YALTA
Youth in Agroecology and Business Learning Track Africa

HANDBOOK ON AGROECOLOGY PRODUCTION

Prepared and Presented by Youth in Agroecology and Business Learning Track Africa (YALTA Initiative)

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YALTA

Table of Contents

I. Acknowledgments

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II. List of Acronyms

CAET	-	Characterization for AgroEcology Transition
CC	-	Country Coordinator
FAO	-	Food and Agriculture Organization
IPDM	-	Integrated Pest and Disease Management
NFP	-	Netherlands Food Partnership
NOAP	-	National Organic Agriculture Policy
YALTA	-	Youth in Agroecology Learning & Business Truck Africa

1 INTRODUCTION

1.1. About this Handbook

This handbook is a consolidation of information from different sources on agroecology and basic production practices. It aims at imparting knowledge to the agriprenuers especially the youths but can also be used by any one intending to implement or facilitate/train on agroecology farming

The handbook briefly gives information on the 10 elements of agroecology and a link for detailed information on these elements by the Food and Agriculture Organization (FAO)

The handbook is categorised into two major parts. One part introduces the handbook and the YALTA program and the second part elaborates on the basic practices implemented under agroecology that range from Agroecology farm planning and design, soil and water conservation, soil fertility management, pest and disease management. Where possible, links to YALTA work with the youths on the practices have been provided in this hand book as well as illustrations in form of pictures, clip arts to emphasize the suggested practices/technology. Some case stories have been added to link the works done by YALTA in the countries of Rwanda, Ethiopia, Uganda and Kenya in Agroecology.

1.2. How to use this handbook

The handbook has been compiled in an easy-to-use format for agriprenuers who intend to implement agroecology. It is advised that they internalize and contextualize it to fit the local context. This could be through simulations with fellow colleagues but also enriching it with own experiences to make it more applicable.

In some cases, especially practical implementation related sessions, existing literature or reference materials on particular practices or technologies (whose information is not captured in this handbook) should be used to complement the handbook.

1.3. Who will use the handbook?

The handbook will be used by various categories of people engaged in community transformation and livelihood promotion through agriculture and other natural resource related fields. The handbook therefore primarily targets producers doing agroecology but can also be used by other development agents like field officers, community resource agents, extension workers, project officers and managers. They will use it to plan and execute agroecology farming.

1.4 About the YALTA Programme

The YALTA initiative is a programme by Netherlands Food Partnership, funded by IKEA Foundation to support youths to drive sustainable food systems and economic development. The initiative follows a market-based approach and convenes a wide range of stakeholders consisting of agripreneurs, practitioners, policy makers and experts. From seed distributors to academia and from farmers to policy makers sharing a wide range of knowledge and experiences to push for collective advancement. The program focusses on three major long-term outcomes that include;
- **Markets reward Youths in Agroecology,**

-Youths effectively adopt Agroecology principles and

-Conducive business ecosystem for Youths (businesses) applying AE principles

By connecting to a broad base of youth networks in Ethiopia, Kenya, Rwanda and Uganda, the initiative has ensured the inclusion of youths every step of the way from identifying the major issues to co-developing solutions. A number of activities have been implemented since the onset of the program among which included; Training of the youth in Organic Agriculture, conducted caravans to expose the youths to successful agroecology entrepreneurs, conducted agroecology business mentorship program among the youths, held annual meet ups for the agroecology actors to strengthen Agroecology Actors' Network.

2. BACK GROUND, RATIONALE AND AGROECOLOGY PRACTICES

2.1 Back Ground and Rationale

For decades, the question of feeding the growing population of the world has attracted every one's attention with innovations coming on board. The industrial farming system was introduced in the 1960s to solve the problem of feeding the increasing population of the world. However, after many years of promoting conventional farming, despite undeniable progress in reducing rates of undernourishment and improving levels of nutrition and health, almost 800 million people are chronically hungry and 2 billion suffer micronutrient deficiencies. Under a 'business-as-usual' scenario, without additional efforts to promote pro-poor development, some 653 million people would still be undernourished in 2030 ***(FAO. 2017. The future of food and agriculture – Trends and challenges. Rome)***

High-input, resource-intensive farming systems, which have caused massive deforestation, water scarcities, soil degradation, loss of biodiversity, high levels of greenhouse gas emissions leading to climate change and a rise to non-communicable diseases among all age groups and classes of people cannot deliver sustainable food and agricultural production. Needed are innovative systems that will increase productivity of healthy foods at the same time conserve the natural resource base with more socio-economic benefits and with less environmental consequences. Needed is a transformative process towards 'holistic' approaches, such as agroecology, agro-forestry, and conservation agriculture, which also build upon indigenous and traditional knowledge.

On the other hand, critical parts of food systems are becoming more capital-intensive, vertically integrated and concentrated in fewer hands. This is happening from input provisioning to food distribution. Small-scale producers and landless households are the first to lose out and increasingly seek employment opportunities outside of agriculture. This is driving increased migratory flows, especially of male and youth members of households, which in turn has left the old and weak as well as 'feminization' of farming in many parts of the world. A more inclusive farming system is needed that will strike a balance in division of labour in farming households among the female and male but most importantly the youths

A more sustainable farming systems will contribute to a number of SDGs among which are; Zero Hunger (SDG2), Good health and wellbeing (SDG3), Responsible consumption and production (SDG12), Climate change mitigation and adaptation (SDG13), increase biodiversity (SDG15).

Agroecology aims to optimize the interactions between people, plants and animals. At the same time, we see that the involvement of youths in agroecology is still limited, yet their involvement is crucial for the future.

2.2 Agroecology

The Content and definitions in this handbook are from international sources but complemented by success stories, challenges, lessons and recommendations from the implementation of agroecology by the youths engaged under the YALTA initiative.

Definition

As defined by the Food and Agriculture Organization (FAO), Agroecology is the science of applying ecological concepts and principles to manage interactions between plants, animals, humans and the environment for food security and nutrition. Agroecology is farming that "centres on food production that makes the best use of nature's goods and services while not damaging these resources."

The science of agroecology explicitly recognises the value of bottom-up participatory research and knowledge and promotes: (i) bridging formal and informal innovation processes; (ii) combining local expertise, with scientific knowledge; (iii) acknowledging and respecting farmers as owners of knowledge and co-researchers and innovators.

FAO's framework on agroecology is based on the following elements:

Diversity, co-creation and sharing of knowledge, synergies, efficiency, recycling, resilience, human and social values, culture and food traditions, responsible governance, circular and solidarity economy. For detailed information on the elements of agroecology, please visit: *https://www.fao.org/3/i9037en/i9037en.pdf*

The choice of management practices and technologies to achieve agroecology or to move towards an agroecological transition is always location specific, shaped by a given social-ecological context.

PRACTICES

Introduction.

This section highlights the fundamental practices for agroecological production. The practices have been selected depending on the major challenges that farmers/youths face during agricultural production. These practices are categorized under; Farm planning and design, Soil and water conservation, soil fertility management, integrated pest and disease management. The content under each of the components has been consolidated from different open sources as well as based on the experiences of the project team. Some of these practices have been implemented by the youths targeted by YALTA and can be found in the story map at YALTA Story Map. Below are highlights of the practices

2.3 Farm planning and Design

Like any other business or project, its success is dependent on planning and understanding the dynamics of implementing the project. Agroecology is both an art and science. Therefore, one to run successfully a farm that is agroecological, planning and designing are very important aspects that look at placing the different elements of the farm in the appropriate locations. Science in agroecology now answers the WHAT HOW and WHY an element is placed in a particular location. Farm planning and design is centred on all principles and elements of agroecology such as diversity, recycling, efficiency, synergies and resilience among others. Farm plans will put into consideration the farmer's needs as the primary benchmark and enhance functional biodiversity within the farming system. Farm planning and design can be done following a number of principles put together based on the experiences of the writer. Below are the principles to consider when developing a fam plan and design

1. Diversity. Diversity as one of the elements of agroecology needs to be thought through while developing a farm plan. Diversity is seen at four levels of crops, animals, trees and livelihood activities. While planning for your farm there is need to mix the different elements that will bring out diversity on the farm. Diversity can further be detailed by looking at the different crop varieties and animal breeds. Diversity on the farm contributes to other elements of agroecology like synergies.

2. Connectivity/Synergy

Everything is connected to everything else i.e. every element of the farm must be placed at the place in relation to other elements to enable recycling of energy resources. In this regard ***"There is no waste to waste"*** in agroecology. i.e what seems to be waste from one element is an input to a different element. For example, the cow dung that is waste from animals is manure (input) for plants. One of the principles of agroecology farm planning and design is connecting the output of one element with the input of another. This is because every element has outputs and inputs.

Illustration of the principle of connectivity/synergy. We have four elements of the farm as free-range chicken, paw paw, fish pond and a kitchen.

- Free range chicken: needs (input) – water, food, shelter, space and Produces (output); meat, eggs, scratching behaviour, pest control, manure etc.Pawpaw: needs – manure, water, warmth and produces – fruit, seeds and leaf litter.
- Fish pond: needs - manure, fingerlings and produces fish and water
- Kitchen needs meat, eggs, fruit, and water while it produces kitchen food, waste, grey water and food.

- Complementary elements must be put together e.g. free range chicken and pawpaw. Chicken benefits from the paw paw by eating fruits while the paw paw benefits from the chicken through manure. Connectivity can be supplemented by other two techniques

At Mbooni Village of Makueni County, Kenya is where Robin Njau hails. Robin's engagement with YALATA transformed his mind set from a linear way of thinking to a systems wide thinking of Agroecology. As a farmer who was doing monoculture of maize, he now diversified his farm with crops and animals more so rabbits that come with a benefit of white meat. **Diversifying** his farm meant that there would be **synergies** between the rabbits and the crops by having feeds for rabbits from the crops but also using the rabbit pellets and urine for soil fertility management and pest control. In addition, **recycling** matter is enhanced at his where leftover feeds from the rabbits are now decomposed into organic manures that further support the vigor of plants on his farm

- **Functionality.** Functional landscaping is where we try to meet all our needs. Having elements on the landscape that can serve more than one purpose. For example, a mango tree can provide shade, give us fruits, act as a wind breaker but also serves to prevent soil erosion. Using functionality as a technique in
- farm planning helps us identify and use those elements that have more than one purpose in our farm.

3. Sector analysis and planning

a) Sector analysis

This involves identifying the external factors or forces that influence your land. Examples include the sun, wind, Slope (running water), pollution. These external factors may be negative or positive. Depending on the vision of your farm, trees can be planted to meet your vision after analyzing the external factors. For example, if strong winds are a problem in your area, then one may have to plant trees perpendicular to the direction of the wind. Likewise, if one needs shade on the farm, trees will be planted perpendicular to the movement of the sun while on the other hand, if one wants to integrate trees and crops that require a lot of sunshine, then the trees must be planted parallel to the movement of the sun. This is to say, tree lines must be planted West – East direction.

b) Sector planning

This involves dealing with external forces or factors that affect your land. E.g. strong winds-establish wind breaks, hot sun-establish shade, runoff-establish pond, pollution establish vegetation barrier.

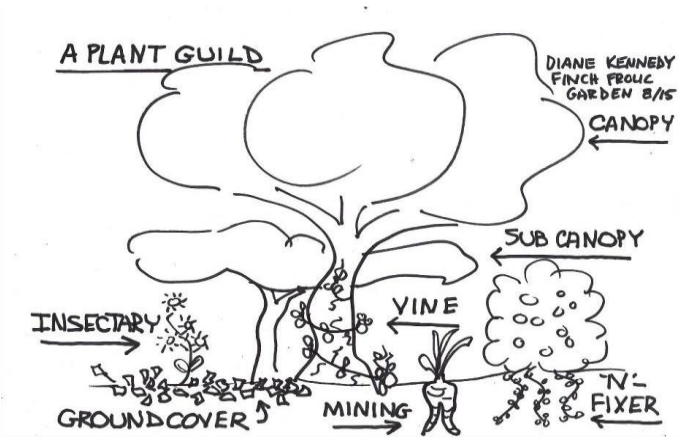
4 Zoning/Efficiency

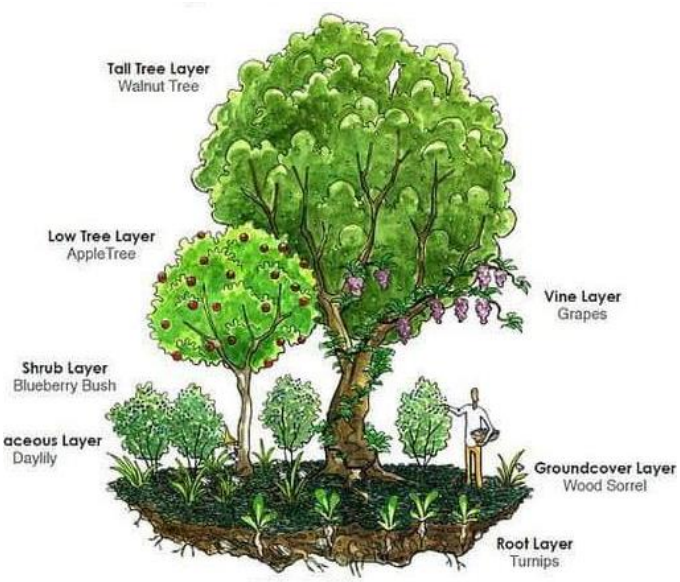
This is placing elements according to the amount of attention they need. Elements requiring more attention are placed nearer to home while elements requiring least attention are placed furthest from the home. ***An example of plants and animals illustrated as shown in the table below.***

Zone	Location	Plants	Animals	Water access
0	Home	Indoor plants	Pets (cats)	Domestic
1	Immediate surrounding home	Seedlings, herbal teas	Dogs, pigeons	Irrigation frequently
2	Moderate distance from home	Orchard garden	Chickens, rabbits	Regular watering
3	Further from home	Staple crops, legume trees	Pigs as tractors	Rain fed
4	Far from home	Pastures	Cows, donkeys	Rain fed
5	Furthest	Forests	Bees	Rain fed.

5 Guilds

This is a community of plants sharing given sites. Plants with different roles at a particular place. A woody tree can be planted together with a shrub, a climbing plant and a shade loving plant in the same place.





In a nutshell,

From the Agroecological farm planning phase while establishing the different designs of biointensive gardens the following are important;

Look at the area to establish biointensive vegetable gardens

Map out the area/sketck (identify shady spots, dry spots, irregular soil patterns etc). This helps in working around them effectively.

A diversity of plants with variety are allocated on the map according to their growth conditions

Inter planting- plant different crops together based on their growth pattern. Also consider planting insect repellent crops ingarden and boundary.

Succession planting also should be done. Stagger planting allows continual harvests and less waste. One can decide to plant at intervals of 2-3 weeks with a variety of vegetables types and varieties.

Ensure companion planting e.g. planting marigold around vegetable gardens helps deter pests

Maximise space-“Think inside the box”. Is there anywhere you can put containers? Some plants do better than others in containers and utilising such can create room/space in your garden for other crops to be planted.

Think of vertical gardens; gardens do not always have to be on ground. You can also make use of walls of houses, structures etc.

2.4 Soil and water conservation

Soil and water conservation is a technique of controlling soil erosion and good use of water by all users sustainably. The effective soil and water management practices can improve soil fertility and increase yields in a sustainable way. These techniques conserve soil and water, preserve soil moisture and/or drain water sustainably to avoid soil erosion and depletion of soil nutrient. Different soil and water conservation measures are used in agroecological farming including terracing, Continuous Contour Trenches (fanya juu and fanya chin, bench terraces, stone terraces), zai pits, grass/contour bounds, use of cover crops, mulching, water harvesting measures (underground tanks, water ditches,) etc.

Well applied practices for water and soil conservation benefit farmers by;

- Reduction of the amounts and velocity of surface runoff
- Removal of unwanted excessive runoff easily
- Maintenance and improvement of soil fertility
- Conservation and retention of soil moisture
- Prevention or minimizing the effects of raindrop impacts on the soil.

Below are procedures for making some of the water and soil conservation practices.

a) **Contour Trenches.**

Contour trenches are ditches dug along a hillside in such a way that they follow a contour and run perpendicular to the flow of water. The soil excavated from the ditch is used to form a berm (a narrow shelf) on the downhill and uphill edge of the ditch. The berm can be planted with permanent vegetation (native grasses, legumes) to stabilize the soil and for the roots and foliage in order to trap any sediment that would overflow from the trench in heavy rainfall events. Contour trenches can be of two forms;- Fanya Jju and Fanya Chini

Fanya juu terraces;

- Dig a trench of 60cm width and 60cm depth. Throw the soils upwards to form a ridge of 40cm-60cm in height
- The trenches could be 10m-20m apart depending on the steepness of the field

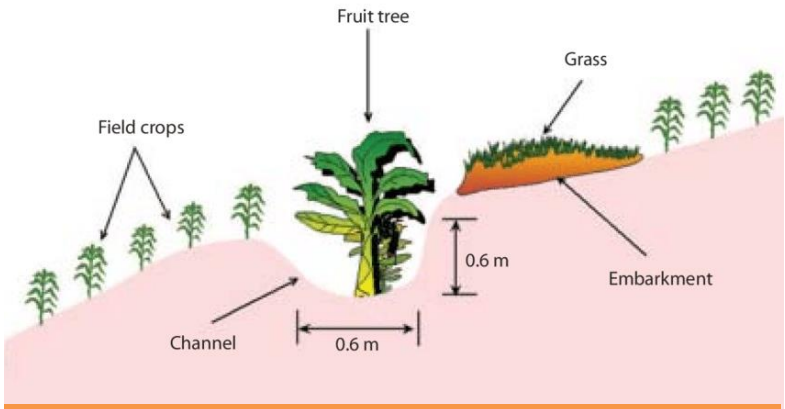


Illustration of the Fanya Jju

- Grasses, crops, trees can be planted on the ridges. These provide food for animals and humans in addition to stabilizing soils against runoffs

Fanya chini;

- Fanya chini means throw soil downhill. Dig the soil and throw downhill to establish a ridges. These terraces are usually used in areas with moderate slopes.
- Grasses, crops, trees can be planted on the ridges. These provide food for animals and humans in addition to stabilizing soils against runoffs

b) Diversion ditches and cut off drains.

Diversion ditches-excavated graded channels to intercept surface water runoff down the slope and diverted to a safe outlet, water way or farm. The structures can be in the form of a trench, a narrow base channel or a hillside ditch.

Cut off drains are channels built to collect runoff from the land above and divert the water safely to water ways thus protecting the land below from excessive erosion. The ditches can be made of earth, stones depending on the available materials'

c) **Cover cropping**; on a larger scale leguminous broad leaved climbers are used in this process. Cover cropping is a multi-beneficial practice during the soil and water conservation. The practice reduces on the speed of water runoff, keeps soil moist for a longer time, and improves on soil fertility since it's a legume crop used in the practice.

d) **Mulching;** this is the covering of soil surface using dry crop residues, stones, wood shelves and shade net. Mulching can be heavy or light mulches hence blanket or light depending on the heat intensity, the type of crop, and the amount of mulches available. Mulches reduce on direct sun heat on the soil and rain water droppings impact on the soil surface. In the long run, mulches decompose and form manure hence improving soil fertility and soil moisture content.

e) **Water Absorption Trenches,**

These are dug at the upper side of the catchment and are constructed by digging 1m wide, 1m deep and 5m in length. These are more less like the Fanya chin and soil is poured on the lower side of the slope which is then reinforced with grass and or Shrubs.

f) **The Stone bands.**

Stones are piled perpendicular to the slope to help in reducing the speed of water but also filtering and enhancing percolation.

2.5 Soil fertility and management

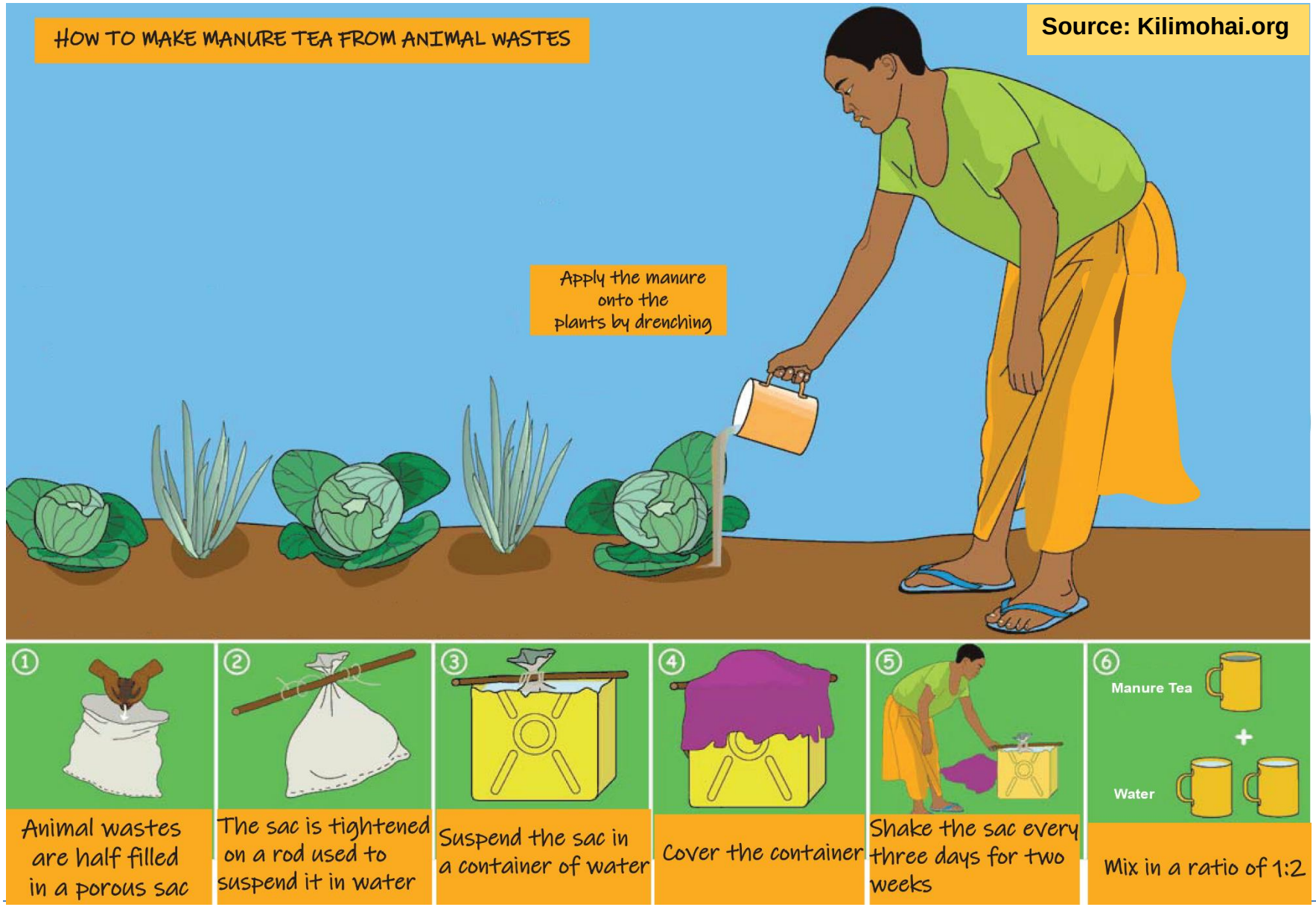
Ensuring healthy and fertile soils is very important for sustainable agriculture production as this continuously leads to better yields. Managing soil health and fertility allows producers to work with the land to reduce erosion, maximize water infiltration, improve nutrient recycling, save money on inputs, and ultimately improve the resilience of their working land. Management of health soils requires to maximize soil cover (plant cover crops, leave crop residuals, use organic mulch), maximize biodiversity (plant diverse cover crops, use diverse crop rotation and companion planting), maximize presence of living roots (Living roots reduce soil erosion and provide food for organisms like earthworms and microbes that recycle the nutrients). Therefore, for sustainable production, soil health and soil fertility are key. Addition of organic fertilizers and manures is one of the ways of maintaining soil fertility.

Soil is a living thing that needs to be looked after well. It requires feeding like any other living thing. Soil can be fed through composting, green manuring, plant tea, manure tea. Compost is a complete soil meal that contains nitrogen (legumes and animal waste), potassium (wood ash), magnesium, phosphorus (wood ash), calcium, trace minerals and carbon (dry matter). On the other hand, green manuring involves use of fresh green grass, dry grass or animal waste. Below are some of the examples of manures/fertilizers used to maintain fertility of the soils

Liquid manure***.*** This is of two types; the plant tea and manure tea.

Plant tea: This is generally made from plant leaves. The common plants used are; *tithonia*, ground nuts, beans, jack bean, elephant grass, pumpkin, etc. Basically, hairy leaves are the best for making plant tea as they can easily decompose. Plant tea is made by chopping the leaves into small pieces which are filled in a container ¾. The container is then filled with water and the leaves are left to rot under shade for two weeks. Keep string after every three days. After the two weeks, sieve the tea and mix in the ratio of 1 tea to 2 of water. Spray on the leaves of the crops. The residues after sieving are used as mulch.

Manure tea: This is made from animal droppings. The droppings are filled in a sac and suspended in a container with water. The sac is shaken after every three days for two weeks under shade. The tea is sieved and mixed in a ratio of 1:2; tea: water and sprayed on the crops. Ash is added in the tea. ***See Illustration below***


HOW TO MAKE MANURE TEA FROM ANIMAL WASTES
Source: Kilimohai.org
Apply the manure onto the plants by drenching
1
Animal wastes are half filled in a porous sac
2
The sac is tightened on a rod used to suspend it in water
3
Suspend the sac in a container of water
4
Cover the container
5
Shake the sac every three days for two weeks
6
Manure Tea
+
Water
Mix in a ratio of 1:2

Compost

Compost is made from a range of materials which include; green matter, dry matter, animal droppings, water, ash and top soil. To make compost, one needs to select an appropriate site that is under shade.

What to Compost

What you put into your compost will depend on what kind of materials are readily available. All compostable materials are either carbon or nitrogen-based, to varying degrees. The secret to a healthy compost pile is to maintain a working balance between these two elements.

A Healthy Compost Pile: Carbon/Nitrogen Ratio

Carbon
Carbon-rich matter (like branches, stems, dried leaves, peels, bits of wood, bark dust or sawdust pellets, shredded brown paper bags, corn stalks, coffee filters, coffee grounds, , egg shells, straw, peat moss, wood ash) gives compost its light, fluffy body.

Nitrogen
Nitrogen or protein-rich matter (manures, food scraps, green lawn clippings, kitchen waste, and green leaves) provides raw materials for making enzymes.

A healthy compost pile should have much more carbon than nitrogen. A simple rule of thumb is to use one-third green and two-thirds brown materials. The bulkiness of the brown materials allows oxygen to penetrate and nourish the organisms that reside there. Too much nitrogen makes for a dense, smelly, slowly decomposing anaerobic mass. Good composting hygiene means covering fresh nitrogen-rich material, which can release odors if exposed to open air, with carbon-rich material, which often exudes a fresh, wonderful smell.

This table details how the items in your compost are likely to be classified:

Material	**Carbon/ Nitrogen**	**Information**
Wood chips / pellets	Carbon	High carbon levels; use sparingly
Wood ash	Carbon	Only use ash from clean materials; sprinkle lightly
Straw or hay	Carbon	Straw is best; hay (with seeds) is less ideal
Shrub prunings	Carbon	Woody prunings are slow to

		break down
Shredded paper	Carbon	Avoid using glossy paper and colored inks
Sawdust	Carbon	High carbon levels; add in layers to avoid clumping
Newspaper	Carbon	Avoid using glossy paper and colored inks
Dry Leaves	Carbon	Leaves break down faster when shredded

Lawn & garden weeds	Nitrogen	Only use weeds which have not gone to seed
Garden plants	--	Use disease-free plants only
Fruit and vegetable scraps	Nitrogen	Add with dry carbon items
Eggshells	Neutral	Best when crushed
Corn cobs, stalks	Carbon	Slow to decompose; best if chopped up
Coffee husks	Carbon	Filters may also be included
Chicken manure	Nitrogen	Excellent compost 'activator'

Procedure

The compost area has to measure 1m in width and any length depending on the availability of materials.

The soil is loosened where the compost heap is to be set up. The compost is prepared as follows.

a) A layer of dry matter (grass, decomposable sticks, leaves, and cereal stems etc.) is set up first on the loosened soil. This helps in aeration. Wood ash is spread and water sprinkled on it.

b) A layer of animal waste is then added. This can be cow dung, chicken refuse, and goat/sheep droppings.

c) Top soil is added to inoculate living organisms that aid in decomposition. Wood ash is spread on the heap and water sprinkled.

d) It is followed with a layer of green matter. Leaves with rough hairy surfaces are recommended as they decompose faster compared to the smooth surface leaves. Wood ash is added and water sprinkled.

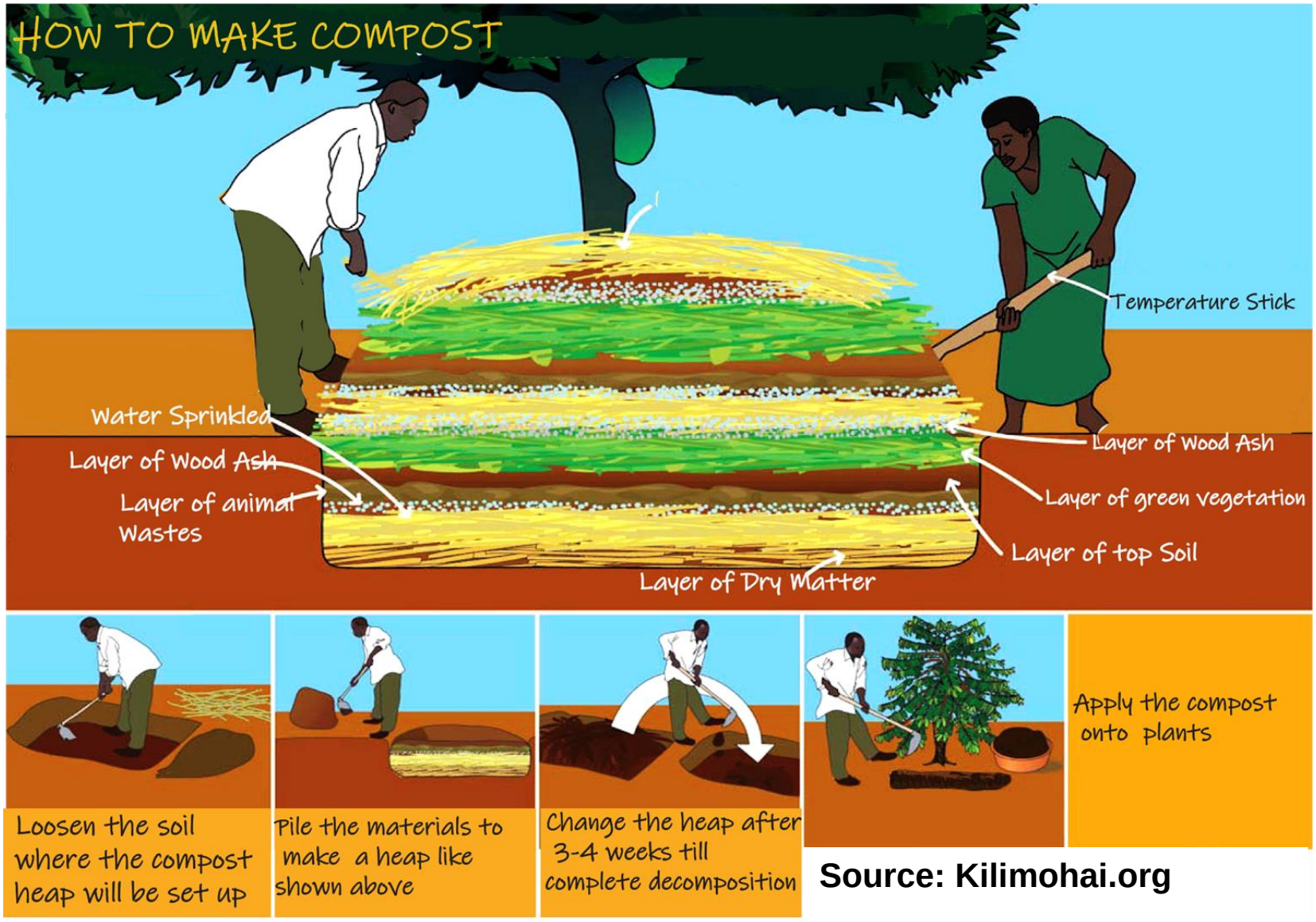
Depending on the availability of resources, steps a - d is repeated.

Once the heap has been set up, a dry stick is pushed diagonally across. This is used to check the level of decomposition and temperature. If the stick is dry or has vapour then it means the temperature is high that can't allow for aerobic respiration. Continuous watering is thus carried on to check the temperature.

The heap is turned after 3-4 weeks for three months and compost will be ready for use in the garden. For a fast compost making, make a small heap and turn it after 2 weeks and will be ready after a month. ***See Illustration Below***

One of the youths from Ethiopia puts the principle of no waste to waste and goes ahead to decompose biodegradable wastes into organic manure. See video at this link

How youths in Ethiopia use locally available materials to make compost that boosts their production. See video at Making Compost using locally available materials



Source: Kilimohai.org

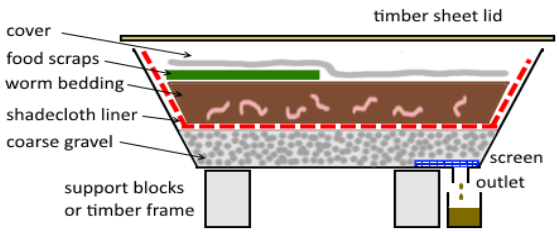
Vermicompost/Virmitea

Vermicomposting is the process by which worms are used to convert organic materials (usually wastes) into a humus-like material known as ***vermicompost***. The goal is to process the material as quickly and efficiently as possible. Worms in addition to microbes and bacteria turn organic waste into a nutrient-rich fertiliser; ***Vermicompost.*** This is also known as worm compost, vermicast, worm castings, worm humus or worm manure.

Vermicompost, like conventional compost, provides many benefits to agricultural soil, including increased ability to retain moisture, better nutrient-holding capacity, better soil structure, and higher levels of microbial activity

Prepare the Bedding And Substrate.

Prepare the substrate for bedding one month before stocking. At a ratio of 70% carbon materials (i.e. shredded cardboard & paper, chopped straw, chopped banana leaves/stalks, wood chips or dust, rice hulls and bran, peat moss) plus 30% animal
manure.
Fill your box half way up with bedding material approximately 40% composted manure and 60% carbon materials. This bedding mixture should be a light & fluffy consistency so that the worms have plenty of air for the entire 60 day period before
splitting. Moisten your bedding until it reaches 70% moisture content.



Stocking

Introduce the compost worms to the bins with well-prepared beddings at 2.5kg/m^2.

Feeding.

The easiest method is to spread the scraps in a thin layer on top of the bedding. If the bin is kept in a dark place or covered, the worms will come to the surface to eat. Once the feed has been eaten down feed them again.

Note: Feeding has to be a gradual process. Do not heap the wastes in the bins as heat will accumulate and may kill the worms. 1cm thick layer is recommended.

Do not also add acidic wastes (fruits) like lemon, oranges, pineapple e.t.c

Harvesting Compost Tea/Vermicompost

Compost tea

The excess water that drains out of the worm bin as a result of watering is compost tea. This tea is used as a liquid fertiliser in organic farming for top dressing/foliar spray. The ratio of dilution is dependent on the type of plant (heavy/light feeder) and the number of worms in the structure.

Vermicompost

Stop watering so that the upper part dries up. This will force the worms to barrow downwards in the cooler regions then scoop off upper part (manure/vermicompost)

A youth from Kenya rears insects to facilitate decomposition of matter for organic manure. See video at link Insects for compost

Bokashi.

Bokashi fertilizer is a fermented organic soil amendment that functions as an inoculant and a fertility builder

Materials for making Bokashi

- **7 sacks manure:** you can use any kind of manure. A mixture of manures is best and it is better if the manure is dry. Manure provides nitrogen and other nutrients and is also a source of microbes.
- **7 sacks dry matter:** this can be husks from processing small grains, coffee husks, maize stover, dry leaves or even sawdust, rice husks. A mixture of materials is best. What's important is that the dry matter is cut up or broken up into small pieces.
- **sacks soil:** Soil is a good source of microbes for Bokashi. It can be clay soil or any available soil.
- **1 sack charcoal dust**. This provides a very good environment for microbes. You can make Bokashi without charcoal dust but it will give you a higher quality Bokashi.

- **1 sack bran:** Bran is the material that is taken off when grinding grain into flour. It is used for stock feed. You can use rice, wheat or maize bran. In a Bokashi heap bran is very good food for the microbes.
- **5L molasses:** Molasses is a good energy source for microbes. If you can't get molasses you can use 2kg sugar made into syrup (dissolve the sugar in water) but molasses is better and cheaper.
- **½ kg of yeast:** Baker's yeast is available in some shops. Yeast speeds up the fermentation process and helps the microbes to multiply fast.
- **Minerals:** These can come from ash, or bone meal. Generally, the more colour in the rock dust, the more minerals it contains.
- **Water:** This should be water that has no chlorine in it. If you only have water with chlorine in then you can leave it in the sun for a day to remove the chlorine. Getting the right amount of water is one of the tricks to making high quality Bokashi. You can only add water on the first day of making the Bokashi. You should never add water after that.

Procedure.

Choose a place that is in the shade and protected from rain. In the dry season make Bokashi under a shady tree. In the rainy season you will need to make some kind of cover to keep the rain off the heap.

Build a Bokashi heap in layers a few centimeters thick. Do this first without adding water, except for the water that you put with the molasses and yeast.

Making the heap

Start by making a layer of dry matter. Add a layer of manure and then layers of soil, charcoal dust and bran. In a separate bucket, mix 5L water with the molasses and yeast and stir well. Sprinkle some of this onto the heap after each set of layers.

Continue making sets of layers sprinkling the water/ molasses/yeast mixture onto them until you have used up all the materials. When the Bokashi heap is completed, it should not be more than about 1.2-1.5m high.

You may need to lower the height of the heap as the days go by, depending on what happens to the temperature.

Turning the heap

Next turn the heap so that all the layers become mixed together. As you are turning, sprinkle more water onto the heap. Be careful that you don't add too much water.

We recommend turning the heap 3 or 4 times until you have the right amount of water. By then all the materials will be very well mixed.

Testing the water content

Getting the right amount of water is important. To test whether you have added enough water, take a small fistful of the mixed Bokashi material in your hand and squeeze it.

If the material can't form a sausage shape when you roll it in your hands, then you have too little water. Do this test in a few different parts of the heap.

If there's not enough water, turn the heap again and sprinkle more water. If you have too much water, add more soil to the heap as you turn the heap again. Try to avoid having too much water it is better to have too little water than too much. After the first day you must not add more water to the Bokashi.

If water comes out between your fingers you have too much water.

Managing the Bokashi heap

You will probably need to turn your heap twice per day for the first 4 days or so depending on the temperature reached. Test the temperature by putting your hand into the heap. If you can leave your hand in there for about 10 seconds without burning your hands, (but only just), then the temperature is correct. For most people this will be about 55°C. The heap should not be hotter than this.

If you have to remove your hand quickly then the heap is too hot.

A well-made and well-managed Bokashi heap should not smell unpleasant and should not attract flies.

For the first four days, if the temperature stays up at around 50-55°C then turn the heap in the morning and evening. If the heap is too hot, then you should lower the height of the heap. If you think it is too wet and perhaps smelling off, then add more soil. Keep a written record of what you do to help you learn and become a better Bokashi-maker.

From the 5th days, turn the heap once per day. Keep checking the temperature — it should start gradually reducing. Continue turning the heap once per day until the temperature becomes the same as the surroundings.

This will usually be after 12-15 days after the heap was first made. You can now use the Bokashi.

Try to use Bokashi soon after you make it as it will be strongest. It's not a good idea to store Bokashif or longer than about a month. Store the Bokashi in a shady, rain free spot.

Using Bokashi

You can use Bokashi in a number of ways. It is half decomposed organic matter and the decomposition will continue to happen in the soil. This will stimulate lots of microbial activity. Bokashi is like a nest for microbes.

Bokashi can be applied to crops and is an excellent promoter of general soil health.

Vegetables: Bury handfuls of Bokashi in the following amounts in the soil near where you transplant or sow vegetables. It is better that the young plants' roots don't come into direct contact with the Bokashi.

• Leaf crops (such as Nakati, Sukuma wiki): one handful of Bokashi.

• Crops with a head such as cabbage: 2 handfuls.

• Crops with ongoing harvest such as tomatoes and egg plants: 3 handfuls.

Keep feeding plants with this amount of Bokashi every two weeks.

Fruit trees: When planting fruit trees, dig a hole of 60cm x 60cm x 60cm. Mix about 5kg Bokashi with the top soil and put this mixture into the bottom of the hole. Put the bottom soil back on top. Water and leave for a month before planting the fruit tree into the planting hole.

For fruit trees that are already growing, dig a shallow trench about 10cm deep around the tree, pour around 5-10kg Bokashi into the trench and cover with soil. Repeat this each year as you feel it is needed. **Field crops:** Bury one handful next to each plant station.

2.6 Integrated Pest and Disease Management (IPDM)

Agroecological farming approach emphasizes use of combined efforts to control and repel pests because equally they are also important in the ecosystem and if biodiversity balance exists, production can be done without chemicals in the system.

With IPDM, you take actions to keep pests from becoming a problem, such as by growing a healthy seed in a health soil to give a health crop that can withstand pest attacks, using disease-resistant plants (crops that are resilient). Rather than simply eliminating the pests you see right now, using IPDM means you'll look at environmental factors that affect the pest and its ability to thrive. Armed with this information, you can create conditions that are unfavorable for the pest.

Monitoring/Scouting

In IPDM, monitoring/scouting and correct pest identification is key for the farmer as it guides on the right decision to take in management of the pests and diseases.

Monitoring means checking your field to identify which pests are present, how many there are, or what damage inflicted and mode of feeding. Correctly identifying the pest is key to knowing whether a pest is likely to become a problem (beyond economic injury level) and determining the best management strategy. After monitoring and considering information about the pest, its biology, and environmental factors, you can decide whether the pest can be tolerated or whether it is a problem that warrants control. If control is needed, this information also helps you select the most effective management methods and the best time to use them.

What is a pest?

A pest is any living organism which adversely affects human activities.

What causes pests?

The history of pest management is a subset of the history largely of agriculture and while pests have been a chronic problem in agriculture since the beginning, many of today's serious pest problems are the direct consequence of actions taken to improve crop production. The intensification of agriculture has created new or greater pest problems in a number of ways:

1. **Monoculture.** Planting only a single crop in a bed (monoculture) encourages large numbers of pests to breed and spread. **Pests breed when they have a large area of their favourite type of crop growing. If many different crops are growing in a bed pests get confused**

2. **Use of Chemicals.**

   Insect Mutations. The use of agricultural chemicals has led to breeding of super pests which are resistant to many sprays.

Pest resurgence. Broad spectrum sprays kill off many useful predators which help control pests such as ladybirds, spiders, preying mantises, frogs, lizards and wasps.

3. **Change in weather patterns (Climate change).** Insect outbreaks, especially of migratory pests, are often associated with particular weather patterns, e.g. outbreaks of the desert locust and butterflies (Spodoptera spp.) The weather can also directly affect population development, if temperatures are favorable for population growth at an appropriate period during the insect's life cycle then outbreaks can occur.

4. **The search for better cultivars** and accelerated movement of plant material around the world and with it the movement of pests. Plant breeders, commercial importers, distributors of food aid and general commerce inadvertently introduce pest species.

5. **Attitude**

Integrated pest management (**IPM**), is a broad-based approach that integrates practices and measures of controlling pest populations below the economic injury level (EIL).

Methods used to control pests

1. Cultural methods (Culture; -way of life)

Good crop management is the best way to prevent pest and disease outbreaks in the first place.

Keeping crops healthy: enough nutrients and water so they use their own defences against pests. Too much water and chemical fertilizers make plants grow too fast and make them weak and susceptible to pest and disease attack. **Use healthy seedlings**. Collect your own seeds.

Some of the cultural practices include,

Crop rotation

Intercropping – (Push Pull technology).

Under this technology, one crop repels the insect and another attracts the insect. the insect repelling plant is usually intercropped with the main crop. as they pest is repelled away from the crop-repellant intercrop, they get attracted to another plant/crop usually planted at the boundary of the fields. Therefore, instead of the main crop being attacked by the pest, the pest settles on the attracting crops and this the main crop is saved.

e.g Use of *desmodium spp*. and elephant grass in the growing of maize. The *desmodium spp*. repels the insects and the elephant grass attracts the pest (stalk borers)

Timing of planting. Ensure that crops are planted at the correct time of year for their requirements. Planting crops at the right time enables the crops to benefit from the nitrogen flush, grows with vigor and be able to resist the invasion by pests. By the time the pest sets in, the crop would have in some cases reached maturity and thus the effects of the pest infestation does not reach economic injury levels. **Trellising.** Crops with weak herbaceous stems are normally supported by the farmers in order to access sunlight and bare fruits are required. Trellising supports/suspends the crop above the ground level and reduces the chances of pest affecting these crops.

Rouging: Destroying infected plant material. Diseased or insect infested plants are removed from the garden to avoid the spread of the disease or the multiplication of the pest to other crops. By doing this, the farmer reduces the chances of pest and disease spread to other crops in the garden. This can be done by uprooting, cutting down, etc.

Weeding. Weeds provides habitat for some pest and subsequently diseases which can attack the crop planted by the farmers. weeding at the right time enables the chance of pest infestation to be reduced. Since weeds compete with crops for nutrients, sunlight and growth space, keeping weed under control ensures that crops are healthy and able to resist invasion by pests and diseases.

Biological control

This means using other plants or animals to help control pests. This helps to create a natural balance between pests and other living organisms.

Predators (Predator attractants)

Ponds, bird baths, piles of rocks and bushes around the garden help attract predators like lizards, skinks, frogs, chameleons and birds which eat many insects. Fish and frogs eat many insect pests. Many predatory insects such as dragonflies lay their eggs in or near water. Encourage owls, which eat mice and rats. Banana groves attract bats which help control night-flying insects.

Livestock- Ducks and geese eat slugs and snails. Chickens eat many pests including grasshoppers, cutworms, caterpillars and bugs. They also remove weeds and eat weed seeds and improve soil with their manure. If fencing is available livestock can be kept and rotated in orchard areas. Predator insects include ladybirds, preying mantis, parasitic and predatory wasps.

Repellents

Strong-smelling plants such as marigolds, nasturtiums, basil, onions and garlic contain

chemicals that repel many pests. Eg control flies and mosquitoes around buildings, by planting rosemary, lavender and lemon grass on the edges of gardens or around the base of fruit trees. Prune the leaves for strong-smelling mulch. Sun hemp repels nematodes and improves soil. Vetiver and lemon grass repel soil insects and moles.

Trap crops

These are grown to attract pests to them and away from your main crop. Aphids will collect
on milkweed rather than on crops. Always leave some milkweed plants in vegetable beds. **(Push Pull technology to control striga and maize stem borers)**

Physical/ Mechanical control

Hand-picking pests

- Hand pick and feed to birds and animals

- Swarms can be removed by brushing plants with a soft broom.

- Squash them on the side of the plant. The smell repels other insects.

Mulching
Spiky grass or leaf mulch repels nematodes, cutworms, grasshoppers, ground beetles, termites, thrips, slugs and snails. Mulch made from clippings of strong-smelling plants such as herbs, Mexican marigold, Zumbani, lantana or gum trees repels insects. Ash deters ants which attack strawberries, beans and carrots.

Windbreaks
To stop the spread of flying insects and wind-borne pests, plant barriers and windbreaks of strong-smelling plants such as rosemary, lavender, and lemon grass around gardens and orchards.

Traps
-Light traps can be used to help catch night-time pests such as moths.

-Pheromone traps can be used in the management of fruit flies

Barriers

-Metallic cones on maize cribs

- Smear stems or trunks of plants with a ring of cooking oil or petroleum jelly to prevent insects from reaching the juicy tips leaves, or fruits of the plant.

Chemical methods

NB. Do not use synthetic chemicals but natural concotions

Instead of using chemicals that are detrimental to environment and human health; in combination with the above control methods, plant extracts/concoctions are used: -

a) Use of marigold

- ✓ Marigold is active against insect pests as a repellent and also controls nematodes. Usually at Namayumba, marigold is planted around vegetables gardens as a repellent to insect pests.

In a different form;

- ✓ Collect 3kg of marigold leaves/flower, pound and mix with enough water and cover them overnight.
- ✓ Strain through a cloth and make up to 18litres with water
- ✓ Add 9teaspoons (castile) hand soap, then spray

b) Use of baking soda

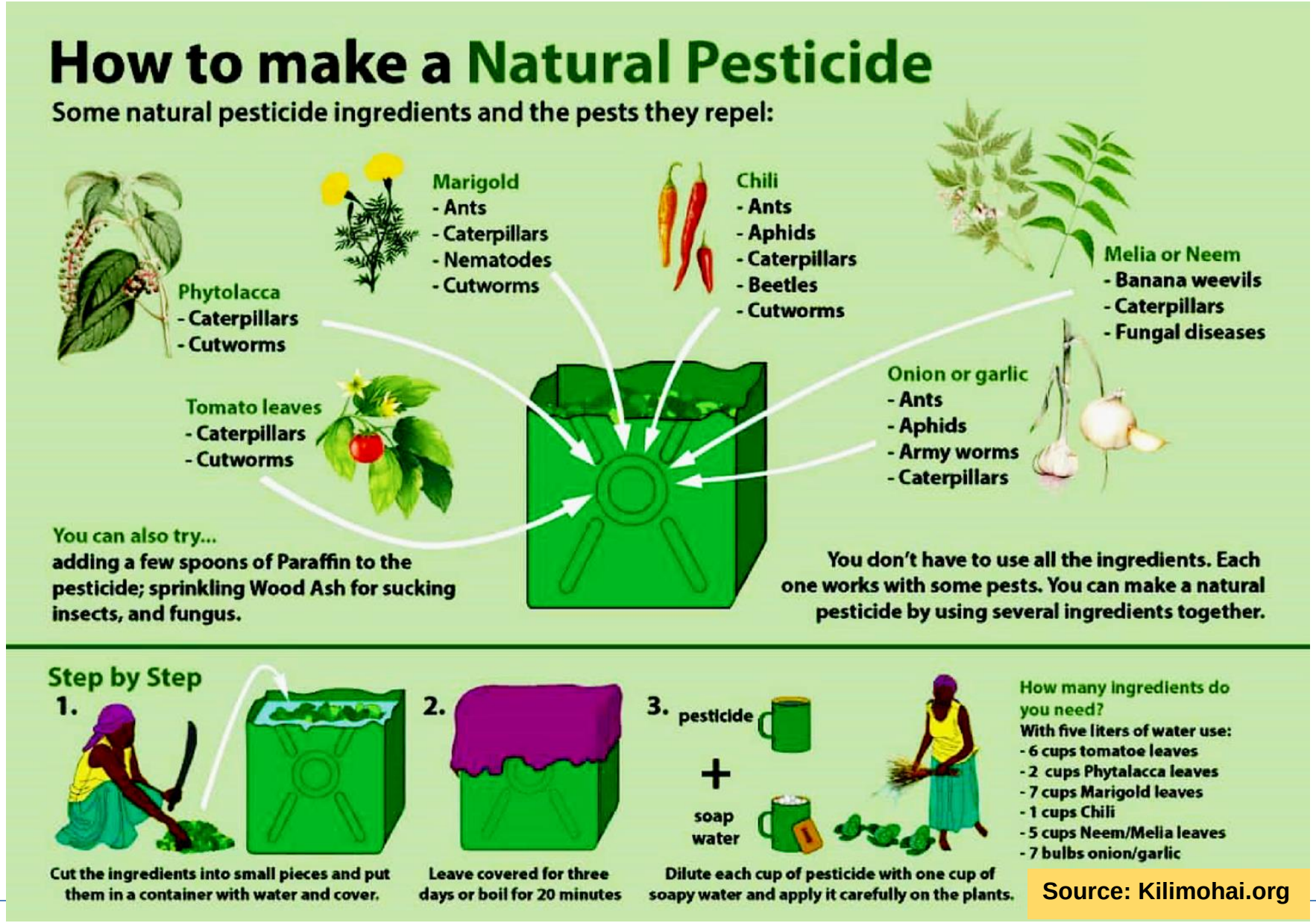
Baking soda is active against fungi and soft bodied pests on most plants but it's just protective not curative for fungi. The solution is made following the below procedures

- ✓ Baking soda is used at a rate of 1g/ltr.
- ✓ Boil 10 liters of water and allow it to cool to lukewarm temperate. Water is boiled to disinfect it from any fungal microorganisms that may be present before application to the target plant. For pest management other than diseases, water may not be boiled.
- ✓ Add 100g of baking soda and 2teaspoons of vegetable oil in the warm water. Steer the mixture well until it dissolves, leave it to cool and spray.
- ✓ Weekly sprays are effective. Do not let plants to be infested by the pathogens causing fungal diseases then

Chemical methods

NB. Do not use synthetic chemicals but natural concoctions

Below is an illustration of making some of the natural concoctions



Source: Kilimohai.org

Annex II. Table of more reading materials and stakeholders who can further support with Agroecology knowledge

#	Reference Material/Stakeholder	Content	Country
1	https://ylta.maps.arcgis.com/apps/MapSeries/index.html?appid=b1ec88e26b5741b5905a9e085a09c7b1	The YALTA story map has success stories of youths from the four countries in Agroecology agripreneurship	Rwanda, Kenya, Uganda and Ethiopia
2	FAO and INRAE. 2020. Enabling sustainable food systems: Innovators' handbook. Rome. https://doi.org/10.4060/ca9917en	This *handbook* provides advice in the form of tips, checklists, and matrices that will help local *food system innovators* to think more in (re)valuing agriculture in sustainable food systems, i.e. changing the way we produce, transform, transport, store, sell, and consume our food and agricultural products.	Rome
3	https://www.kilimohai.org/	Infographics on making organic manures and pesticides	Tanzania
4	https://www.fao.org/3/i9037en/i9037en.pdf	Elements of Agroecology in Details	
5	St. Jude Family Projects – Masaka	Has a training college and demonstration on Agroecology practices for both animal and crop Husbandry	Uganda

6	Uganda Martyrs University	Higher Level of learning Institution. Offer courses from certificate to Masters in Agroecology and Organic Agriculture	Uganda
7	Kulika Uganda	A centre of excellence in Agroecology and Organic Agriculture for both crop and animal husbandry	Uganda
8	Rural Community in Development - RUCID	Has a training college and demonstration on Agroecology practices for both animal and crop Husbandry	Uganda
9	Sustainable Agriculture Community Development Program (SACDEP- Kenya)	A centre of excellence in sustainable Agriculture focusses on Agroecology and Organic Agriculture for both crop and animal husbandry	Kenya
10	Baraka Agriculture College	Agricultural Training institute. Offers courses from certificate to Diploma in sustainable agriculture	Kenya
11	Kenya Institute Of Organic Farming (KIOF) https://www.kiof.net/	Provides Education in Organic Agriculture	Kenya
12	Resources Oriented Development Initiative (RODI- Kenya) https://www.rodikenya.org/	Train school pupils and prisoners in organic agriculture.	Kenya

13	National Organic Agriculture Movement of Uganda (NOGAMU)	Supports Organic Agriculture Value chain in Kenya from production to consumption	Uganda
14	Kenya Organic Agriculture Network (KOAN) https://www.koan.co.ke/		Kenya
15	PELUM Uganda	A network of civil society organizations working with small holder farmers promoting Agroecology	Uganda
16	PELUM Rwanda		
17	PELUM Kenya		Kenya
18	PELUM Ethiopia		Ethiopia
19	Movement for Ecological Learning and Community Action (MELCA) Ethiopia https://melcaethiopia.org/	Promotes ecological farming practices and technologies.	Ethiopia
20	Integrated Sustainable Development (ISD)		Ethiopia
21	Ethiopian Biodiversity Institute (EBI)	Plant Genetic Resources Centre, research on the proper conservation of Ethiopia's Biodiversity and associated indigenous knowledge	Ethiopia
22	Ethio-Organic Seed Action (EOSA)		Ethiopia
23	Rwanda Organic Agriculture Movement (ROAM)	Supports Organic Agriculture Value chain in Rwanda from production to consumption	Rwanda

24	Gako Organic Farming Training Centre	trains farmers in sustainable agriculture for sustained livelihood	Rwanda
25	PELUM Rwanda	A network of civil society organizations working with small holder farmers promoting Agroecology	Rwanda
26	Rwanda Institute of Conservation Agriculture https://www.rica.rw/	Offers courses in conservation agriculture	Rwanda