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Crop Production and Plant Protection in Organic Farming

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1. Introduction

The use of chemicals (fertilizers and pesticides) has taken over crop production these days. Crops have lost their natural resistance and stamina and become susceptible to disease due to the use of chemical fertilizers. As a result, farmers resort to increased use of pesticides. Residues in the soil from the use of these pesticides harden the soil so it becomes like rock. To overcome this the farmers are forced to use even larger quantities of chemical fertilizers for growing the next crop. The damage to the soil increases with every new, crop season. These factors increase farm work and simultaneously increase the cost of farming. Organic farming is the only recourse for farmers, to save both livelihood and the health of the soil.

Organic farming methods enable farmers save money. It is possible to turn one's own farmyard waste into value-added products for increasing crop production. We will thereby avoid poisoning our land. Our soil will get enriched. We will be able to provide healthy food crops for our own consumption and for sale. Our environment will be saved. Diseases can be averted. Farmers will not have to be dependent on agri-business companies for seeds, fertilizers and pesticides. Our self-reliance is thus preserved.

A large portion of our country's foreign exchange is used to pay for the import of petroleum products. By going organic we will also help our country save on valuable foreign exchange. Our land will keep giving us returns for extended periods of time unlike farming as per the green revolution, where the land stays productive for a short time and then becomes sterile.

The uppermost question in the minds of farmers who have recently converted to organic farming or who want to turn organic is how to ensure that crop production does not reduce and how to protect the plants from disease, without the chemical fertilizers and pesticides that their fields have grown used to. This booklet provides the answers and it also seeks to reassure all farmers that there is no farm which cannot turn around and produce quality crops in sufficient quantity, using organic farming methods.

Prof. Dhabolkar, Dr. L. Narayana Reddy (Bangalore), and Mr. G. Balakrishnan (Ilankadu, Thanjavur) are our chief resource persons and guides. They give us energy and infuse enthusiasm, which are the driving force for us to think organically and to make a variety of cocktails and concoctions, to enhance crop production and ensure plant protection.

2. Raising Crops to Enrich the Soil

Try this experiment. Uproot a green plant, wash its root to remove all soil and weigh it. Suppose this green plant weighs one kilogram (1,000 grams). Dry this plant well in the sun and weigh it again. It may now weigh only about 300 grams. Burn the dry plant and weigh the residual ash. It will be only about thirty grams. This is because water forms 70% of the total weight of a green plant, air forms 27%, and only the remaining 3% is due to the minerals that the plant took from the soil while it was growing. The water evaporated when we dried the plant in the sun. When we then burned it, whatever carbon and nitrogen gases there were in it evaporated. What is left is the carbon and other minerals. We may conclude from this experiment that a plant takes very little from the soil and a lot more from the air and water and uses sun light to grow. Hence, if we return to the soil what we have taken from it, our soil will not be depleted at all. On the contrary we will enrich the soil considerably by not throwing out or burning farm wastes and instead, by putting it back in the soil.

The first step therefore to enrich the soil organically is to grow a variety of crops on the land and then plough the green matter back into the soil. Using this method it is possible to enrich the soil in just two hundred days. Even land that has been depleted of all nutrients due to chemical farming can be resuscitated in this manner.

By growing the following crops for 50-60 days and then plowing them in-situ we add balanced nutrients and micro-nutrients to the land. The soil will become enriched in less than a year and micro-nutrient deficiency is eliminated. Dhabolkar, an organic farming expert in Maharashtra, has proved the efficacy of this method, which helps to return to the soil many times more nutrients than what we take from that same soil.

The following quantities will suffice for one acre.

Choose four of each of the following types:

1. Grains. Example: 1 kg jowar, 500 gms pearl millet, 250 gms *thinai*, 250 gms *sAmai*.
2. Pulses. Example: 1 kg blackgram, 1 kg greengram, 1 kg pigeon peas, 1kg bengalgram.
3. Oilseeds. Example: 500 gms sesame (gingelly), 2 kg peanuts (groundnuts), 2 kg sunflower seeds, 2 kg castor seeds.
4. Green manure seeds. Example: 2 kg *thakkaippUNdu* (daincha), 2 kg *saNappu* (sunhemp), 500 gms *narippayaRu*, 1 kg horsegram.

Sowing a variety of seeds in this manner is beneficial in many ways. The biomass of the soil increases. The physical and chemical properties of the soil are

enhanced. The natural cycles of growth and decomposition take place unhindered. We incur very little expense because we minimize the use of external inputs like fertilizers. The water retaining capacity of the soil improves, thereby minimizing the need for irrigation. The leaf area is increased leading to the maximum harvesting of light energy for photosynthesis. This leads to increased yields. Addition of biomass is important for improving the organic carbon content of the soil. The population of microbes increases, thus softening the soil. This helps plant roots sink deeper so they can reach nutrients that are farther down from the surface. This is the key principle. Dhabolkar advises each farmer to do this on her/his farm according to facilities available on the farm itself. This is the first step towards self-reliance.

3. Catalysts for Growth

Preparation and use of a variety of growth enhancers and catalysts is the second aspect of our self-reliant farming methodology. Healthy soils support healthy crops that have no need for growth catalysts. (This is similar to the fact that babies that are brought up on mother's milk have no need for formula milk.) But, as the child grows, along with mother's milk, we give babies some solid food as well. Similarly, by giving our crops some catalysts like *amudham* solution, *AvUttam*, coconut-buttermilk solution, and buttermilk-*arappu* solution, we can hasten plant growth. The solutions are also be useful to control disease. All the five solutions listed below may be used if desired, one after the other in the field.

(i) *amudham* solution

This solution acts right away as a catalyst for growth. With very little work we can create this solution within twenty four hours.

Ingredients: 1 liter cattle urine, 1 kg dung, 250 grams jaggery, 10 liters water

Preparation: Mix the dung thoroughly in water. Add urine and mix well. Powder the *jaggery*, add to the above, and mix well. Make sure there are no lumps. Cover and set the mixture aside for 24 hours.

Usage: Add one liter of this solution to ten liters water (for a 10% solution) and spray. You must make sure to dilute the solution or else the leaves will get scorched.

This solution helps give green manure to leaves directly. It also repels insects.

Instead of using jaggery, you may use waste fruit in this manner: Tie one kilogram waste fruit into a nylon bag and immerse this in urine solution. Let it soak for five days. This helps the fruit ferment well. Add ten times water to this and spray or add 60-100 liters of this in irrigation water for one acre.

(ii) Concentrated *amudham* solution

Ingredients: 5 liters cattle urine, 1 kg dung, 1 liter juice of any waste fruit.

Preparation: Mix the dung thoroughly in urine and the juice and mix well. Set aside the mixture for five days.

Usage: Use 20-30 liters per acre of this solution.

Note: In this method, the use of jaggery, an external input, is avoided. This mixture can only be used for irrigation and not for spraying. Ordinary *amudham* solution used in irrigation requires 50-100 acres per acre. To reduce the quantity and work we developed this combination. It ensures excellent growth.

(iii) AvUttam (Panchakavya)

This solution is based on the well-known Panchakavya preparation that utilises five products from the cow: milk, curds, *ghee*, dung, and urine. A few more ingredients are added to make this solution which helps to increase the population of beneficial microorganisms and acts as a good catalyst for plant growth.

Ingredients: 5 kg dung, 3 liters urine, 2 liters fermented curds, 2 liters milk, 500 ml *ghee*, 1 kg *jaggery*, 1 kg *arasu* fruit (or other fruit), 3 liters tender coconut, 10-12 *pUvan* or other varieties of banana (or similar quantity of other fruit), and 3-5 liters water.

Preparation: Mix dung, *jaggery*, and *ghee* that has been melted and cooled. Knead it well. Cover this mixture with moist cloth for four days. Knead it once daily. On the fifth day add the remaining ingredients to this and let it ferment for fifteen days. (Add sufficient quantity of cattle urine and water.)

In twenty days you will find nice-smelling AvUttam.

Usage: Mix one liter of this with 35-50 liters water (2-3% solution) and spray. Or, mix 5-10 liters per acre with irrigation water. It provides all kinds of micro-nutrients, enhances plant growth, repels insects, and helps increase disease resistance in plants.

Note: It is best to tie the fruit in a nylon mesh and leave it immersed in the solution. This obviates the need for filtering later. And there is no need to mash the fruit when we use this technique. Also, the contents of the nylon bag can be reused a few times in subsequent solutions.

(iv) Coconut-buttermilk solution

This easy-to-make solution enhances plant growth, including flowering, repels insects, and increases resistance to fungal diseases. This solution has the same growth enhancing potential as that of cytozime/biozyme (trade names).

Ingredients: 5 liters buttermilk, 1 liter tender coconut, 1-2 coconuts, 500ml - 1 liter juice from waste fruit (or 500 gms - 1 kg waste fruit, if extracting juice is not easy).

Preparation: Break the coconuts and collect the coconut water in a vessel. Add buttermilk to this and mix well. Grate the coconuts, add to the mixture, and let it soak. Or, mix grated coconut and fruit (if not in juice form), put the mixture in a

nylon mesh, tie it, and immerse it in the buttermilk solution. The solution will ferment well in seven days. The contents of the nylon bag could be reused a few times in subsequent solutions by adding a small quantity of grated coconut everytime.

Usage: Mix ten liters water with 300-500ml solution and spray. This can also be used in irrigation at the rate of 5-10 liters per acre.

(v) *arappu*-buttermilk solution

Ingredients: 5 liters buttermilk, 1 liter tender coconut, 1-2 kg *arappu* leaves (or, 250-500 gms leaf powder), 500 gms waste fruit or 1 liter juice from waste fruit.

Preparation: Mix the buttermilk and tender coconut. Crush the leaves well. If using waste fruit, add it to the crushed leaves and put this mixture in a nylon mesh and tie it. Immerse the mesh in buttermilk - tender coconut solution. Let it ferment for seven days. By using the nylon mesh we eliminate the need for filtering the solution while spraying.

If you use *arappu* leaf powder, use fruit juice instead of waste fruit. Mix all four ingredients and let it ferment for seven days. Wherever *arappu* is not available, you may use soap nut seed powder instead. In that case, we call it the soap nut-buttermilk solution.

Many plant parts when they ferment release a sticky, gum-like liquid. Hibiscus leaves, *kattukkodi* (*cocculus hirsutus*) leaves, *pasalai klrail* (greens), *AvArai*, tender betel leaves, and the thick peel (outer skin) of jackfruit are examples. You may add this liquid to the buttermilk and let it ferment.

Usage: Mix ten liters water with one liter solution and spray. This helps plant growth, repels insects, and adds resistance to fungal diseases. This solution has the same potential as that of gibberlic* acid.

Note: Our goal is to simplify the process for farmers. That is why we suggest various options like waste fruit versus juice and *arappu* leaves versus leaf powder.

It is essential that farmers use whatever organic material is easily available and develop simple processes for using the solutions in the field. Shri Dhabolkar insists that every farmer should become an innovator.

(vi) Archaeobacterial solution (Plant Growth Promoting Rhizobacteria - PGPR)

It is of no use to plants if we simply dump dung and other wastes next to the plant. We have to process them properly before plants can make use of these. Microorganisms exist precisely to carry out this task. Archaeobacteria are the best such microorganisms. These thrive in anerobic conditions and are considered to be the earliest microorganisms that came into being in the course of the evolution of life on earth. We will reap good harvests if we make use of these microorganisms in the proper fashion. Mr. G. Balakrishnan has devised a simple way of preparing this solution.

Ingredients: 20 kg dung, 200 liters water, 3 kg *jaggery*, 100 gms *kadukkAi* powder, 10 gms *adhimadhuram*.

Preparation: Mix dung, *jaggery*, and water well in a container. Add *kadukkAi* powder to it and mix well. Boil the *adhimadhuram* powder in 250 ml water and let it cool. Add the cooled *adhimadhuram* solution to the *kadukkAi* solution. Fill the rest of the container with water so that no air is left inside and close it tight. Methane will form inside the container. Let the air out of it once in a while by slightly unscrewing the cap for a moment. The solution will be ready in ten days. It will be light brown in color.

This solution enhances plant growth. The archaeobacteria are directly absorbed by plants; other microorganisms also ingest it. We can use this solution to grow blue-green algae. Mr. G. Balakrishnan has recorded 15-20% increase in the leaf area. Such an increase in leaf area leads to a corresponding increase in photosynthesis (harvesting of solar energy as per Mr. Dhabolkar) and enhances yield.

Usage: 200-300 liters of this solution is sufficient for an acre. You can also mix one liter of the solution with ten liters water to spray.

Plant Diseases

To control plant diseases, irrigate the field with the archaeobacterial solution @ 200-300 liters per acre of this solution mixed with any one of the following solutions: (a) 30-50 liters concentrated *amudham* solution, (b) 5-20 liters *AvUttam*, (c) 5-10 liters coconut-buttermilk / arappu-buttermilk / soapnut-buttermilk solution, (d) 3 liters fish extract; and any of the following, depending on the disease you wish to cure:

To control diseases which damage the rhizosphere/rhizomes and to control fusicladium wilt, use beneficial fungi like *Pseudomonas fluorescens*, *Trichogramma viride*, *Trichoderma harzianum*, and *Basilus subtilis*.

To control root knot nematodes, use *Paecilomyces lilacinus*.

To control root grubs, use *Beauveria brongniartii* and *Metarhizium*.

Let the mixture (of the powders and the archaeobacterial solution) ferment for a day before mixing with irrigation water.

Note: Farmers have to buy these substances from outside. To reduce costs, farmers should buy in small quantities (100-500 gm) and increase the population of the fungi using the archaeobacterial solution. (Each of the fungi should be developed in a separate container.)

(vii) Fish Extract (fish amino acid)

Fish extract is widely used by organic farmers in Japan, Korea, etc.

Ingredients: 1 kg native fish, 1 kg *jaggery*.

Preparation: Remove the fish intestines and chop into fine pieces. (The smell may not be very pleasant.) Powder the *jaggery*. Add the two to a broad-mouthed glass jar (best) or plastic jar that is just the right size (not too big), cover the jar with

the lid (cap), tighten it, and mix well by shaking the jar. Don't add water. In ten days this will have fermented. Filter it using nylon mesh to get 300-500 gms solution into a honey-like syrup. This is a great nutrient for the plants.

Usage: Add 5 ml of this with one liter water for spraying. It could also be mixed with irrigation water.

4. Plant Protection

In addition to ensuring that crops grow well, we must also protect them from insect pests and diseases. Due to indiscriminate use of pesticides in the past 30-35 years, we have not only polluted our land, water, and air, but weakened the resistance of plants to diseases.

If we wish to escape from these poisons, we must opt for organic ways of controlling pests and diseases. We must practice prevention rather than wait until the plants are attacked. Prevention is better than cure.

Plants that do not get enough nutrients are sapped of their strength. That is when they fall prey to attacks. Pests attack plants from outside. Diseases attack from within. Too much nutrition from chemical fertilizers encourage excessive vegetation, turn the leaves are dark green and attract pests, which not only feed on the leaves but can also destroy the entire plant. If we understand this we can easily prevent disease and pest attack.

Types of Insect Pests

Based on their food preference, we may classify insect pests into two groups: (1) Vegetarians that only eat leaves and other parts of the plant and (2) Non-vegetarians that eat other insects.

Of these, it is the vegetarians that harm our crops. The non-vegetarians help us control the population of the vegetarians. The population of non-vegetarian insects is much more than that of vegetarian insects. But, in our misguided attempts at destroying the vegetarians using chemical pesticides, we also destroy the helpful non-vegetarian insects. We thus destroy the natural balance and instead increase the population of vegetarian insects. As a result our crops sustain severe damage.

In organic farming our goal is not to kill insects. Our goal is to protect our crops from harmful insects and to make sure they stay away from our crops. Organic farming takes the view that every life form helps us in some way. So we need not use chemicals that kill. Instead we can prepare, on our own farms, solutions that help to repel harmful insects and keep them away from our crops.

Pest Repellants

The following leaves help repel insect pests:

1. Leaves that cattle don't eat. For eg. *AdAthOdai*, *nochchi*
2. Stems that secrete milky sap when broken. For eg. *erukku*, *Umaththai*

3. Leaves that taste bitter. For eg. Neem, aloe vera
4. Leaves that taste salty. For eg. *kAttAmaNakku*
5. Seeds that taste bitter or salty. For eg. Seeds of neem, custard apple, *etti*.

Fermented solutions and extracts made with such leaves and seeds act as excellent pest repellents by creating unpleasant odors. When sprayed, these solutions prevent pests from feeding on plants because, in general, insects and worms use their sense of smell to identify edible plants. Therefore when we spray solutions made with the above plants and with dung/urine, we disrupt the sense of smell of the worms and insects. So they avoid crops thus sprayed and go elsewhere or, having eaten leaves sprayed with such repellents, they are considerably discomfited. This considerably lowers the number of egg-layers and thus reduces the population of insects that will prey upon the plants.

Preparation: Take 2 kg each of leaves/seeds (as the case maybe) from the five categories mentioned above. Prepare solutions either by fermenting or boiling, as described below.

(a) *Fermentation method*: Add 12-15 liters cattle urine to the above. (Add more if necessary, so the plant material is completely immersed in cattle urine.) Add 3-5 kg dung (mixed with cattle urine) and 100-250 gms turmeric powder (if available). Let it ferment for 7-15 days.

Usage: Mix 500-1,000 ml with 10 liters water and spray.

(b) *Boiling method*: Chop the 10kg leaves/seeds and soak in 25 liters water. Make sure the plant material is fully immersed in water. Boil this under steady heat. Filter this and set apart in a separate container. Add 25 liters of water to the solid matter that is left over after filtering. Boil this. Filter it and add the liquid to the first container (in which the filtered solution was kept earlier). Add 100-200 gms turmeric powder to this liquid and let ferment for 12 hours.

Usage: Add sufficient water for a total of hundred liters solution and spray.

Pest Repellant Remedies for Specific Plant Diseases

The following remedies use the basic solution of plant leaves described above:

To control larva-caterpillar, leaf curl worm, leaf roller, or stem borer

- (1) Prepare solution using either the fermentation or the boiling method
- (2) Powder any one of the following seeds/fruits and add to the solution:
 - (a) neem, *pungan*, or *malai vEmbu* (1-2 kg),
 - (b) *kadukkai* (250-500 gms),
 - (c) custard apple or *thanga araLi* (200-250 gms),
 - (d) *etti* (100-250gms),
 - (e) *suNdaikkAi* (1-2 kg),
 - (f) green chillies (500-1000 gms),
 - (g) *vilvam* fruit (5-10 numbers), or

(h) *Umaththai* fruit (10-20 number).

(3) Let the entire mixture ferment for 12 hours. It is then ready for use.

Here is another preparation to cure the same disease:

Ingredients: (a) 100 gms custard apple seeds, 1 kg *plchchangu*, 500 gms *siRiyAnangai*, 500 gms *AdAthOdai*, 1 kg *thanga araLi* fruit, 1 kg *nochchi* or custard apple leaves, 1 kg aloe vera, (b) 1 kg powdered tobacco, (c) 1 kg tobacco powder, and (d) soil from a termite hill (enough to make the whole mixture into a paste).

Preparation: Grind into paste the ingredients in (a). Boil it in about 6 liters water. Add tobacco powder and let ferment for twelve hours. Add tobacco juice and let ferment for 2-3 days. It will acquire a sour taste. Add turmeric powder and enough soil from a termite hill to give the entire mixture into paste-like consistency.

Usage: Mix 1 kg paste in 100-125 liters water and spray.

To control sucking insects: aphids, thrips, mites

This problem normally occurs in chillies, vegetables, and cotton. The pests attack the tender leaves and branches. They occur in thick colonies. As a result of this attack the leaves start curling up and wither. Cut the heavily affected portions once a week and put them in the fermented or boiled solution prepared as explained earlier. Physical removal is one of the practices of integrated pest management techniques.

You may also control the problem with the following concoction:

Ingredients: (a) 2-3 kg of five of the following leaves: lantana camara, neem, *nochchi*, tobacco, *siRiyAnangai*, custard apple, *plchchangu*, aloe vera, *piraNdai*, or *vilvam* fruit (5-10 numbers) or green chillies (2-3 kg) (b) 100 gms turmeric powder.

Preparation: Chop the leaves into small pieces (if using *vilvam* fruit or chillies, crush them). Add turmeric powder. Use the fermentation method described earlier to make the solution. Let the mixture ferment for seven days.

Usage: Add ten liters water to one liter solution and spray. Depending on the intensity of the attack, you may repeat the spray 2-3 times at intervals of 7-10 days.

To control fungal infection and leaf spot disease:

You will see long eye-shaped spots on leaves during the early stages of this disease. At the center of each of these spots are the fungal spores that cause this disease. As the disease progresses the spots grow larger and eventually all the spots combine into one. The leaves turn brown/yellow and ultimately wilt.

Ingredients: (a) 3-5 kg aloe vera, (b) Any two of the following: 3-5 kg custard apple leaves, 3-5 kg bougainvillea leaves, 3-5 kg lantana camara leaves, 3-5 kg papaya leaves, (c) 100 gms turmeric powder, (d) 250-500 gms pseudomonas, and (e) 10 liters archaeobacterial solution.

Preparation: Pound all the leaves, add enough water to immerse them, and boil. Prepare 50 liters solution The solution will have a dark color. Add turmeric powder

to it. Let it ferment for about 12 hours. At the same time, mix the archaeobacterial solution and pseudomonas and set aside for 12 hours. Mix the above two solutions, add sufficient water to bring the total to 100 liters, and spray.

To control blast, leaf blight diseases

Ingredients: 3-5 kg aloe vera, 200 gms ginger, 3-5 kg *pudhina*, *savukku*, or lantana camara leaves, 100 gms turmeric powder, 500-1000 gms pseudomonas fluorescence, and 10 liters archaeobacterial solution.

Preparation: Add enough water to immerse the above ingredients. Boil and let it cool. Add turmeric powder. In a separate container prepare take the archaeobacterial solution, add Pseudomonas fluorescence to it and keep aside for 12-24 hours. Mix the above two solutions, add sufficient water to bring the total to 100 liters, and spray.

To control bacterial diseases

Ingredients: (a) 3-5 kg aloe vera, (b) 3-5 kg tender leaves of two of the following: bamboo, *pudhina*, *savukku*, thulasi, or lantana camara, (c) 100 gms turmeric powder, (d) 250-500 gms pseudomonas fluorescence, (e) 10 liters archaeobacterial solution.

Preparation: Prepare 50 liters solution of (a) (b) and (c) as explained earlier, using the boiling method. At the same time, mix the archaeobacterial solution and pseudomonas and set aside for 12 hours. Mix the above two solutions, add sufficient water to bring the total to 100 liters, and spray.

To control powdery mildew

Ingredients: (a) 3-5 kg aloe vera, (b) 12-10 kg tender leaves of one of the following: bamboo, *savukku*, or lantana camara, (c) 100-200 gms turmeric powder, (d) 250-500 gms pseudomonas fluorescence, (e) 10 liters archaeobacterial solution.

Preparation: Prepare 50 liters solution of (a) (b) and (c) as explained earlier, using the boiling method. At the same time, mix the archaeobacterial solution and pseudomonas and set aside for 12 hours. Mix the above two solutions, add sufficient water to bring the total to 100 liters, and spray.

Note: The above-mentioned quantities of pseudomonas are adequate as a prevention measure. If the pest attack or disease has already set in, increase the quantity of pseudomonas to 1-2 kg to achieve the knock-down effect. It should be sprayed twice at 7-days intervals; the third spray should be after ten days.

5. Efficient Microorganisms (*thiRan nuNNuyir* or *thiRami*)

Dr. L. Narayana Reddy introduced Effective Microorganisms (EM) to us. (EM technology was invented by Prof. Teruo Higa of Japan. In India EM is marketed by Maple Orgtech (I) Limited.) Dr. Reddy cautioned that uncontrolled production of microorganisms by farmers may lead to the proliferation of harmful organisms because farmers lack the laboratory equipment to check quality. So Dr. Reddy recommends that farmers buy EM from authentic laboratories.

However, Mr. G. Balakrishnan has perfected a method for preparing a similar

solution which he calls Efficient Microorganism solution. In Tamil we call it *thiRanuNNuyir* (*thiRami*, for short). We will refer to it hereinafter as *thiRami*. We use his method in our laboratory in Madurai to prepare small quantities of *thiRami* and supply to trained organic farmers in our association (thamizhaga uzhavar thozhilnutpak kazhagam). In the past five years we have used it on a variety of crops under different conditions in twelve districts in Tamil Nadu and have been getting good results. Based on our experience, we now describe the preparation and use of the following solutions.

(i) Extended *thiRami* (ET)

Ingredients: (a) 20 liters potable water free from chlorine, (b) 1 kg jaggery, (c) 1 liter *thiRami* stock solution.

Preparation: Mix all the ingredients in a plastic drum and fill twenty, one-liter plastic jars with this mixture. Tighten the bottle caps. Keep for 7-10 days for multiplication of the various microorganisms. Methane gas forms in each bottle. On the first or second day unscrew the cap to release the gas and close it tightly again. Repeat this as often as necessary. Each unopened bottle's contents should be used in 3-4 months.

Usage: Mix 1-2 liters of the ET solution in 100 liters water for spraying.

This promotes growth and controls pests. It may also be used in composting at the rate of 500ml to 1 liter per 100 liters water to increase the rate of breakdown of crop residues. ET may be used in irrigation at the rate of 3-6 liters per acre.

(ii) *thiRami*-Treated Cow Urine (TTCU)

Ingredients: (a) 5 liters cow urine, (b) 250 gms jaggery, (c) 250 ml ET solution, and (d) 250 ml water.

Preparation: Mix all the ingredients and allow to ferment for 7-10 days.

Usage: Use within 30 days. For spraying: Mix 1-2 ml in one liter water. For irrigation use 20-30 liters per acre.

This controls pests and diseases.

(iii) *thiRami*-Fermented Plant Extract (TFPE)

Ingredients: Collect tender leaves of the following: (a) tamarind or *vAdhanArAyaNan* (source of zinc), (b) *AvArai*, hibiscus, or *vallArai* (copper), (c) curry leaf, drumstick leaf, or any other leafy greens (iron), (d) *erukku* (boron), (e) all types of flowers (molybdenum), (f) *thuththi* (calcium), (g) gingelly or mustard plants (sulphur), (h) ladies finger plant (iodine), (i) lantana camara, casurina, or bamboo (silica), (j) *neyveli kAttAmaNakku* (ipomea) (mercury), (k) glyricidia (nitrogen), (l) *thulasi*, *nochchi*, neem, aloe vera (to build resistance to fungal, bacterial, and powdery mildew diseases).

We have selected the above list based on the *Siddha* and *Ayurveda* systems of medicine.

Preparation: (a) Collect 5kg leaves and plants from the above list. Choose any combination depending on micronutrient deficiency of the crops. (b) Chop into small pieces and crush. (c) Add the crushed leaves to 250 gms jaggery in ten liters water. (d) Add 250-300 ml ET. (e) Set the mixture aside for 7-10 days for

fermentation. This provides ten liters solution.

Usage: Use within 90 days. Spray: 2-5% solution. Irrigation: 10-20 liters per acre.

Benefits: Using EMFPE with other growth promoters as a prophylactic measure takes care of all problems for any crop. It rectifies micronutrient deficiency, acts as a pest repellent by preventing pests from feeding and it also induces disease resistance.

(iv) Extended *thiRami-5* (ET5)

Since it contains five items, it is named ET5.

Ingredients: (a) 100 ml organic vinegar, (b) 100 ml ET, (c) 100 gms jaggery, (d) 100 ml brandy, (e) 600 ml water, for a total of one liter.

Preparation: Mix all the ingredients and allow to ferment for 7-10 days.

Usage: Use within 30 days. Spray: 1-2 ml per liter of water, along with any of the growth promoters. In case of severe infection use 5ml per liter of water.

Benefits: Controls fungal, bacterial, and powdery mildew diseases.

To prepare organic vinegar, use one of the following methods (taught to us by Dr. L. Narayana Reddy): Add 500 gms jaggery to 1 liter tender coconut and store in a container for a minimum of 15 days. Grind 8 numbers rotten bananas, 200 gms jaggery, and a small quantity of water to a semisolid form. Mix this with the jaggery mixture. Add water to make it two liters and keep to ferment. Use after a minimum of 15 days.

Vinegar may be kept for a long time. With each passing day the quality improves due to fermentation. The older it is, the more effective it will be in ET5 preparation.

Microorganisms Enriched Mixture (MEM)

Ingredients:

Group 1: 60 kg fully digested compost or vermicompost, 20 kg ash or rice bran ash, and 20 kg saw dust.

Group 2: (a) five liters AvUttam/panchakavya, (b) five liters concentrated amudham solution, (c) five liters coconut-buttermilk, arappu-buttermilk, or soapnut-buttermilk solution, (d) ten liters ETFPE, (e) five liters archaeobacterial solution.

Group 3 (to control root rot, rhizome rot, and fazarium wilt): 500 gms - 1 kg each of *Pseudomonas fluorescence*, *Trichoderma viride*, *Trichoderma harzianum*, and *Bassillus subtilis*.

Group 4 (to control nematode): 1-2 kg each of *Paicyllomycis*

Group 5 (to control root grub, white grub, rhinoceras beetle and other soil-dwelling beetles and grubs): 500 gms - 1 kg *Beauveria brongniartii* and *Metarhizium*

Preparation:

(a) Mix well the items in Group 1.

(b) Mix the solutions mentioned in Group 2.

(c) Mix the powders either in Group 3 or 4 or 5, depending on the disease that has attacked your crop.

(d) Add the mixtures from steps (a) and (c). Over this combination sprinkle the solution mixture from (b) and mix thoroughly so that the combined mixture is uniformly moist.

Note: MEM can be used at the rate of 100-500 kg per acre. The ingredients given above are for preparing 100 kg MEM. To prepare larger quantities increase the quantities in Group 1 accordingly maintaining the same ratio of the ingredients in that group. This increases the quantity of the mixture. Do not change the quantity of other items in Groups 2 to 5. To make this mixture uniformly moist add sufficient quantity of archaeobacterial solution.

Usage: Use within 30 days. When you need to store it for longer periods, store it in a heap that is about 2 feet broad and nine inches tall; the length could be chosen based on convenience. Cover it with wet gunny bags, coconut leaves, or sugarcane leaves. Take care to maintain uniform moisture, by sprinkling water as often as necessary. This heap should be in a shed or under the shade of a tree.

This can be used as basal application or as a top dressing, depending on the need. Use it as a precautionary measure depending on the condition of the crop. If the crop growth is not healthy and you cannot irrigate the crop because of rain, use the mixture at least twice with a fifteen days interval. If the crop is healthy, use it once in 1-2 months during the growth period.

For bed crops like vanilla, pepper, and cardamom, use MEM over the bed and cover it with leaves.

In the rainy season, move the mulch away from the stem for effective drainage and spread MEM over the feeder roots to protect these roots.

Fruit Gaudi

We prepare and use fruit gaudi in irrigation, for enriching soil health and improving the population of microbes and beneficial fungi.

Ingredients: (a) 10-50 kg cattle dung, (b) 5-20 kg waste fruit, (c) convenient quantity of all kinds of leaves that decay fast, (d) intestine wastes from 1 cow or 2-4 goats, (e) 5-10 liters AvUttam/panchakavya, (f) 5-10 liters any of the buttermilk solutions, (g) 5-10 liters concentrated amudham solution, (h) 5-10 liters TTCU, (i) 5-10 liters TTFPE, (j) 50-100 liters archaeobacterial solution.

Preparation: Mix all the ingredients in 200-500 liters water in a tank. Allow it to ferment for a week. Add the beneficial microorganisms listed in MEM preparation. Allow it to ferment for a day.

Usage: Use in irrigation for one acre, once in 15-30 days.

6. Some General Organic Practices

(i) Intercropping/Mixed Cropping

This is a very important technique in controlling pest and disease attacks. As

opposed to monocropping, in organic farms, more than one crop is grown at the same time. Farmers have seen for themselves that intercropping helps minimize pest and disease attacks.

Here are some examples:

(a) Growing cowpea and black gram along with jowar, maize, or pearl millet like our ancestors used to do.

(b) Growing castor plants on the boundary ridges of paddy/vegetable fields.

Note: Plan the sowing such that all crops get enough sun light.

Leguminous plants are important. They help fix atmospheric nitrogen in their roots. This helps other crops get sufficient quantities of manure.

Identify the right mix of crops for intercropping.

By intercropping, both yield and income are enhanced. Since intercropping is well known and also since it is location-specific, we have only given an outline of the practice.

(ii) Using Parasites

Insects go through the egg, larval, and pupal stages before emerging as insects. Helpful parasites exist that eat harmful insects in one or more of these stages. These are classified based on their eating habits. Some parasites are grown in laboratories and can be used as follows:

(a) For Paddy (to control leaf roller and stem borer): use jpanicum and chylonis at the rate of 2cc parasites per acre 4-6 times in 10-15 day interval.

(b) For Sugarcane (to control inter-node borer): use 2 cc trichogramma wasps per acre, eight times from the third or fourth month onwards, in 15-day interval.

(To control the top shoot borer): use 2cc chylonis per acre, 4-6 times at 15-day intervals from the eighth month onwards.

(c) For vegetable crops, chillies, and cotton (to control sucking pests): use crysoperla wasps (2000 eggs per acre, two times at 15 day intervals).

(to control mealy bug): use criptomus (200-300 per acre in two applications at 15 day intervals).

(to control stem- or pod-borers and bollworm eggs): use 2cc Jpanicum and 2cc chylonis (6-8 times at 15 day intervals).

(to control the larvae of these pests): use praonit wasps (800 insects per acre, two times).

(d) Banana (to control stem-borer): use 2cc Jpanicum and 2cc chylonis per acre (four times at 15 day intervals from the fifth month onwards).

Appendix 1: Botanical names of plants whose Tamil names are used in this book

AdAthOdai	adathoda justicia
adhimadhuram (sweetwood/liquorice)	glycyrrhiza glabra
arappu	albizzia amara

arasu	ficus religiosa
AvArai	cassia auriculata
erukku	calotropis gigantea
Etti	strychnos nux-vomica
kadukkAi	terminalia chebula
kAttAmaNakku	jatropha curcas
narippayaRu	
nochchi	vitex negundo
plchchangu	clereodendron inerme
piraNdai	vitis quadrangularis
pudhinA	mint
sAmai	panicum miliare
saNappu	sunhemp
savukku	casurina
siRiyAnangai	andrographis paniculata
suNdaikkAi	solanum torvum swartz
thanga araLi (oleander)	neerium odorum
thinai	setaria italic
thuththi	abudigan indicum
Umaththai	datura metel
vAdhanArAyaNan	delonixalata
vilvam	aegle marmelos

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