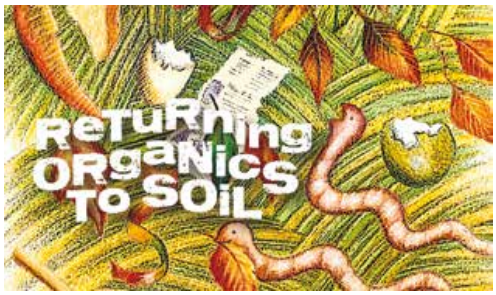
Bioferments, Biostimulants & Biofertilizers

Making them on the farm

There are a number of simple biotechnologies that can be made on the farm to help improve soil condition, stimulate plant growth and improve plant health. These include bioferments, biostimulants, biofertilizers and compost inoculants. This booklet outlines some basic recipes for making these on-farm.



SOIL LAND FOOD
ECOLOGICAL AGRICULTURE

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Understanding the different biological technologies

The main types of agricultural biotechnologies are:

- **Aerobic:** these are made in high oxygen environments where microbes adapted to *oxygen* are cultured. The best-known examples are aerated compost and compost tea.

- **Fermentation:** these are made in conditions of *low/no oxygen* levels. Effective Microorganisms (EM) and Biofertilizers are some examples.

- **Vermi-products:** these are based on the products of worms as they transform organic materials into stable products. Worm leachate and worm castings are two examples.

What are bioferments, biostimulants & biofertilizers

There are a wide range of bacteria, yeasts and related organisms that do not use oxygen to breathe. They are known as *anaerobic microbes*. They live by a process called *fermentation*. Other microbes can live with either oxygen or no oxygen. These are called *facultative microbes.* Some microbes also only live in low levels of oxygen. Fermenting microbes live without oxygen but like all other organisms they need energy and nutrients to survive. Fermentation is where these microbes are cultured in no oxygen conditions. A home brew is an example of fermentation!

During fermentation these microbes create a number of compounds known as *fermentation products*. Most of these products are beneficial and include vitamins, enzymes, amino acids and organic acids. Some fermentation products however like gases and alcohols can be toxic to plants at certain concentrations. The aim when making fermentation-based bioferments, biostimulants and biofertilizers is to ensure a balanced complete fermentation process that results in a range of beneficial stable compounds and microbes.

Bioferments should contain *plant growth factors* and sometimes microbes and they can provide a number of beneficial functions to soils and plants including:

- Improving the cycling of nutrients
- Chelating nutrients
- Stimulating root growth
- Reducing plant stress
- Increasing plant health

When culturing microbes it is important to remember that they all need:

1. **Energy** – they get this from carbohydrates like sugars
2. **Nutrients** – they need a full range of elements and trace elements
3. **Ideal oxygen levels** – either no oxygen, low oxygen or high oxygen levels
4. **Water** – they need clean water
5. **Ideal ambient temperatures** – not too hot and not too cold.

Always use non-chlorinated water
Always use clean equipment
Always seal your fermentations properly.

Recipe 1 – LAB Serum (also known Lacto!)

This is a base inoculant that is based mainly on a well-known group of fermenting bacteria called *Lactobacillus*. It can be used directly on soils and plants or further fermented with other ingredients to make a wide range of products including the Static Pile Inoculated Compost Extension (SPICE) compost inoculant. It makes a product which is similar in some ways to Effective Micro-organisms (EM).

Ingredients & Equipment

Clean water non-chlorinated	Milk/Milk Powder – must have lactose
Rice – any type	Containers - clean
Molasses	50-Gal Barrel / 260 Gal IBC with lid

Process

Step 1: Capture inoculant by putting rice into a large open-mouthed container with clean water. Leave for 3-5 days in dark place with a loose-fitting lid. The liquid should change and after this time it should smell slightly sour and may have a slightly milky color in it. Decant the water off and keep it. Throw away the rice. This liquid is a *Lacto Culture* mainly of *Lactobacillus* species.

Step 2: **Feed inoculant** by adding the liquid *Lacto culture* to the milk in a large container with a wide mouth. Cover with loose fitting lid and store for a few days until it curdles, and milk solids separate. Remove the solids. Keep the creamy- yellow *whey*. This is also known as the *Base Serum*.

Step 3: Stabilise the product by adding equal parts water to this liquid. Add about ¼ quart of molasses for every quart of water you add. This is your stable *LAB Serum* product.

Step 4: Store the product in a cool place with the lid tightly on. It should remain stable for a number of years. It should be light to mid brown color with a slightly sweet-sour smell. Some light brown yeasts may colonise the surface. This is OK. The pH should be around 4.

Batch Recipes

Step	2 Gal		20 Gals		250 Gal	
1	Rice	8 ozs	Rice	5 lbs	Rice	62.5 lbs
	Water	1 Quart	Water	2.5 Gal	Water	31.25 Gal
2	Milk	2 Quarts	Milk	5 Gal	Milk	62.5 Gal
	Lacto Culture	1 Quart	Lacto Culture	2.5 Gal	Lacto Culture	31.25 Gal
3	Whey	Approx. 3 Quarts	Whey	Approx. 7.5 Gal	Whey	Approx. 93.5 Gal
	Water	Approx. 3 Quarts	Water	Approx. 7.5 Gal	Water	Approx. 93.5 Gal
	Molasses	1 Pint	Molasses	1.25 Gal	Molasses	15 Gal

Store in a sealed container, in the shade if possible. It should last at least 2 years.

Recipe 2 – SPICE Compost Inoculant

The SPICE Compost Inoculant is a biological product that contains micro-organisms that help to decompose and compost organic materials under low oxygen conditions. It can be made and stored easily on the farm. This inoculant is applied to the feedstock material as you are setting up a no-turn compost pile.

The compost inoculant is partly a fermentation-based product. This means the micro-organisms in them can live in low/no levels of oxygen. These are the conditions that exist in the SPICE Compost system where a cover is used to control the level of air and the pile is not turned. The aim of using the inoculant is to help control the process of composting in the pile and ensure that the right community of micro-organisms are doing the composting process. See the SPICE Compost Fact Sheet for more info.

Ingredients & Equipment

Clean water - non-chlorinated	Seawater – or equivalent
Lab Serum – Recipe 1	Measuring jugs / Buckets
Molasses	Wheelie Bin / 250 Gal IBC - with lid
Blood & Bone Meal	Hessian sack & string – coffee or potato sack
Bran – rice or any cereal	Basalt powder - optional
Fresh green leafy plant material	Seaweed liquid or meal - optional

Process

Step 1: Fill bin or IBC with half the water

Step 2: **Prepare Hessian "teabag" sack** - by placing fresh green leafy plant material (grass, weeds, herbs, fresh seaweed etc.), blood and bone meal and bran into the sack and closing it with string. You can add basalt rock dust or seaweed meal if available. Place the 'teabag' sack into the Bin/IBC and secure to the side so you can readily access it.

Step 3: Add energy/nutrients to water - mix molasses, seawater and Lab Serum (Recipe 1) to the Bin/IBC. You can also add seaweed liquid instead of meal if available. Now add the balance of water to the Bin/IBC.

If you do not have access to seawater you can make it by adding 1 cup of sea salt to 7 Quarts of clean water. If you need a larger quantity then just multiple this recipe, keeping the ratio the same.

Step 4: Activate the mixture. Close the lid loosely on the Bin/IBC and leave the mixture to activate for 5 days. Every day open the lid to check on the mixture and jiggle the 'teabag' sack at least once a day every day for the 5 days. After 5 days remove Hessian tea bag and discard the contents of the tea bag. Keep the liquid in the barrel. This is the SPICE Compost Inoculant and is now ready for use.

Step 5: Store the product in a shaded cool place with the lid loosely on. Do not be concerned if a gray mix (yeasts) forms on top of the mixture after a few weeks. The product should be used within 1 – 3 months.

Batch Recipes

Step	Wheeled Kart 60 Gal		260 Gal IBC	
1	Water	100 Q	Water	500 Q
2	Green leafy stuff	15 – 20 Q	Green leafy stuff	100 Q
	Blood & Bone	6 pounds	Blood & Bone	30 pounds
	Bran	6 pounds	Bran	30 pounds
	Basalt Dust*	2 pounds	Basalt Dust*	10 pounds
	Seaweed Meal*	2 pounds	Seaweed Meal*	10 pounds
3	Molasses	3 Q	Molasses	15 Q
	Seawater	7 Q	Seawater	35 Q
	Lab Serum/EM	7- 10 Q	Lab Serum/EM	50 Q
	Water	60 -70 Q	Water	300 Q

* Optional if available

When applying as a compost inoculant apply at 1 pint per 5 cubic yards of compostable material. See the SPICE Compost Fact Sheet for more info.

Recipe 3 – Hydrolysate

A hydrolysate is a bioferment made with high protein material such as animal carcasses or vegetable scraps. These are macerated (smashed up) and then fermented with Lab Serum, water and a sugar source. The result is a bioferment with both fertiliser value and a range of biostimulants. There has been a lot of research showing that the compounds in hydrolysates, including amino acids and organic acids, are very beneficial to plant growth.

Ingredients & Equipment

Clean water - non-chlorinated	High Protein biomass – animals or vegetables macerated
Lab Serum – Recipe 1	Measuring jugs / Buckets
Molasses	50-Gal Barrel / 260 Gal IBC - with fermentation lock

Process

Step 1: Macerate High Protein Biomass – using a macerator, insinkerator or smash with a spade. You may need to add a small quantity of water to macerate.

Step 2: **Fill Barrel or IBC** with the biomass

Step 3: Add water – carefully add the water to the Barrel/IBC.

Step 4: Add Lab Serum and Molasses – Mix these 2 thoroughly through

Step 5: Ferment – make sure the product is in a reasonably warm place and will not be disturbed. Leave 3 – 6 inches space between the top of the liquid and the lid for gases. Seal the fermentation lock. Ferment for at least 6 - 8 weeks. When fermenting is finished the product should have a mild smell and should have a pH of around 4. It should be a mid-brown to dark brown color. A product with black and/or purple/green colors with a strong smell has putrefied. This is not to be used.

Step 6: Store the product - in a shaded cool place with the lid sealed. The product should last 12 months or more if properly stored. Check the pH, color and odor before use if stored for a long time.

Batch Recipes

Step	50-Gal Barrel		260 Gal IBC	
2	High Protein Biomass	80 Q*	High Protein Biomass	400 Q*
3	Water	80 Q	Water	400 Q
4	Lab Serum	16 Q	Lab Serum	80 Q
	Molasses	11 Q	Molasses	55 Q

* Recipe is done by volume not by weight.

This product needs to be filtered before use. It can be applied as a foliar or soil application. 5 – 10 pints per acre diluted in water at least 1:10 is a general rule. For foliar applications, early in the morning or late afternoon is best.

Recipe 4 – Biofertilizers

A biofertilizer is a bioferment that can be made with a variety of ingredients and usually aims to provide bioactivated nutrients to soils and plants. Depending on the ingredients used the product will have both fertilizer and biostimulant value. There are many recipes available on the internet. Below is just a simple one. Feel free to experiment. Add seaweed, humates etc. if required. It is important to remember that any recipe needs to have the right balance of: an *energy source*, *nutrients*, *water* and an *inoculant*. You can custom blend biofertilizers by adding in trace elements during the fermentation process.

Ingredients & Equipment

Clean water - non-chlorinated	Fresh Cow Manure / Lab Serum / EM - inoculant
Molasses	Yeast
Milk/Whey	Wood ashes
Basalt Dust	Measuring jugs / Buckets
Seaweed meal/liquid*	50-Gal Barrel / 260 Gal IBC
Rock Phosphate powder*	Fermentation Lock

* optional

Process

Step 1: Add manure to Barrel or IBC – use fresh, clean manure. If you do not have enough manure or do not want to use it then use some LAB Serum instead.

Step 2: **Add dry ingredients –** add in basalt powder, wood ashes, and yeast and mix in to manure. You can add seaweed meal and rock phosphate powder at this stage if you want.

Step 3: Add water – carefully add 90 % of the water to the Barrel/IBC.

Step 4: Add Molasses/Milk mix – Mix milk and molasses with about 10 % of total water volume and then add this to the ferment. You can use whey instead of milk. You can add liquid seaweed now if you want.

Step 5: Mix well – carefully mix everything together.

Step 6: Ferment – make sure the product is in a warm place and will not be disturbed. Leave at least 5 – 10-inch space between the top of the liquid and the lid for gases. Seal the fermentation lock. Ferment for at least 8 weeks. When fermenting is finished the product should have a mild smell. It should be a mid-brown to

dark brown color. A product with black and/or purple/green colors with a strong smell has putrefied. This is not to be used.

Step 6: Store the product - in a shaded cool place with the lid sealed. The product should last 12 months or more if properly stored. Check the pH, color and odor before use if stored for a long time.

Batch Recipes

Step	50-Gal Barrel		260 Gal IBC	
1	Cow manure^	8 Gal	Cow manure^	40 Gal
2	Basalt powder#	3 pounds	Basalt powder	15 pounds
	Wood ashes	5 pounds	Wood ashes	25 pounds
	Yeast*	10 ounces	Yeast*	3 pounds
	Seaweed meal*	2 pounds	Seaweed meal*	10 pounds
	Phosphate powder*	2 pounds	Phosphate powder*	10 pounds
3	Water	37 Gal	Water	190 Gal
4	Molasses	2 quarts	Molasses	10 quarts
	Milk/Whey	2 quarts	Milk/Whey	10 quarts
	Water	10 quarts	Water	13 Gal

^ You can use half cow manure and half LAB Serum instead. You can also make on 100% LAB Serum.
# If you can't get basalt powder then you can use seaweed meal and wood ashes instead.
* Optional

This product needs to be filtered before use. It can be applied as a foliar or soil application. 5 – 10 pints per acre is a general rule. Dilution rates are 1: 10 to 1: 200. For sensitive crops use more water. For foliar applications, apply early in the morning or late afternoon.

Custom Blending

You can customise the biofertilizer recipe as long as you keep the general ratios of energy, water, nutrients and inoculant. Specific Nutrients and Trace Elements can be added to make a custom blend. A general procedure for a Trace elements blend is:

Step 1: Make basic biofertilizer recipe

Step 2: Leave it for 5 days

Step 3: Add Minerals, Inoculant & Molasses – after 5 days add in custom minerals*, 1 - 2 quarts milk/whey/LAB Serum, and 1 – 2 quarts of molasses. You may have to dissolve some trace elements in a small amount of water before adding. Reseal the ferment. * see table over page for mineral quantities.

Step 4: Complete fermentation– allow the fermentation to finish

Mineral Quantities for Biofertilizer Custom Blends

50-Gal Barrel		260 Gal IBC	
Magnesium Sulphate	3 pounds	Magnesium Sulphate	15 pounds
Calcium Carbonate	3 pounds	Calcium Carbonate	15 pounds
Calcium Chloride	2 pounds	Calcium Chloride	10 pounds
Potassium Sulphate	3 pounds	Potassium Sulphate	15 pounds
Potassium Silicate	3 pounds	Potassium Silicate	15 pounds
Rock Phosphate	3 pounds	Rock Phosphate	15 pounds
Borax (Boron)	2 pounds	Borax (Boron)	10 pounds
Zinc Sulphate	2 pounds	Zinc Sulphate	10 pounds
Manganese Sulphate	9 ounces	Manganese Sulphate	3 pounds
Sodium Molybdate (Molybdenum)	5 ounces	Sodium Molybdate (Molybdenum)	25 ounces
Iron Sulphate	10 ounces	Iron Sulphate	3 pounds
Cobalt Chloride	1 ounce	Cobalt Chloride	5 ounces

* Use soluble minerals where possible. Dissolve in a small quantity of warm water before mixing if possible. Alternatively use very fine grades of minerals like super fine.
* Take care when applying trace elements to crops and pastures. Excessive trace element applications can lead to toxicity. Monitor crops using soil tests, tissue tests or visual assessment to determine trace element needs.
* These quantities are a guide only.

When using bioferments and custom mineral biofertilizers it is important to apply the product using soil tests, tissue tests and/or by assessing visual performance of the soil/crop/pastures.

References

Kalema & Chacon; 2010; *Organic fertilisers and bio-ferments; a practical manual for smallholder farmers;* Louis Balk Institute

Journey to Forever Project -
www.journeytoforever.org/farm_library.html

Jadam Farming - www.en.jadam.kr/

Various YouTube Channels - Type *Korean natural farming* or *biofertilizers* into YouTube.