

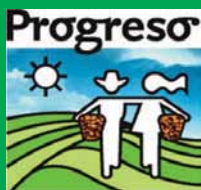
A practical
manual for
smallholder
farmers

ORGANIC FERTILIZERS AND BIO-FERMENTS

Improving soil
health, crop
productivity and
quality



Technology in the hands of a farmer



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A practical manual for
smallholder farmers

ORGANIC FERTILIZERS AND BIO-FERMENTS

Technology in the hands of a farmer

The manual focuses on the regeneration of exhausted and depleted soils of small holder farmers in Africa. It is based on the technology of using mountain microorganisms to restore soil life, increase crop productivity and quality in order to improve farmers' livelihoods.

This manual has been produced with financial support of Progreso Program of The Netherlands. The manual is partly based on the Spanish manual "Manual para bosques locales - Abonos y Biofermentos Organicos" published by Cooperativa Agraria Cafetalera Divisoria Ltda - A coffee and cocoa producer and exporter farmers organization in Peru, published in 2009.

The manual has been developed with technical support from Agro Eco Louis Bolk Institute (AELBI) Eastern Africa Uganda Branch with support from AgroAmbiente Soluciones S.A that validated and adopted the technology to suite small -holder farmers and extension workers in Africa.

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Coordinations:

Ing. Kalema Andrew Joseph, Advisor AELBI, Eastern Africa

Ing. Mario Chacon, Consultant AgroAmbiente Soluciones S.A

Layout & Print:

Kezy Accrues, +256 (0) 772 512 685, wasswaesau@yahoo.co.uk

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For more information, contact

Agro Eco Louis Bolk Institute, Eastern Africa Branch - www.louisbolk.org

P. O Box 71982, Kampala

Tel: +256(0)782 879 614 or +256(0)713 879 614

Or

Progreso Program - www.progreso.nl

Leliegrecht 19

1016 GR Amsterdam

The Netherlands

Tel: +31(0)20-625 41 20

Introduction

The loss of potential productive forest and agricultural soil due to bad agricultural practices and change of land use, is the main cause of reduced crop productivity and quality together with increased problems of crop pests and diseases. At the present, small scale farmers do not have low cost technologies and access to cheap inputs that guarantee better incomes and sustainability of their crops.

The production of organic compost using effective Mountain Microorganisms is one of a demonstrated alternative that will allow or permit small scale farmers to regenerate the fertility of their soil. This technology was implemented for the first time in Japan, 20 years ago. The practice requires extraction of microorganisms from their natural habitat (nearby natural forest) and are reproduced using inputs and techniques that are easy to understand. These microorganisms are then incorporated in the preparation of organic solid fertilizers (Bokashi) and Bioles (fermented liquid fertilizers), in order to regenerate soil health and fertility of farms which has been affected with poor agricultural practices and the use of agro chemicals. This puts in action the restoration of ecological equilibrium of the farms that were once enjoyed by our ancestors.

The right application of organic fertilizers will permit the increase in crop productivity and improvement in the quality of harvested produce, thus contributing to economic development and improvement in the livelihood of small scale farmers.

The manual is a collection of a wide range of experiences from Costa Rica, Colombia and Uganda, adapted to the African situation and easy to implement by all small scale farmers. This will serve as a guide in the process of preparation of organic solid fermented fertilizers and bioles based on effective Mountain Microorganisms.



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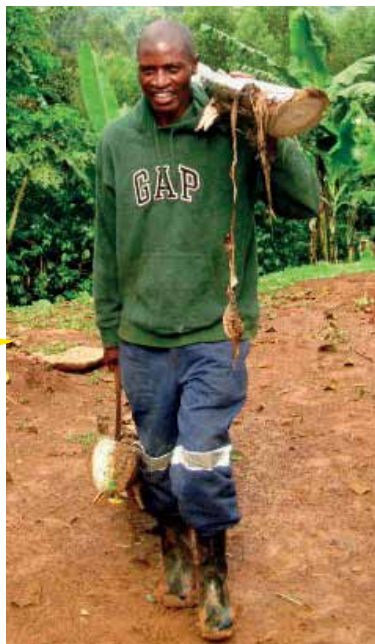
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Organic fertilizers



Organic fertilizers are products obtained from the decomposition of organic matter; in this process effective microorganisms are important because they break down the organic matter thus realizing nutrients for plant growth.

Organic fertilizers can be prepared on my farm at a low cost using crop residues, animal dung and other plant material such as banana stems, leguminous leaves and green grasses.



Importance of organic fertilizers

- Organic fertilizers reduce the dependence on artificial chemical products on different crops.
- They improve the soil, physical structure (soft and loose soil), chemical (increase nutrients), and biological (high population of beneficial microorganisms) composition.
- Improve yields and the quality of produce
- Source of food for soil organisms



Reproduction and activation of microorganisms



To a farmer
Its healthy and profitable

Effective mountain microorganisms (mm)

What are Mountain Microorganisms?

Is a collection of various beneficial microorganisms that are found in virgin soils or forest decomposing organic matter. They are used in the preparation of organic fertilizers in order to speed up the process of breaking down organic matter.

If there were no beneficial microorganisms, the process of decomposition would be slow and we would not obtain high quality organic fertilizer.



Collecting decomposing material from a natural forest.



Decomposing forest matter is a natural source of Mountain Microorganisms.

Importance of Effective Mountain Microorganisms (M.M)

- Improves the soil health, crop productivity and quality of produce.
 - Stimulates seed germination and root growth
 - Protects the crops from being attacked by disease causing organisms.
- Are used in the preparation of Bokashi, Bio-ferments and Bio-crop repellents.

REPRODUCTION OF M.M (Effective Mountain Microorganisms)

Is a process of reproducing beneficial microorganisms, obtained from a natural forest, by giving them the right conditions for their growth which will later be used in the preparation of solid and liquid organic fertilizers. They can also be applied directly on the plant leaves to control certain pests and diseases or as a growth booster.

INPUTS

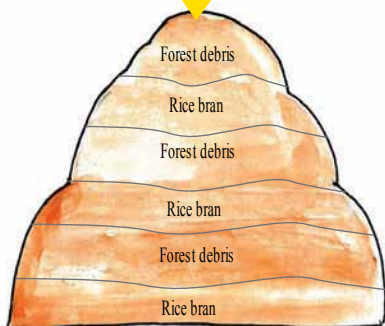
- 1/4 a sack of decomposing forest leaves (debris)
- 10 kg of rice/wheat or maize bran
- 1 litres of molasses
3 litres of clean water (not contaminated)



Dissolve



Add



Molasses is important because it's a source of energy for microorganisms in order for them to reproduce .

You can also use sugarcane juice, mucilage solution from coffee and cocoa processing in higher quantities.



From this mixture, you can prepare
AEROBIC and ANAEROBIC MOUNTAIN
MICROORGANISMS

Mix well.
Mixture should have optimal moisture. Test by pressing mixture in hand, no water should come out through the fingers. It should form a ball that breaks easily when pressed.



Preparation of aerobic mountain microorganisms (in presence of air)

- From the M.M solid mixture, get one part and use it to prepare AEROBIC EFFECTIVE MOUNTAIN MICROORGANISMS.
- Cover the MM solid mixture with banana leaves or a cloth to protect it from cold and animals for the first night
- For the first or second day, the MM solid will generate a high temperature in the interior, therefore turn it during the first 8 days and then later put it in sack or bucket and cover it.

Aerobic means: in presence of air or oxygen



The option of the MM solid kept in open environment in a cool dry place.



Two days after, whitish growth is observed on the surface of the MM solid mixture.

If at the 8th day the MM solid mixture is still hot, make the last turn and once it cools down it should be kept in a bucket or a sack.

- From the second day you will observe white strains or growth and a smell of mold (like spoiled bread). Don't worry, these are microorganisms that are reproducing which indicates that the process is going on well.



Turn the MM solid to lower the temperature generated inside the MM solid

This mixture when well kept and handled, can last for 3 years before getting spoiled. The microorganisms do not die, they go into what is called dormant state (sleeping state) but become active after adding water and molasses.

Preparation of anaerobic mountain microorganisms (In absence of air)



- Take the remaining portion of MM solid mixture and use it to prepare ANAEROBIC EFFECTIVE MOUNTAIN MICROORGANISMS.

Anaerobic means, in absence of air or oxygen

- Put this M.M solid mixture in a bucket or a small plastic drum.
- When placing mixture in bucket, compact it to eliminate any possible air. Cover the bucket tightly to prevent entry of air.
- Store it in a cool and dry place for a period of 30 days. There after it is ready for use.
- Write the date of preparation



and stick it on the bucket as a remainder of the initial date

- Only open the bucket when necessary and fasten immediately after removing the necessary content of anaerobic M.M mixture.

In the anaerobic M.M mixture, other types of beneficial microorganisms are reproduced; also if correctly stored, it can last up to 3 years.



Activating effective mountain microorganisms

Activated Mountain Microorganism is a mixture of aerobic and anaerobic effective mountain microorganisms dissolved in water mixed with molasses converting into a solution of beneficial microorganisms.

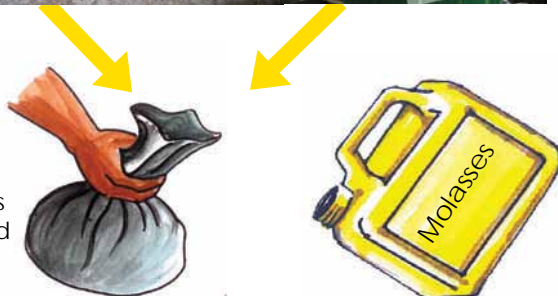
INPUTS

- 2 kg of ANAEROBIC M.M solid
- 1 kg of AEROBIC M.M solid
- 1 litre of molasses
- 20 litres of clean water (not contaminated)



Put the two portions in a porous cloth or clean plastic gunny sac.

- Note that molasses is important because it provides energy to microorganisms and they reproduce fast.



Activated mm to be used after four days of preparation

- Between 4 – 10 days you get fungi.
- Between 11 – 15 days you obtain bacteria.
- From the 16th day onwards you only obtain yeast.



- Stir the mixture such that molasses dissolves well and remember not to put the mixture in direct sunshine.
- Store it well in a cool place with shelter where no rain or sunlight can reach.
- The activated MM solution is ready for use from the 4th – 10th day after preparation.
- Activated MM is then used in the preparation of organic solid and liquid fertilizers.

Remember that you can use activated effective microorganism solution in all organic fertilizer preparations such as bokashi, bio-stimulants, bio-ferments and organic plant teas.



You can apply the activated Mountain Microorganism solution directly on the crops to control pests and diseases. It can also be applied to the soil, around the crop, such that microorganisms can increase and break down soil organic matter.

This diagram shows activated solution of Mountain Microorganisms. The liquid contains beneficial microorganisms used to prepare organic fertilizers, bio-ferments, bio-insecticide, etc.

Bokashi

Is a fermented mixture of solid organic materials acted upon by beneficial microorganisms to realise nutrients that are important for crops. When applied to soil, the microorganisms help to restore soil life and minimize incidences of crop diseases thus producing healthy crops with vigorous growth and high yields.



Advantages of using bokashi

It is a fertilizer that is easy to prepare by any farmer using locally available material

- Has no danger as the direct use of other fertilizers
- It is a rich source of crop nutrients and contributes to soil fertility improvement and restoration of soil microorganisms
- It increases the organic matter content in the soil thus improving its water retention capacity

It is an economical alternative fertilizer to a farmer compared to other chemical fertilizers



How to prepare Bokashi

Inputs

- 1 sack of chicken manure
- 1/2 sack of charcoal or carbon dust
- 1 sack of saw dust
- 2 litres of molasses
- 2 litres of activated M.M solution
- 1 sack of rice or coffee husks
- 1/2 sack of chopped green grasses and banana stems
- 2 kg of wood ash
- 2 kg of fresh cow dung



Charcoal dust

Chopped grasses

Chopped Banana stems

Rice husks

Chicken manure

Saw dust

- Put the inputs in layers and later mix them well.
- Mix water, molasses and fresh cow dung in a basin and sprinkle it while mixing the heaped inputs.
- The material should have an optimal water content (moisture). The best practical way to determine this, is by squeezing firmly the mixture in the hand-palm and no water comes out of the fingers. It forms a ball when you open the palm and collapses easily.
- Remember that if mixture is dry add water and when its very humid add chicken manure or dry soil or coffee husks.
- When it has a lot of water, the temperature generated during the fermentation process will be low resulting into a "rotten bokashi" and if it has less water (moisture content), the temperature generated will be very high which will results into "burnt bokashi"
- After mixing and the moisture content is right, leave the material in a heap-like structure of 1 metre tall, if the quantities permit, cover with banana leaves or fibres under shelter.

Different layers of organic material put together during preparation of Bokashi



HIGH QUALITY BOKASHI INCREASES PLANT NUTRIENTS AND LIFE IN THE SOIL, THUS IMPROVING CROP PRODUCTION

Preparation of Bokashi



- A day after, the material start to generate temperature. Turn the bokashi to lower the temperature and to accelerate uniform fermentation.
- For the first 4 days, turn the heap twice a day (morning and evening) and then after turn it once a day for 10 days.
- Each day you turn the heap, lower its height by widening its base up to about one foot tall.
- On the 15 day after preparation, when it cools, put the bokashi fertilizer in gunny sacs to storage and apply it during rainy season.
- Bokashi can be applied in the hole directly during planting of annual crops or during transplanting of seedlings. For perennial crops, spread it around the plant (where feeding roots are located).



How to prepare nursery bed and potting soil substrate

Inputs:

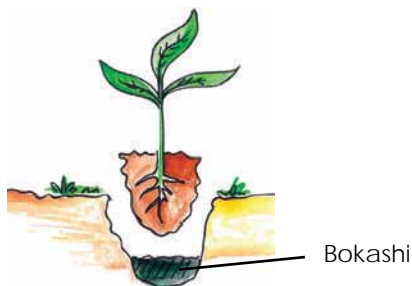
- 3 sacks of organic fertilizer
- 2 sacks of soil
- 2 sack of rice husks
- 3 litres of activated M.M

Mix well and keep the mixture for a period of 2 months, there after you can use to fill the potting bags



How to apply organic fertilizers during planting

- The quantity to be applied varies, from $\frac{1}{4}$ a kilo up to 1 kilo per transplanted plant of coffee and cacao.
- For nursery seed soil, mix 10 kg of bokashi with 90 kg of soil.
- For potting mixture, for raising coffee and cocoa seedlings, mix one part soil and one part bokashi



At the time of transplanting

For soft or succulent plants, do not apply organic fertilizer directly between the roots and the plant. Put the layer of soil between the crop roots and the organic fertilizer.



After transplanting

For the plants that are 10 – 12 days old after transplanting, apply again the organic fertilizer and this time apply or put the organic fertilizer at the top but not close to the plant stem.

Bio-ferments or Bioles

This is a fermented liquid organic fertilizer produced from organic liquid material acted up on by effective Mountain Microorganisms, such as yeast, fungi and bacteria.

The liquid organic matter is then transformed into plant elements, vitamins, organic acids and other substances for plant growth.

It is sprayed on crop and the nutrients are absorbed through the leaves immediately.



Bio-ferments have no harm to our crops, they bring the plant back to life



Advantages of using fermented liquid fertilizers



Better nourishment for plants resulting into healthy and strong plants.

It is a microbial soup which permits the re-establishment of microbial equilibrium in the ecosystem.

They reduce incidences of plant pests and diseases making them more resistant.

They do not permit growth of plant pathogenic microorganisms on plants by working in a way to prevent and eliminate diseases.

Inputs used in preparation of Bio-ferments

- 2 litres of fresh milk or 4 litres of whey
- 10 kg of fresh cow dung
- 2 litres of molasses
- 2 litres of activated effective Mountain Microorganisms
- 1 kg of wood ash
- 20 litres of clean water



Fresh Milk



Fresh cow dung



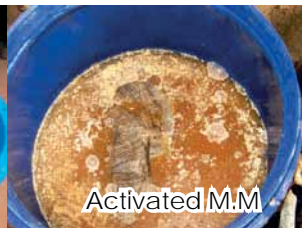
Molasses



Wood ash



Clean water

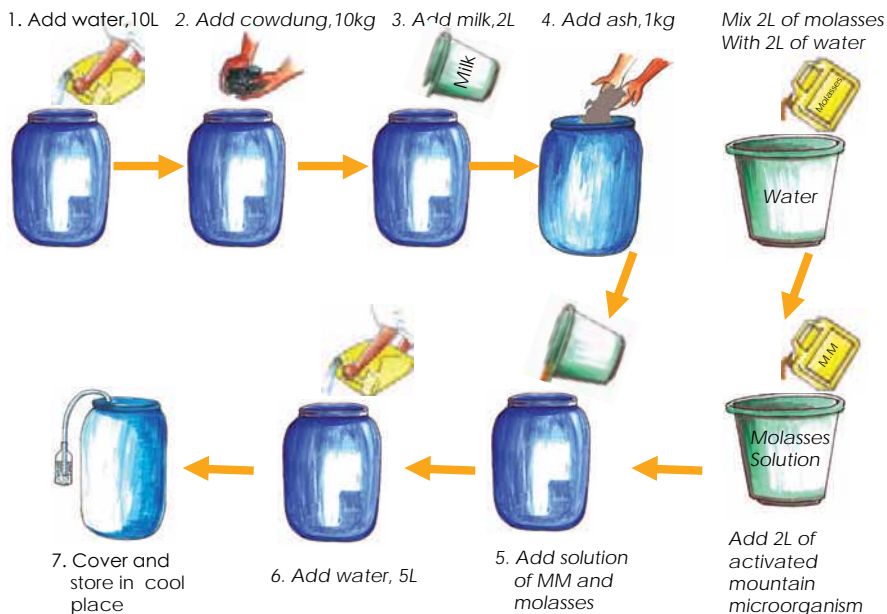


Activated M.M

How to prepare a Bio-ferment

- Put 2 litres of fresh milk in the 30 litre plastic drum or container, added 10 kg of fresh cow dung, plus 2 litres of molasses diluted in 20 litres of water.
- Stir the mixture well to ensure that it becomes uniform. In case there are small wood particles or other objects, they should be removed.
- You should not add acidic fruit juices such as lemon juice, orange juice etc.

Note: The cow dung should be fresh and should not be in contact with direct sun light. The cow should not have been vaccinated with antibiotics, since this can affect the quality of cow dung.



- After mixing, cover the drum firmly with a metallic ring fastener to prevent entry of air.
- Insert the end of the hose pipe in the plastic bottle containing water - it acts a breather for the escape of gases produced inside the drum and also prevents entry of air (oxygen).
- Gases produced inside the container will escape through the hose pipe forming gas bubbles in the plastic bottle containing water.





Farmers learning how to prepare quality bio-fermented organic fertilizers using Microorganism

Do not open the drum before 25 days elapse. Only when its necessary but then should be closed immediately.



- Store the plastic drum under shelter.
- Protect it from direct sunlight and rain.
- The bio-ferment will be ready for use 25 days after preparation.

Application of Bio-ferments

- Before use, shake well the container to allow uniform mixing of solution.
- Open the container and measure the quantity of fertilizer you need and cover immediately.
- Mix with water as follows: 1 L of fertilizer with 1 L of clean water or 10 L of fertilizer with 10 L of water in a 20L spray pump and spray on crops.

How to prepare mineral enriched Bio-ferments



Bio-ferment fertilizer enriched with Potassium



Bio-ferment fertilizer enriched with Magnesium

NOTE: The initial process of preparing bio-fertilizers enriched with plant elements is exactly the same as that of preparing a bio-fermented liquid fertilizer. It requires the same initial inputs, however, on the FIFTH DAY after preparation, in this case you add some quantities of plant element(s) of your choice—depending on the future use. You can make a bio-ferment fertilizer containing one or more plant elements.

On the 5th day

- Add the bio-plant element, plus 4 litres of molasses, 4 litres of activated efficient Mountain Microorganism and finalize by adding up with water.
- Put back the cover of the container and tighten it.
- Leave the container to rest for another 25 days.

Note: For each container you prepare, you can make a different plant enriched bio-fermented fertilizer. They can be any of the listed bio-elements on the right side.

Quantities of plant mineral elements that can be added to a bio-ferment fertilizer - either as single or in combinations.

- Bio-magnesium and molybdenum (2 kg of magnesium sulphate + 3 grams of molybdenum)
- Bio-calcium (2 kg of calcium carbonate)
- Bio-zinc and manganese (2 kg of zinc sulphate + 2 kg of manganese sulphate)
- Bio-potassium (2 kg of potassium sulphate)
- Bio-phosphorus (2 kg of rock phosphate)
- Bio-Boron (1 kg of borax)
- Bio-Sil (2 kg of silicate)



Remember

Do not fill up the container or plastic drum completely with water, leave a space of about 10-15 litres between the mixture and the top level of the drum. In that way, the space will be occupied by the gases generated during the fermentation process.

It is important to add molasses to the mixture in order to provide food for microorganisms to reproduce themselves.

The bio-enriched fermented fertilizers are chemical products allowed in organic agriculture that when utilized with organic fertilizers provide plants with minerals required for healthy and vigorous growth.



Different types of mineral enriched bioles

It is important to prepare all the bio-fermented fertilizers enriched with plant elements (minerals) at once such that, there after you can formulate your own liquid fertilizer mixtures which you can use in the development stages of the plant (growth, flowering, fruit formation, leave formation etc.)

Calendar: Make your time chart or calendar to help you to follow up the number of days for fermentation of bio-fermented liquid fertilizers.

Formulating mixtures of mineral enriched Bio-ferments

These formulated mixtures are important for feeding crops to obtain vigorous plant growth and high yields. The application dosages differ from 5 – 10 litres of mixture per spray pump.

Tropical mixture

• Bio-magnesium	5 litres
• Bio-manganese + zinc	5 litres
• Bio-boro	4 litres
• Bio-calcium	3 litres
• Bio-silicate	3 litres



A tropical mixture is used on any crop which grows your farms. It contains necessary elements for good plant growth in the tropical region.

Crop strengthening mixture

Bio-phosphorus	5 litres
Bio-potassium	5 litres
Bio-borax	4 litres
Bio-magnesium	3 litres
Bio-calcium	2 litres
Bio-silicate	1 litre



This **strengthening mixture** is used to obtain fruits or seeds with big size and also produced in large quantities. Apply this mixture when the plant/crop starts to produce fruits or during the flowering stage.

Multi-element mixture

Bio-phosphorus	4 litres
Bio-manganese + zinc	4 litres
Bio-magnesium	4 litres
Bio-silicate	2 litres
Bio-potassium	2 litres
Bio-boron	2 litres
Bio-calcium	2 litres



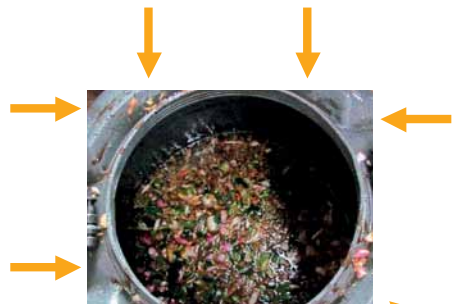
The multi-plant element mixture is used when you observe slow or retarded plant growth and low yields. It can be applied at any stage of plant growth, from transplanting to harvesting.

Preparation of Bio-repellant or Bio-insecticide

It is an organic product used to control crop pests and insects such as caterpillars, piercing and plant sucking insects, coffee berry borer, scale insects and a number of other pests that attack crops. It also prevents plants from being attacked by fungal diseases.

Inputs

- 1 kg of garlic
- 1 kg of hot pepper or red eye bird chilli
- 1 kg of onion
- 2 kg of Ginger
- 40 litres of clean water
- 3 litres of vinegar
- 3 litres of local alcohol or waragi
- Aromatic plant leaves such as cilantro, Parsley, marigold, lemon grass, citrus leaves etc
- 3 litres of molasses
- 3 litres of activated Mountain Microorganisms





Bio-repellant 15 days after preparation

After mixing all the inputs in a container, cover the container tightly.
No air should enter into the mixture.
Store the container in a cool and dry place for a period of 15 days. Can last for 1 year when kept and stored well.

APPLICATION

APPLICATION DOSIS: Use 250cc of bio-repellant in 20 L spray pump and spray on the crops attacked.

- Apply after seed germination
- Can also apply the insecticide each time you see pests attacking your crops

Uses

Increases plant resistance to pests and diseases
Prevents pests problems in field crops and ecto-parasites in animals
Repel insects



Spraying bio-insecticide on coffee



Good coffee berries

THE STRONG SMELL AND TASTE OF THE PRODUCT ACTS AS A REPELLANT AGAINST INSECTS AND DAMAGING MICROORGANISMS. THE RESULTS ARE HEALTH, GOOD AND QUALITY PRODUCE.

Preparation of Bio-stimulant

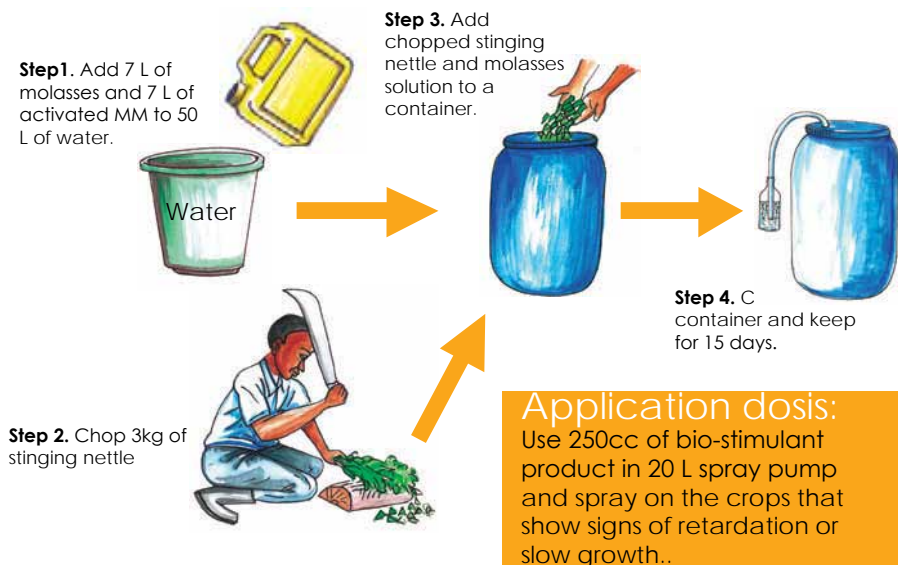
It is a product that is used to stimulate the growth and development of the plant. It is applied to weak plants and retarded plants - those that take time or delay in their growth.

Inputs

- 3 kg of stinging nettle (*Urtica dioica*)
- 7 Litres of activated efficient Mountain Microorganisms
- 7 Litres of molasses
- 50 Litres of clean water

Preparation

- Chop 3kg of stinging nettle plant
- Dissolve 7 L of molasses in 15 L of clean water
- Add the solution of molasses to a container or plastic drum
- Then add 7 L of activated Mountain Microorganisms to the drum followed by 3kg of chopped and crushed stinging nettle.
- Add the remaining balance of water (35 L) to the plastic drum. The drum should not be filled to the top, leave a space between water and the top cover for accumulated gases produced inside the drum during fermentation process.
- Cover the container and insert the hose pipe in a plastic bottle to allow escape of gases and leave store in cool dry place for 15 days.



Understanding the technology and not just doing it!!

The MM technology regenerates poor managed soils, reduce incidences of crop pest and diseases and improves productivity and quality of your crops. It can be implemented by all producers whether large, medium, small, organic, conventional or sustainable.

It is very important to prepare and apply the different organic remedies presented in this manual but the most important thing is to understand why you do it.

This technology is based on the four principles of Organic Farming as stipulated by IFOAM;

1. Principle of health

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

2. Principle of ecology

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

3. Principle of fairness

Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities

4. Principle of care

Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. For detailed understanding of these principles, please visit the IFOAM website at www.ifoam.org

Plant performance is a reflection of the health status of the soil and so are all the living things. When the soil is sick, it produces stunted crops, poor yields and high prevalence of pests and diseases resulting into hunger, famine and a malnourished population. A health and fertile soil produces vigorous crops, high crop production and quality produce and a healthy –happy population.

An alternative and sustainable solution to soil problem rise in the Mountain Microorganism technology and as a farmer, its never to late to rebuild the fertility of your soil, act now and tomorrow you will tell a story

With our organic fertilizers rich in soil life and nutrients.....



..... we can restore soil fertility, increase crop yields and improve our livelihoods.