature rises to 60-65^{o}C within 3-4 days. After 15-30 days, the material inside is turned over and moistened with water if needed. This is repeated every 30 days. The compost becomes ready within 3-4 months.

NADEP Compost

This method was developed by Narayan Devrao Pandri Pandey. A 10ft x 6ft x 3ft

tank is made of bricks. Holes are left in the sides to ensure adequate supply of air during composting. NADEP composting requires approximately:

Soil – 16-18 qtls

Farm wastes – 14-16 qtls

Dung – 1-1.2 qtls

Water – 1300-1400 litres

All the material, including the water is kept ready before starting the process of filling the tank. Once started, it needs to be finished at one go.

The tank is filled in layers starting with agricultural waste, then cow dung and water mixture, followed by fine soil. The layers are then repeated. Once the tank is full (about 14 layers), the top is plastered with a mixture of soil and dung up to a depth of 3 inches. Cracks are covered with mud paste as and when they appear.

The tank is then covered with mulch, or a shed is constructed over it to protect it from sunlight and rain.

The compost is ready after about 110-120 days, giving about 2.5-2.75 tonnes, which is enough for one hectare of land.

NOTE: ADDING AZOTOBACTER, RHIZOBIUM, AND PHOSPHATE SOLUBILISING ORGANISMS CAN IMPROVE THE QUALITY OF COMPOST AFTER 75-90 DAYS.

NADEP Phospho Compost

To the above ingredients, rock phosphate at the rate of 12.5% w/w, and phosphate solubilizing bacteria are added. The material is turned over on the 15th day, and thereafter at intervals of 30 days. At each turning, water is added to maintain moisture. The bacteria turn the rock phosphate into soluble form during the process of composting. When ready, the compost contains N-1%, P_2O_5 – 2-4% and K_2O – 1-2%.

How to apply compost

Most farmers heap or spread organic manure in the field before sowing time. While this fertilizes the soil to some extent, it is not the best method, as it leads to wastage. To get the best results, apply compost in furrows so that it mixes properly with the soil a few weeks before sowing. Make sure that there is sufficient moisture in the soil during and after applying the compost. You can also apply compost between crop periods to condition the soil to maintain its productivity.

VI. Vermicomposting

Vermicompost is today a very important aspect of organic farming. It is easy to prepare, has excellent properties, and is harmless to the plants. The process of converting organic waste into vermicompost using earthworms is called vermicomposting. It is the best way of quickly degrading/recycling or organic matter, including urban waste, into highly useful manure.

Vermicompost consists of the casts of earthworms. It provides energy for the various microorganisms that are essential for maintaining the structure and texture of the soil, for releasing nutrients to plants. It contains about 1-1.5% N, 0.2-1% P_2O_5 and 1-2 K_2O, depending upon the raw matter used.

Vermicompost can be made in pits, tanks, wooden or brick-lined beds, wooden or plastic crates. The place chosen is very important – it needs to be under shade, in an upland or elevated area where water will not stagnate during rains. In fact, in regions where the rainfall is heavy, it is best to avoid pits.

Preparation of Vermibeds

Vermibed or worm beds do not need any soil if non-burrowing or epigeic worms are used; if a combination of epigeic and anecic (burrowing) varieties are to be used as in fields, then a base of loamy soil of at least 15 cm. is required. In the latter case,

1. Make the base layer of the vermibed with broken bricks or pebbles mixed with sand to a thickness of at 6 to 7.5 cm. to ensure proper drainage.
2. On top of this spread layer of moistened soil (at least 15 cm. high). In this layer, about 100 local earthworms are inoculated.
3. Scatter small lumps of fresh or dry cow dung all over the soil.
4. Cover with a 10cm. layer of hay.
5. Spray water till the whole bed is moist but not wet.
6. Cover it with large leaves or coarsely woven gunnysack so that birds do not disturb the vermibed. DO NOT COVER WITH PLASTIC, as this traps heat and gases.
7. Keep watering it for 30 days. The vermibed should be moist enough for the worms to survive, but not so wet that the worms are chased away. The appearance of young earthworms by this time is a healthy sign.
8. On the 31st day, start adding organic refuse, by spreading it over the bed after removing the top leaves/sacks. Do this every day, or at least twice a week. Continue with the watering.
9. After every few applications, turn the refuse over with a fork, without disturbing the bed.
10. When you have added enough, just continue to water the bed until the compost is ready (usually the 41st or 42nd day. It turns into a soft, spongy, dark brown compost that is sweet smelling. Stop watering. This will force the worms to move into the vermibed, and allow you to harvest the compost without damaging the worms.
11. The compost is ready for harvest on the 45th day. Place the compost on solid ground in bright sunlight. Any worms left in it will move to lower layers. By spreading the compost pile after 24 to 36 hours, you can recover the worms, and take them back to the vermibeds.

If you want to inoculate your fields with earthworms, do not screen the compost to remove the worms.

Precautions for compost making

- Moisture level in the bed should not exceed 40-50%. Water logging in the bed leads to anaerobic condition and change in pH of medium. This hampers normal activities of worms leading to weight loss and decline in worm biomass and population.
- Temperature of bed should be within the range of 20-30^{o} C.
- Worms should not be injured during handling.
- Bed should be protected from predators like red ants, white ants, centipedes and others like toads, rats, cats , poultry birds and even dogs.
- Frequent observation of culture bed is essential as accumulation of casts retards growth of worms.
- Space is the criterion for growth and establishment of culture. Minimum space required is 2 square meter per 2000 worms with 30-45 cm. thick bed.

Best composting tips

1. Mixture of cattle, sheep, and horse dung with vegetable wastes forms ideal feed for worms.
2. Addition of neem cake in small quantity enhances growth of worms.
3. Biogas slurry aged aerobically for 15 days enhances vermicomposting process.

VII. Bio-Fertilizers

Bio-fertilizers are products of nature that can increase the productivity of the soil. Common bio-fertilizers include:

1. ***Rhizobium*.** It decreases the requirement for nitrogen, as it induces root and stem nodulation. It is specially suited to the cultivation of pulses, oilseeds, and legume green manures.

   Method of application: seed treatment

2. ***Azotobacter***. Especially useful for helping to fix nitrogen in vegetable, plantation and orchard crops. Thus it reduces the need for nitrogen fertilizers

   Method of application: seed treatment, seedling treatment and direct soil application.

3. ***Azospirillum*.** Again, reduces the need for nitrogen fertiliser. It also induces better root formation. Useful for paddy, vegetables, plantation and orchard crops.

Method of application:

Seed treatment: use 500g. culture for 5-10kg. seeds. Moisten seeds by sprinkling water. Mix with culture in plastic tray or basin, and dry in shade for 30 minutes. Seeds may be sown immediately afterwards.

Seedling root dip (for transplanted crops). Mix 500g. culture with 50 ml. water. Dip roots in this for 15-20 minutes before transplanting.

Soil application: Mix one part of culture with 25 parts of FYM or compost, and apply directly in the soil.

Inoculation for paddy: Mix 2kg. culture in 60 lt. of water, and soak 60 kg. seeds

(for 1 ha.) for 24 hours. At the time of transplanting, mix 2kg. culture with 40lt. of water, and dip roots for 15-20 minutes before transplanting. Also add 2kg. culture along with FYM to the field.

4. *Blue green algae (BGA)*. This nitrogen fixing bio-fertilizer cannot be used in soils with pH below 6.0.

   Method of application: Direct broadcasting in fields one week after seedlings have germinated (or transplanted) at the rate of 10kg. per hectare.

5. *Azolla*. Another extremely effective nitrogen-fixing bio-fertilizers that farmers can raise in their fields themselves.

   Method of application: Apply fresh azolla at the rate of 10 tonnes/ha. at the time of ploughing.

6. *Phosphate solubilizing bacteria and fungi*. These microorganisms weather rock phosphate and tricalcium phosphate by reducing the size of the particles to almost powder. They can also mineralize organic phosphorus to soluble form. They include bacteria (*Bacillus megaterium, B. circulans, B. subtilis, Pseudomonas straita, P. rathonis)*, Fungi *(Aspergillus awamori, Pennicillium digitatum, Trichoderma sp.)*, and Yeast *(Schwannimyces occidentalis).*

   The microorganisms are particularly useful in neutral and slightly alkaline soils.

   They also produce fungicides and growth-promoting substances that help the plant to grow well. Their performance improves in the presence of carbon, phosphorus concentration, and factors like temperature and moisture also affect them.

   Method of application: Seed treatment and direct application.

7. *VAM.* Available as roots and soils with spores, it is applied directly to the soil.

Seed Treatment for bio-fertilizers

1. Use 500g. of commercially available culture for treating seeds for one hectare area.

2. Prepare 1.25 liters of the following solution – 10% jaggery solution (or 5% sugar solution) to which is added 40% boiled and cooled rice gruel (gum Arabic if it is available can also be used). This helps the bio-fertilizer stick to the seed.
3. Mix the culture with this solution.
4. Gently mix the seed with this slurry, taking care not to damage the seed coat.
5. Spread on gunny bag in the shade for drying.
6. Sow immediately.

Note: DO NOT DRY IN DIRECT SUNLIGHT OR FOR A LONG TIME AS THE ULTRAVIOLET RAYS WILL REDUCE THE EFFICACY OF THE BACTERIA ON THE SEED SURFACE.

Seedling Treatment

Mix 500g. culture with 2.5 liters of water, and dip roots of seedlings in this for 15-20 minutes before transplanting.

Soil Application

This is recommended for almost all bio-fertilizers, except for rhizobium and azotobacter. Mix the bio-fertilizer well with dried FYM, compost or vermicompost at one part bio-fertilizer to 25 parts of FYM/compost/vermicompost. Apply at the time of sowing, transplanting or between cultivation, at the following rate:

For crops of six months or less duration: 1-2kg. bio-fertilizer per hectare

For crops of more than six months duration: 2-4kg. bio-fertilizer per hectare

For perennial crops: 10-25g. bio-fertilizer at the root zone during the first year, and 25-50g. in the subsequent years.

Increasing the efficiency of bio-fertilizers:

Use adequate quantities of organic manure to ensure that the microorganism can grow and multiply, and effectively carry out its work.

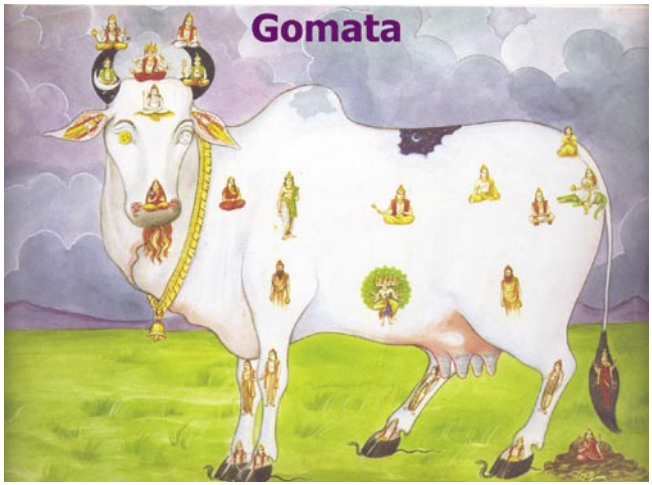
Ensure that the pH value of the soil is 6.0. If it is below this value, the soil is acidic. Add lime at the rate of 250kg./ha. to neutralize the soil.

Ensure that the soil has moisture to enable the microorganism to grow and multiply.

VIII. Other Home-made Fertilizers

Cow dung is used for making many kinds of fertilizers including fertilizing sprays.

Panchakavya



An organic solution constituted by adding with 5 parts of cow's fresh milk, 5 parts of curd made from cow's milk, 2 parts of ghee made from cow's milk, 40 parts of fresh cow urine, and 48 parts of fresh cow dung. To this is added 2% common salt, and 0.1% yeast. This is also an extremely effective pesticide.

Bhabut Amrit Pani

This is a preparation made by mixing 10 kg. cow dung with 250 gm. desi ghee and 500 gm. honey. This material is mixed with 200 liters of water and spread in the field after sowing a crop.

Amrithakaraisal

Take a plastic vessel of 50 liters capacity. Place 10 kg. of cow dung (as far as possible fresh). Add 10 liters of cow's urine and 1kg. jaggery (palm jaggery for better results). Stir with hand all these constituents until the solution becomes uniformly dissolved. Allow the mixture to settle down for 24 hours and then it can be used for the required purposes like seed treatment, fertigation, etc.

Pitcher Khad

This is a fermented preparation made from 15kg. cow dung, 15 liters cow urine, 15 liters water and 250 gm. jaggery. All this is mixed in a container and covered with a cloth or gunny bag. The material is fermented for 4-5 days. The fermented mixture is mixed with 200 liters water and sprayed over the crop in one acre area. Two to three sprays are sufficient for short duration crops.

Biogas Slurry

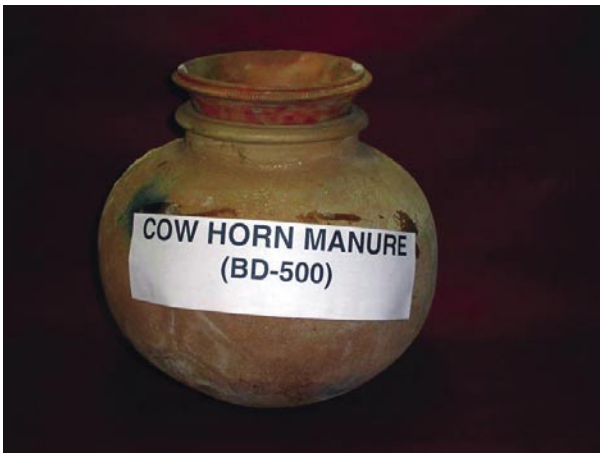
Biogas slurry is a good manure. Slurry is dried in solar drier. Dried slurry is directly applied in fields. Slurry becomes even richer in nutrients if it vermicomposted before use.

Green manuring

Green manuring is an age-old practice for producing organic matter in the fields themselves. Plant varieties that make good manure (including sunhemp, daincha, kulath, beans) are sown in the field to be cropped. The plants are turned into the soil when 8-10 weeks old.

Another method is to grow shrubs and trees on field bunds or in other areas. The top branches are used from time to time for green manure. They can also be used as mulch in fruit orchards, especially if the volume of dried leaves is high. Mulching conserves soil moisture, and over time, the material turns into organic manure. Leaves of pesticidal plants such as neem, pongamia, when used as mulch or green manure, also help in preventing pest attacks.

IX. Biodynamics



(This chapter has been taken from the Auroville website)

The term 'biodynamics' has been derived from two Greek words 'bios' (life) and 'dynamics' (energy). Hence, the name biodynamics indicates, working with energies, which create and maintain life. The main motto is to secure a healthy soil on which healthy plants grow, resulting in the production of healthy food and feed for human beings and cattle respectively. The biodynamic method is more than just another organic method. It stands truly scientific way of producing humus. Here completely digested form of crude organic matter known a stabilized, stable or lasting humus is prepared by different biodynamic preparations and applied to improve the soil productivity. In other words, the method involves a skillful application of all factors contributing to soil life and health. Life and health of soil depend on the interaction of matter and energies, rather a blend of chemicals (organic and inorganic).

Organic and Biodynamic Farming practices

Organic Practices	Biodynamic Practices
Green Manures, Cover Cropping Tillage and Cultivation Composting Companion Planting Integration of crop and livestock	Special compost preparations Special Sprays Planting by calendar in accordance to the astronomical influences Peppering for pest control Homeopathy

A set of eight fermented herbal preparations is used to activate the biodynamic process. These preparations are prepared during a specific season of the year in accordance with the astronomical influences. The biodynamic preparations are numbered from 500-507.

Prep. 500 - Cow Horn Manure

Prep. 501 - Horn Silica

Prep. 502 - Yarrow blossoms (*Achillea millefolium*)

Prep. 503 - Chamomile blossoms (*Matricaria chamomilla*)

Prep. 504 - Stinging Nettle (*Urtica dioeca*)

Prep. 505 - Oak bark (*Querqus robur*)

Prep. 506 - Dandelion blossoms (*Taraxacum officinale*)

Prep. 507 - Valerian (*Valeriana officinalis*)

X. Agnihotra

(Taken from the internet website: www.homatherapy.org/agnihotra/)

Agnihotra is a vedic method of healing through fire, that is said to increase yields when used in agriculture. The specially prepared fire purifies the atmosphere.

The process involves preparing a small fire with dried cow-dung in a copper pyramid of fixed size and putting some grains of rice and the ghee (clarified unsalted butter) into the fire exactly at sunrise and sunset accompanied by the chant of two simple Mantras.

Rice

Uncooked, unbroken pieces of rice preferably less polished or whole brown rice should be used for Agnihotra. If the rice is broken the chemical analysis of both pieces may be the same but the subtle energy structure is broken and hence, it should not be used for Agnihotra healing fire, states the ancient science of bioenergy.

Ghee (Clarified Butter)

Place pure **unsalted**, unadulterated butter from cow's milk in a saucepan and bring it to a slow boil over low heat. Remove and discard the white substance that rises to the top. Strain the liquid through a fine strainer. What passes through is ghee. Store the ghee in a container. It does not have to be refrigerated. Please note ghee must be only 100% pure cow's ghee and not from the buffalo or any other species.

Dried cow dung

Dried cow dung cakes are used to prepare Agnihotra fire.

Cow dung is medicinal. In all ancient cultures, like the native Indians of North and South America, Scandinavians, Asians and Africans, cow dung applications are used for a variety of ailments. In books of folk medicine practiced in Europe, one finds many references to cow dung as a medicinal substance. When we use the words cow dung, we mean dung from the male or female progeny of the cow species only.

How to prepare dried cow dung

Make pancake-like patties from fresh cow dung and let them dry in the sun on a window screen or similar material. Store the dry dung patties for daily use.

Mantras

Morning Agnihotra Mantra:

sooryáya swáhá, sooryáya idam na mama

prajápataye swáhá, prajápataye idam na mama

Evening Agnihotra Mantra:

agnaye swáhá, agnaye idam na mama

prajápataye swáhá, prajápataye idam na mama

About Janhit Foundation

Agriculture and healing are amongst the first sciences of humankind. For thousands of years, farmers have fed the world adequately. They have innovated, given us new crops, and devised ways to make sure that health of the soil, water, plants, animals, and humankind is not harmed.

The current agricultural crisis has led to a revival of traditional forms of agriculture. Numerous individuals and organizations across the world are working to adapt the old methods to the new situations of today as well as to promote chemical-free agriculture.

OrganiC AaharaM

On June 12, 2007, Janhit Foundation, with support from Ford Foundation, launched OrganiC AaharaM - the first organic outlet in Uttar Pradesh.

The objective of this initiative is to provide a market to organic farmers at their doorstep and to make chemical-free certified products available to the consumers of Meerut and adjoining districts.

Ever since its inception, Janhit Foundation has been working simultaneously on raising consumer awareness with regard to the dangers

of consuming foods containing agricultural chemicals and pesticides, as well as weaning farmers away from chemical and water-intensive agriculture towards organic farming. As consumer awareness rises and they start demanding for healthy and organically produced foods, local farmers are encouraged to shift to organic farming.

OrganiC AaharaM is an effort to build direct linkages between the farmer and the consumer without the involvement of middlemen so that farmers get a fair and equitable price for their produce and consumers get access to naturally grown foods at affordable prices.

Janhit Foundation in April 2005 has become a member of International Federation for Organic Agriculture Movements (IFOAM), Germany.

Janhit Foundation works towards the promotion of organic farming in Meerut district, an area which was the center for Green Revolution in the 60's. Excessive use of pesticides, chemicals and urea has adversely affected the fertility of the soil in this region, which is slowly becoming barren. Janhit Foundation has motivated the farmers of Meerut district to adopt organic farming and shed chemical-based farming. Farmers in more than 100 villages in the district mainly under Rohta, Parikshitgarh and Machra blocks have become a part of this movement. In April 2004 the Foundation adopted 100 more villages in Meerut with an aim to help the farming community to initiate organic farming. It is also in the process of setting up a soil-testing laboratory in the region. It organizes training programs, workshops and seminars for the farmers to create awareness on organic farming. JF has also brought out an organic manure manual in Hindi entitled "***Jaivic Khad Sandarshika***" for the farmers and those who

are interested in organic farming. A documentary film entitled "***Kheti Badli Re, Aas Jaagi Re***" has also been produced by the organisation which serves as an important part of the organic farming movement being spread by Janhit Foundation.

It is worthwhile mentioning here that increase in the costs of inputs has fractured the backbone of the farmers in this region. The farmers of Muzaffarnagar, Meerut. Bijnore and Moradabad districts approached Janhit Foundation and the practice of organic farming snowballed in the area. Farmers are being provided training, organic exposure trips to different parts of the country to understand the success stories of organic farming and are given organic seeds and earthworms. This work has spread in 100 villages of district Meerut. Janhit Foundation's coordinators move from village to village, educating farmers about the importance of the organic farming and bio-pesticides. As such, hundreds of acres of land have been converted to organic fields.

Janhit Foundation has brought a sea change in the lives of the farming community in the region by helping them bring down production costs, and at the same time, helping them get a fair price for their organic crops. This has helped reduce poverty, and has generated livelihood for the unemployed youth of the area.

List of resources:

Books:

1. Jaivic Khad Sandarshika (Third Edition) *By Omkar Chaudhary (2006)*
2. A Handbook of Organic Farming *By Arun K. Sharma (2001)*
3. The Natural Way of Farming: The Theory and Practice of Green Philosophy *By Masanobu Fukuoka (1997)*
4. Secrets of the Soil *By Peter Tompkins & Christopher Bird (2004)*
5. Seeds of Suicide: The ecological and human costs of globalisation of agriculture (Revised Fourth Edition) *By Vandana Shiva & Kunwar Jalees (2006)*
6. Panchakavya: A Manual *By K. Natarajan (2003)*
7. The Earthworm Book *By Sultan Ismail (2005)*

Videos:

1. Kheti Badli Re, As Jaagi Re *by Janhit Foundation (2007)*
2. Kasorgarh
3. Deepak Suchde