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How to Make Soil Amrut Mitti (Fertile Nursery Soil)

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Think of a natural system, such as a forest or meadow: it thrives year after year by recycling available nutrients. There is no human intervention. Leaves fall off and break down; grasses and flowers grow, bloom and fade; animals die and decompose – all life adds organic matter to the soil.

The cycle of growth and decay is often depicted as a wheel, where birth, growth and maturity take place above ground in the light, and the process of decay below the surface in the darkness, giving birth to life anew. If growth is faster than decay, the wheel is broken, destroying nature's balance. What lives, eventually dies, its substance returns to the soil to be recycled into new life. This is nature's law of return. This is the cycle you must try to create on your farm.

It has been proved beyond doubt that healthy soil results in healthy plants. When you build and maintain fertile soil, rich in organic matter, you lay the groundwork for thriving plants/crops that can develop quickly, resist pests and diseases, and yield bountiful crops.

Can synthetic chemical fertilizers provide a short cut to healthy soil and healthy plants? After all, we know that the plant's needs are fairly basic: air, water, light, warmth and balance of nutrients and minerals. So why not put some seeds in the ground and apply the appropriate chemicals to speed up growth and then reap the harvest? This is the argument that the manufacturers of chemical fertilizers present when they sell NPK formulations for all manner of crops.

Chemical fertilizers do provide most of the nutrients plants need in an easy to use form. But these chemicals have a number of shortcomings:

1. Plants can absorb only a limited amount of nutrients at a time. Much of these water-soluble products will therefore be wasted and end up as run off during rain or watering.
2. Many chemical fertilizers provide a quick burst of nutrients but may leave the plants to draw on its own resources over the rest of the season.
3. As petroleum products are needed to produce fertilizers, they consume a valuable non-renewable source of energy.
4. Chemical fertilizers don't build or maintain healthy soil. Utilizing them is very much like taking a vitamin pill rather than eating your fruits and vegetables.

If you watch Nature closely as she goes about her daily round of chores, you will clearly notice that her first concern is always to build topsoil and then to protect it. It is easy to see why: no topsoil, not much nature either. The Earth's green carpet of living things is really just the soil's skin.

A single spade full of rich garden soil contains more species of organisms than can be found above the ground in the entire Amazon rain forest. Although the soil surface appears solid, air moves freely in and out of it. The air in the upper 8 inches of a well-drained soil is completely renewed about every hour ('Soil Factoids,' US National Soil Survey Center).

Therefore, soil is alive and involves the interactions of thousands of different species of microorganisms (2 million, per gram), in a highly complex ecosystem. This living soil makes its presence felt everywhere! On both sides of tarred city roads after the first rains, on vast wastelands, in the wild weeds growing on our farms. According to the seasons they grow, get trampled over and decompose. Gradually a new type of soil mix of well-composted material grows above the original layer of soil.

This booklet is about how to produce this living soil on our farms. We need this soil in our fields which have become degraded either from previous use of chemical fertilizers and pesticides or simply through neglect. The methods recommended in this booklet are based on Prof. Dabholkar’s tried and tested scientific experiments in which he has shown that assured, calculated results can be obtained, if basic principles of preparing nutrient rich soil (Amrut Mitti), harvesting maximum sunlight and monitoring proper root growth are followed. He has termed this science ‘Natueco Farming.’ Let us study how we can prepare our own Amrut Mitti by using the resources available in our environment.

COMPONENTS OF AMRUT MITI (Fertile Nursery Soil)

Amrut Mitti can be described as soil that is living, productive and full of nutrition. It contains well composted organic parts and mineral parts in equal volume and has various types of well established micro flora present in it. We will examine each of these components briefly.

(i) Organic matter: Well composted organic matter is generally in the nature of humus or ligno protein. The factors that promote humus formation by bacteria are the availability of lignin, cellulose, nitrogen, water, warmth and oxygen. Cellulose is the energy source for the bacteria. Nitrogen is required for the formation of bacterial protein. If nitrogen is present in the form of protein, such as animal manure, or a leguminous green manure, then the humifying bacteria can use it directly. Humus and ligno protein contribute towards stability and structure of soil.

(ii) Minerals: If we burn any plant material completely, the white ash that remains – containing the various nutrients taken from the soil – is merely 1%-5% of dry weight. Half of this weight is silica and calcium. So to grow healthy vigorous plants just a small portion of these active nutrients are essential. And these come from the activated mineral parts of the soil.

There are about 16 essential micronutrients and 88 macronutrients which the plant needs of which some are taken from air and water and the rest from the soil. **During physical and chemical weathering processes of rocks, extremely small particles are formed, which generally possess a negative charge, allowing them to attract positively charged ions known as cations. Much like a magnet, in which opposite poles attract one another, soil attracts and retains many of these plant nutrients such as potassium, calcium etc. The magnitude of the soil's electrical charge is therefore an important component of the soil's ability to retain these nutrients in a form available to plants. In general, the more clay or organic matter present, the higher the ability of a soil to attract these nutrients.**

Nutrient availability is influenced strongly by soil pH. In general, the availability of nitrogen, potassium, calcium, and magnesium decreases rapidly below pH 6.0 and above pH 8.0. Manganese, zinc and iron are best available when soil pH is in the acid range. As the pH of an acid soil approaches 7.0, manganese, zinc, and iron availability decreases. Soil pH is thus a powerful regulator of nutrients.

3. Soil Microflora: The third component of living soil is that various types of micro flora should be well established in it. The total weight of soil organisms per acre of healthy topsoil is about 4 tonnes. Some of the predominant microflora are bacteria, fungi, actinomycetes and algae. Of these, bacteria are the most abundant in soil; next in order are actinomyeetes, followed by fungi. One of the major benefits of microflora is that they help plants to absorb nutrients. They break down soil minerals and release potassium, phosphorus, magnesium, calcium and iron, all natural plant growth hormones which stimulate the roots of plants.

BACTERIA

Bacteria are essential elements found most abundantly around the roots of plants. Two types of bacteria provide nutrients to plants: heterotrophic and autotrophic. Heterotrophic bacteria break down organic matter in the soil and convert it into nutrients which the plant needs for photosynthesis. Autotrophic bacteria generate their own organic matter from carbon dioxide in addition to breaking down other organic materials.

By decomposing organic material so that it is available for plant nourishment they recycle natural elements that would be bound up in the soil. They also control the amount of carbon dioxide in the atmosphere: ninety percent of carbon dioxide produced on earth from natural processes comes from the biological activity of bacteria and fungi.

ACTINOMYCETES

The second key soil species are the actinomycetes which resemble both bacteria and fungi. Actinomycetes are more abundant in dry than in wet soils and more in grasslands and pastures than in cultivated soils. Actinomycetes give soil its earthy smell; it comes from a compound, geosmin, which is released as actinomycetes break down organic matter. Though they play an important role in soil quality, actinomycetes are more commonly known as the source of antibiotics such as actinomycin, tetracycline and neomycin and by producing these they maintain balance in nature.

They are responsible for the decomposition of the more resistant organic matter of soil (known as chitin). Adding matter containing chitin to the soil increases its resistance to disease. Some organic matters containing chitin are: dead bodies of bees, bird’s feathers, hair, crab shells, nails and horns. Actinomycetes are also nitrogen fixers; they convert atmospheric nitrogen into a form that can be used by plants.

Bacteria and fungi thrive in soil having high amounts of nitrogen. Actinomycetes are weaker than bacteria and fungi; therefore as long as bacteria and fungi are working and thriving they are dormant. They thrive only after bacteria and fungi become inactive.

ALGAE

Algae are common in ponds and streams, but they are also common in soils. They are pioneer species and contribute to building soil, making it possible for plant species to grow. Algae photosynthesize energy from sunlight and contribute vast amounts of organic matter to the soil. Many strains of blue-green algae fix nitrogen from air. The organic matter that algae add to the soil improves soil quality because it is sticky and contributes to making soil porous.

FUNGI

Fungi along with bacteria are the most important recyclers of nutrients. Fungi also protect plants by consuming nematodes and insects that prey on plants. Fungi can be observed in the field, particularly after damp and rainy weather when mushrooms, which are fungal spores, appear. Fungi and algae pair together to form lichens. The algae partner produces nutrients through photosynthesis and the fungus partner absorbs inorganic nutrients from the soil, which the algae needs for growth. Lichens can therefore colonize the harshest environments, even those with scarce nutrients, water, and cold temperatures. Because lichens can absorb even trace inorganic and organic materials, they serve as an indicator of environmental quality, because they take up trace toxic materials in the environment.

PROTOZOA

Other soil organisms include protozoa, which are one-celled animals found in moist areas in the soil. Protozoa can have flagella (whips) or cilia (hairs) or they can be amoeboid and constantly changing in shape. The role of protozoa in the soil is to control the populations of bacteria on which they feed.

NEMATODES AND EARTHWORMS

Larger organisms in the soil include a variety of flatworms, earthworms, and nematodes. The various worms play several vital roles in maintaining soil quality as predators and as recyclers of nutrients. Nematodes are one of the world's most prolific species. Nematodes are predators in the soil. They control bacterial population, as well as protozoa and other organisms. Nematodes, in turn, are preyed by fungi.

Earthworms shape soil quality by consuming plant and organic matter and converting it to humus. Earthworm ‘castings,’ the product of their digestion, are richer and less acidic than the surrounding soil. Earthworms excrete calcium carbonate which lowers soil acidity. Earthworm castings also contain more calcium, nitrogen, phosphate, and potassium than other soil. Earthworms also contribute to soil quality by burrowing, which helps to loosen and aerate the soil.

SNAILS, SLUGS, INSECTS

Soils are also home to a variety of snails, slugs and insects, and one of the most intriguing creatures of all, the tardigrade. The name tardigrade means ‘slow stepper’ and simply acknowledges the slow movement of these creatures. Tardigrades are considered to be related to insects but they are distinct enough to have their own phylum. Tardigrades are most unusual because of their colour; although some are brown or colourless, they can also be pink, orange, green or yellow. Tardigrades are predators in the soil, consuming protozoa, algae, fungi, nematodes and other tardigrades. Tardigrades are also unusual because they can go into a state of suspended animation to survive when environmental conditions such as temperature or moisture levels are unfavourable.

CONTRIBUTORY FACTORS

Aeration: Microbes consume oxygen from soil air and give out carbon dioxide. In the absence of such gaseous exchange, carbon dioxide accumulates in the soil air and becomes toxic to the microbes. Rate of oxygen intake and simultaneous generation of carbon dioxide are measures of microbial activity. Direct sunlight is injurious to most of the microorganisms except algae. Therefore for microbes to thrive, soil should be well aerated.

Bacteria that need oxygen to live are called aerobic and those that survive without oxygen are called anaerobic. Aerobic decomposition of organic material does not give out foul smell. However, anaerobic decomposition of organic material results in formation of toxic gases in the air due to lack of oxygen.

Moisture: Moisture levels should be sufficient to allow plant growth. In the presence of excess water, waterlogging, anaerobic conditions occur, the aerobes become suppressed and inactive. In the absence of adequate moisture in the soil, some of the microbes die due to tissue dehydration and some of them change their form into resting stages of spores or cysts. Aerobic microbes need 50-75% humidity, in air and soil; some need 90% humidity to survive. Therefore for microbes to thrive proper moisture content is necessary.

Temperature: Temperature is the most important environmental factor influencing biological processes and microbial activity. When the temperature is low, both numbers and activities of microorganisms fall. Most of the soil organisms are mesophiles and grow well between 15 ^{0}C and 45 ^{0}C. A temperature of 25-37 ^{0}C is considered to be optimum for most mesophiles.

pH Reaction: Bacteria prefer near neutral to slightly alkaline reaction between pH 6.5 and 8.0; fungi grow in acidic reaction between pH 4.5 and 6.5; actinomyeetes prefer slightly alkaline conditions. In acidic or alkaline soils microbes become inactive. Some bacteria do grow in media with pH of 3. In acidic soil, if we add lime, bacteria increases. pH of 7 is ideal for growth.

Food: Well-aerated soil rich in organic matter is an essential prerequisite for maximum number and activity of heterotrophic microorganisms.

A soil in good physical condition has good aeration and moisture supplying capacity, both of which are essential for optimum microbial activity.

BUILDING AMRUT MITTI (NURSERY SOIL)

To build up soil our best resource are the plants that grow on the farm and in its vicinity. As plants will contribute different nutrients to the composting heap, depending on its stage of growth or decay, we must know these differences in order to build fertile soil.

Composition of different parts of a plant

Any new plant or any new growth of a plant will contain all the micro-nutrients and required phosphate content in it. This is because every new cell in the meristem needs all of these before it can come into existence. Thus all tender parts of plants are capable of providing these micro nutrients to us and we can use them to improve the necessary mineral contents of our soil.

When the new growth begins to lose its tenderness and as the leaves expand, the mineral nutrients that are necessary for this growth are nitrogen, potash, magnesium, sulphur, iron, manganese and copper. Since these are necessary to maintain the healthy leaves of the plants, on recycling, they will yield these minerals back to the soil.

As leaves mature with age, calcium is incorporated more and more in the cells. When these leaves age and die before falling from the plant, 70% of the mobile contents of nutrients are carried back to the plant for further use or as a reserve for new growth. Nitrogen, phosphorus, potassium, magnesium, sulphur, zinc, copper are such elements. But 30% of the elements like iron, manganese, boron, calcium are not returned to the plant as these are immobilized in the system.

To summarize:

Tender leaves provide	zinc, boron, phosphate, molybdenum
Mature leaves provide	nitrogen, magnesium, potash
Dried leaves provide	calcium, silica, boron, iron, manganese

Apart from changes in the leaves – as the plant grows – the cellulose and hemicellulose components of its body begin to accumulate. With further maturity the lignin component also accumulates. The cellulose (tender) and lignin (tough and fibrous) parts of plants on decomposition yield humus and ligno protein respectively. Therefore, with proper insight and understanding of plant technology, by decomposing tender and mature green leaves together with dead fallen leaves and discarded parts of the same plants we will be able to reclaim all the minerals and nutrients and thus reestablish the lost balance in the fertility, form and structure of the soil.

PREPARING COMPOST SOIL HEAPS for AMRUT MITTI

Good Amrut Mitti = 50% organic part (parts of plants) and 50% mineral part (topsoil). These two must be combined by alternating layers of biomass and soil in the form of heaps. As the heaps will take a long time to decompose on their own, we introduce a catalyst called Amrut Jal (water) to accelerate the decomposition.

The method of preparing Amrut Mitti is detailed below:

Step 1: Prepare Amrut Jal

Ingredients: 1 litre fresh cow dung; 1 litre cow urine; 50 gms black jaggery; 10 litres of water.

Method: Mix all the above ingredients in a large container and keep for 3 days. Stir the mixture 2 to 3 times in a day, clock wise and anti-clock wise twelve times, each time. On the 4th day, mix this concentrate with 100 litres of water. Your Amrut Jal is ready for use.

Step 2: Collect Top Soil

Top soil can be found below big trees or under the bushes, or in nooks and corners of the path of flowing water. The top soil should be collected by scraping (only1 cm) the layers of any unturned soil and never by digging. This top soil is a necessary ingredient because it contains essential minerals along with dormant forms of microbes. By using this top soil with the bio mass (leaves) we are providing an atmosphere to activate the dormant microbes. The microbes will become active when we mix the topsoil with the biomass.

Step 3: Collect Green Biomass

Collect different kinds of green biomass from surrounding areas. Chop green parts of plants, leaves and let them dry. After they dry, soak them in Amrut Jal for 24 hours. By soaking them, all the veins in the leaves and branches will get saturated with Amrut Jal, which also provides non-aerobic microbes that help to accelerate the decomposing process.

Step 4: Prepare the compost heaps

On the ground put one layer of soaked biomass and then one layer of top soil and sprinkle Amrut Jal to keep the top soil moist. Keep on alternating the layers, until a height of one foot is reached, i.e., about 25 to 35 layers. In this way the surface area is increased which accelerates the decomposing process. Heaps should be 3 ft broad, 1 ft high and of any desired length. (The quantity of biomass in the layer should be such that it equals the mineral part after complete decomposition.) Keep the heap moist (not soggy) by sprinkling it with Amrut Jal. Every seven days till the heap. Amrut Mitti will be ready after 30 days.

PREPARING COMPOST HEAPS BY USING DRY LEAVES

While using dry leaves for composting we also need to add greens. This is because dry leaves only contain 30% of nutrition (elements), the rest 70% have already been transferred to the mother plant before falling from the tree. To obtain this remaining 70% of nutrition, we have discovered that we can green the heap through different types of seeds.

Method:

Crush the dry leaves into pieces of two to three inches. This breaks the waxy layer on the veins and ensures seeping of Amrut Jal into the veins. Arrange layers of this biomass with topsoil sprinkled in between layers as explained above. On top, after 25-35 layers, add a 2 inch layer of fertile soil or farmyard manure or vermicompost or Amrut Mitti (if you already have some).

Greening the Heap

Collect easily available local seeds. Seek a good combination of seeds for best results. For example:
Grain - rice, jowar, bajra, maize, wheat
Ceral - mung, channa, muth, udid
Oil seeds - groundnut, till, castor, mustard, kardi
Spices - methi, jira, rai, chili, mustard

Vegetable - tomato, bringal, bean, bitter gourd
Creepers - cucumber, red & green gourd, turi, galka
Root plants - turmeric, ginger, sweet potato, tapioca
Fibrous plants - cotton, ladyfinger, ambadi
Flowering plants - marigold
Herbal plants - tulsi, satavari, ardusi, kadukadiatu
Long life trees - subabul, neem, drumstick, karanj, mahua, glyricidia

Although any selection of seeds can be made, we can also provide balanced nutrition by making a selection according to the six rasa (*shud rus*) as described in Ayurveda:
The sweet taste is provided through varyali or *sauf*
The sour taste through *ambadi, amli, tomato*
The pungent taste through chili
The astringent taste through gawar
The salty taste through spinach, rajagara
The bitter taste through methi, bitter gourd.

Mix the seeds together and soak them in Amrut Jal for 8 hours. Then broadcast the soaked seeds on the heaps. Use 10 gm of mixed seed per square foot. **Cover the seeds with topsoil or Amrul Mitti or any FYM. The layer of soil should be twice the size of the seeds. Cover the heap with 2-4 inches of mulch, i.e., dry grass or dry leaves. Sprinkle Amrut Jal (water) in order to maintain moisture levels continuously. Remove the top mulch after the seeds germinate.**

After the first 21 days:

During first 21 days, the seeds will germinate and grow to some height. Harvest (cut off) 25% of the greens without disturbing the roots. Allow one inch of the stem to remain on the heap at the time of harvesting. Through this process, we are harvesting tender leaves of the plant which must be put on the compost heap.

After the second 21 days interval, i.e., on the 42nd day

Again cut off 25% of the growth which will consist of matured leaves. **Put these green cuttings on the compost heap.**

After the third 21 days interval, i.e., on the 63rd day

By the 63rd day, some plants would have started flowering. Remove all the plants by cutting from the stem just above the heap without disturbing the root portion. **Chop them up into 2 or 3 inch pieces and spread them out on the heap of compost. Leave for 3 to 4 days till they become yellow. Then soak them in Amrut Jal for 8 hours. Remove all the roots and mix them together with the soaked biomass into the heap. Keep this heap for 30 days. However, after every 7 days, it should be tilled and kept moist by providing Amrut Jal at proper intervals.** We are in sense repeating nature’s grassland and pasture eco system evolution in our limited space. *On the 97th day, this will become the best soil on the earth.*

- It will have proper CN ratio
- It will have a pH of 7
- It will have maximum water holding capacity
- It will be airy soil with a carbon content of 1 to 5%
- Microbial count will be highest

- It will have the same sweet smell that emerges with the first rainfall on the soil.

Maintaining the compost heap

Every year the compost heap will reduce its volume by 30%. The 30% loss is due to the conversion of carbon into carbon dioxide because of the heat. Mulching can minimize this, i.e., covering the heap with grass cuttings and dry leaves from time to time. It is also a good practice to add ash to the **compost heap every three months. Ash from** trees that are pruned from one's own compound and then burnt will suffice. **This will help overcome any deficiency of minerals and also help in maintaing the pH of the soil.** 30 grams of ash can be added per square foot at intervals of 100 days.

REQUIREMENTS FOR A COMPOST HEAP

From experience it has been found that a compost heap of 10 ft X 3 ft X 1 ft requires:

1. 55 kg of dry leaves (approx) (depending on the quality of biomass)
2. 6 kg of top soil (mineral soil)
3. 300 gm of seeds of different varieties for greening
4. 77 litres of Amrut Jal (water) – which will again depend on the quality of the fibre and the dryness of the biomass.
   A. 750 gm cow dung
   B. 750 ml cow urine
   C. 50 gm jaggery

(All are variables depending on the quality of biomass you use)

All this is required for preparing one heap.

So ten guntha or ¼ of an acre will require 188 such heaps which are to be prepared only once in a life-time.

This is a simple science which will bring prosperity to all. We are using nature's bounty without destroying Mother Earth and in the process growing organic fruit, vegetable and grain, all wholesome and free from poisons. The farmer will become the caretaker of the earth in a real sense.

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