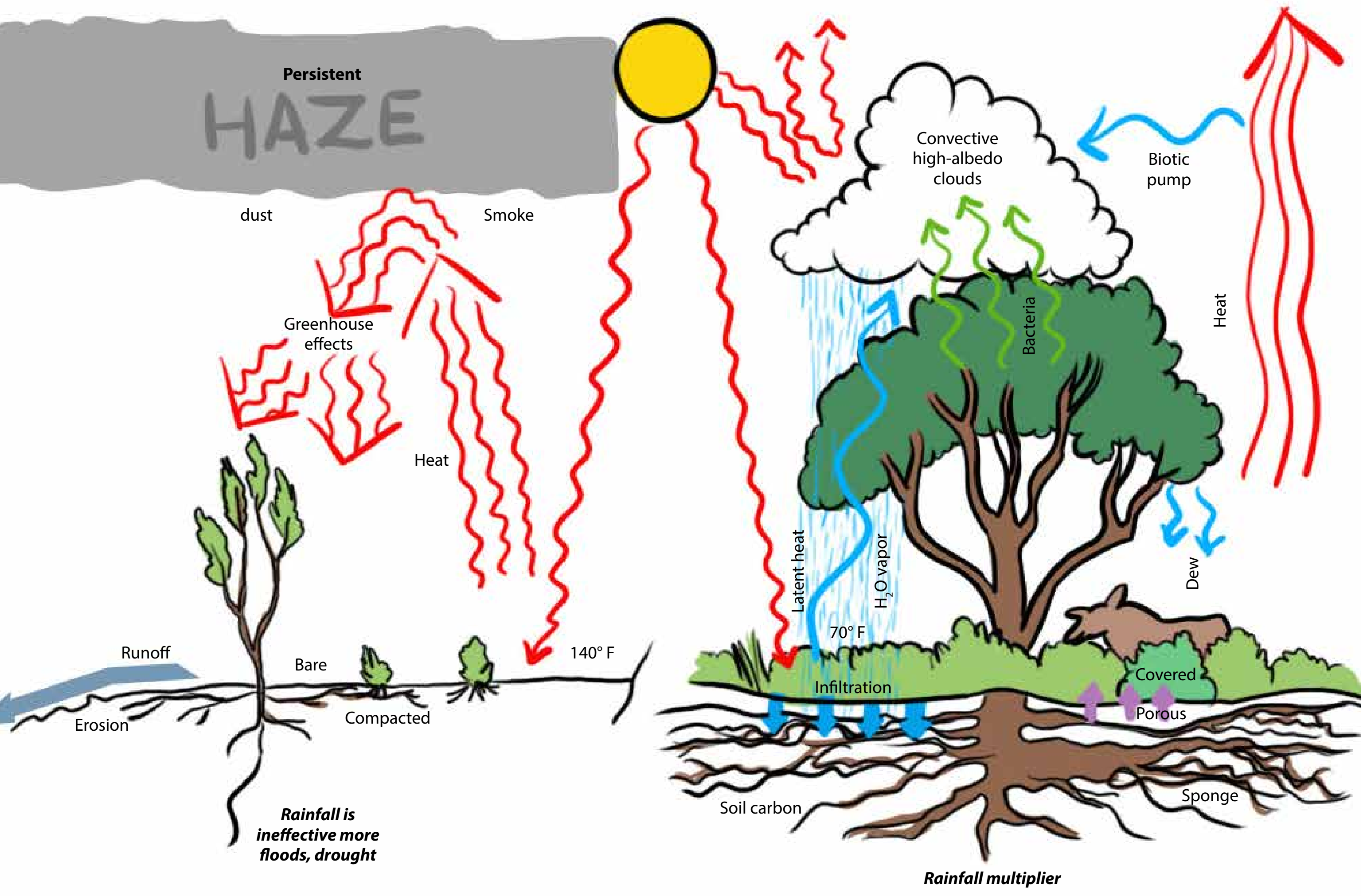
Healthy Soil for Healthy Communities

An Introduction to Soil Health Practices for Africa

AFSA
ALLIANCE FOR FOOD SOVEREIGNTY IN AFRICA

SKI
Seed and Knowledge Initiative



Adapted from: "Recognizing the Soil Sponge" by Peter Donovan, SoilCarbonCoalition.org

CONTENTS

Published by AFSA and SKI 2021

ISBN: 978-9970-595-12-9

The African Food Sovereignty Alliance (AFSA) and the Seed and Knowledge Initiative (SKI) would like to thank Anna Brazier for recording the learning and sharing sessions and developing the draft of this book and Sandra Hill for doing the copy editing. We would also like to thank the following for their contributions: Batamaka Somé, Didi Pershouse, Gerry Gillespie, John Wilson, Peter Gubbels, Precious Phiri, Stéphanie Aubin and Swati Renduchintala. Lastly, we would like to thank all the presenters and participants of the Healthy Soil Healthy Food online sessions held between September and December 2020.

ACKNOLEDGEMENTS

The **Alliance for Food Sovereignty in Africa** (AFSA) is a broad alliance of civil society actors who are part of the struggle for food sovereignty and agroecology in Africa. AFSA brings together farmers, pastoralists, fishers, indigenous peoples, faith groups, women's movements, youth, and consumer associations from across Africa to create a united and louder voice for food sovereignty. It is a network of networks operating in 50 African countries.
https://afsafrica.org/

The **Seed and Knowledge Initiative** (SKI) is a dynamic partnership of diverse Southern African organisations committed to securing food sovereignty and agroecology in the region. SKI partners work with smallholder farmers to become more seed, food, and nutritionally secure through farmer-led seed systems, improved crop diversity, and the revival of local knowledge systems within the context of supportive agricultural, cultural and ecological practices. While the partnership has relationships with several organisations and individuals all over the world, its primary stakeholders are the farmers in Malawi, South Africa, Zambia, and Zimbabwe SKI partners work with.
https://www.seedandknowledge.org/

SKI and AFSA gratefully acknowledge financial support for this publication from SwedBio, Bread for the World (BfdW) and the Swiss Agency for Development and Cooperation (SDC), whose official policy and position is not necessarily reflected in the views and opinions expressed herein.

SwedBio
A programme at Stockholm Resilience Centre

breadfortheworld
HAVE FAITH. END HUNGER.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

Our life support system is dying because humans have disconnected from the web of life. This is evidenced by multiple crises manifesting as poverty, food insecurity, land degradation, climate change, and biodiversity loss.

Various initiatives within the agroecology movement have opened my eyes to these contemporary challenges, particularly related to how we produce food. Industrial agriculture has failed us and is causing untold destruction in its wake, damaging our life support system and exacerbating the challenges smallholder farmers and the communities who depend on them face. Degraded soil is a case in point: poor soil health erodes farmers' capacity to produce sufficient, nutrient-dense, and diverse food in a system that is in harmony with nature.

Smallholder farmers and civil society organisations that I interact with concur that building soil fertility is key to achieving food security and better livelihoods. While a lot of work has been done to address soil fertility, there seems to be little understanding of what it takes to regenerate soils so that we can rebuild the foundations of a healthy ecosystem.

In 2020 I was excited to learn how SKI and AFSA collaborate to fill this gap. Together they support various training initiatives aimed at improving soil health in Africa. This book, emanating from one such collaboration, the Healthy Soil Healthy Food initiative, is a gift for our times and a fountain of wisdom on building soil health. It is intended to broaden our perspectives and deepen our understanding of the need to bring life back into Africa's degraded soils.

As Coordinator of a network organisation, I have seen the huge value of bringing like-minded individuals and organisations together to learn from each other. By getting 15 soil health improvement centres from across Africa together, SKI and AFSA are tapping into the power of networks to transform communities. I am confident of the creative and innovative work that will emerge from this process.

By offering us this book, SKI and AFSA remind us of the great work of reconnecting to the web of life that lies ahead.

Gertrude Pswarayi-Jabson
SKI Steering Committee Chair
PELUM Zimbabwe Country Co-ordinator

FOREWORDS

Some two decades ago, I was responsible for establishing the Tigray project to demonstrate sustainable farming's effectiveness compared to high input agriculture. The project had five years, and I was using Participatory Rural Appraisal techniques for my assessment. During one data collecting exercise, as I walked with farmers across their land, I asked them about the local names of the soil, what they planted in it, were there pests associated with each type of soil, and whether each soil had a different water-holding property. The farmers showed me nine kinds of soils, each with its own name. Each of the soil types suited particular crops and were vulnerable to specific pests. I was astounded by the farmers' knowledge. It proved to me that farmers know their soil. My research has also shown me that farmers can increase their productivity and crop diversity and improve their livelihoods and family's nutrition with the right kind of support from government and external actors. What we called sustainable agriculture at that time and what we now call agroecology works.

This book is a treasure trove of cutting-edge soil science, soil-improvement practices and farmers' stories. It has testimonies of the future of agriculture and food. If there is one thing the COVID-19 pandemic has shown us, it is the need to be self-sufficient. When lockdowns and disruptions to food trade hit the world, it was mainly those who could support themselves that best survived. For those in rural areas, the message is clear: build your soil and build it urgently. This book is a massive help in that direction.

This book is also ammunition in our struggle against the corporatisation of our food. Those in power are using the climate crisis and the COVID-19 pandemic to push failed and untested farming technologies in Africa. The core of the industrial agriculture paradigm is increasing productivity using agrochemicals and hybrid seeds. The failure of AGRA (Alliance for a Green Revolution in Africa) shows this does not work. It is only practices and experiences such as those documented in this book that can take us out of our predicament.

I wish you to dive into this sea of tested knowledge and practice and be part of the struggle to own our lives and our future.

Dr Million Belay
AFSA General Coordinator

INTRODUCTION

There is a growing awareness across Africa that we need to dramatically improve the health of soils if we are to produce nutritious food and use water sustainably. This realisation follows a 20th century in which the state of soil-ignored by most 'modern' farming practices and further damaged by climate change-has declined at an alarming rate.

The first step in beginning a soil regeneration process is to shift mindsets — to unlearn the ways we think about soil-or indeed-fail to think about soil.

This publication is not a technical book. Instead, it aims to help people move towards this mindset shift. The first chapter on soil is the bedrock of the whole book. It presents the kind of understanding of soil needed if we are to have any chance of successfully regenerating soils. The chapters that follow present practices that can help farmers transition to agriculture that prioritises soil health and is in greater harmony with nature. There is a list of references at the end of each chapter and a short glossary at the end of the book.

The book has been made possible by the Healthy Soil Healthy Food (HSHF) initiative, jointly established by AFSA and SKI. This initiative has brought together 15 soil regeneration organisations working closely with smallholder farmers across the continent. Given COVID-19 risks and restrictions, the HSHF initiative held 12 online learning and sharing sessions from September to December 2020, during which the practices outlined in this publication were presented and discussed. The content of the book draws heavily on this material.

Please share this publication and spread its messages as widely as possible. We need people everywhere in Africa and elsewhere to understand the why and how of soil regeneration and promote and practice the principles of good soil care.

1

Down to Earth: An Introduction to Soil

This chapter is based on a learning and sharing session facilitated by Didi Pershouse.

***Didi Pershouse** is an independent trainer whose work shows the relationships between soil health, human health, water cycles, and climate resiliency. She is a curriculum developer for the United Nations' Food and Agriculture Organization (FAO) Farmer Field School Program and the Andhra Pradesh Community-managed Natural Farming Initiative in India.*

Didi is the author of The Ecology of Care: Medicine, Agriculture, Money, and the Quiet Power of Human and Microbial Communities; Understanding Soil Health and Watershed Function; and lead author for the "Future Directions" chapter of the UN-FAO Technical Manual on Soil Organic Carbon Management.

Few things are as important and as overlooked as soils. Yet without them, you'd have nothing to eat. Not only that, but you'd also lose fodder, fuel, building materials, and several essential, life-sustaining services only soils provide. Consider: Soils store water and food for plants, prevent flooding by slowly feeding streams and groundwater, moderate temperatures, filter pollutants, recycle carbon, prevent leaching, and provide a home for 1000s of living things.

Our life on Earth depends on the life and health of our soils. And although no aspect of human life is more dependent on soil than agriculture, agriculture is ironically the soil's biggest threat.

For thousands of years, most human societies developed through agriculture—the cultivation of soil to raise crops and livestock. This gradually changed the Earth's landscapes, soil, water, atmosphere, and even climate. In the past fifty years, the pace of this change suddenly increased, seriously threatening the natural world and human societies. The industrialisation of agriculture that began in Europe and America after the Second World War was taken to developing countries in the 1960s to ensure food security and end world hunger. A range of new farming products and techniques was rolled out, including hybrid seed and livestock breeds; synthetic pesticides, herbicides and fertilisers, ploughing; large-scale irrigation; and crop processing. But in many cases, industrial agriculture achieved just the opposite while also destroying soils, damaging ecosystems, and escalating climate change. The Intergovernmental Panel on Climate Change estimates that 23% of greenhouse gas emissions result from land clearance, crop and livestock production[1].

[1]*IPCC, 2019. Summary for Policymakers. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.- O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press. https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf. Pg 8.*

SYNTHETIC FERTILISERS

Most synthetic fertilizer applied to soils are developed to feed plants with only three minerals: nitrogen, phosphorus and potassium. However, there are serious disadvantages to using them. Because of the focus on nutrients that make plants grow quickly, other nutrients are steadily depleted. Synthetically fertilised soils often become deficient in several micro-nutrients and so does the food produced from them. This could be one reason why the nutrient content of many foods is declining.

It is easy to over fertilize plants causing them to grow too quickly and become weak and susceptible to pests and diseases. These nutrients (nitrogen, phosphorus and potassium) cannot be stored in the soil. Nitrogen is easily leached into water so contributes nothing to long term soil fertility or soil structure. It also acidifies the soil, degrades organic matter and pollutes water systems.

Synthetic fertilizers are expensive and often have to be state subsidized. The production and transportation of fertilisers uses a lot of energy, producing greenhouse gases which cause climate change. Most importantly the use of synthetic fertilisers damages soil organisms particularly microbes on which soil health depends. Farmers who want to transition from conventional farming to agroecology have many ecological options available to restore their soils to their natural well-functioning state.

MONOCULTURES AND THE LOSS OF DIVERSITY

Diverse farming systems that included annual and perennial crops in small fields integrated with livestock were gradually replaced by large-scale cultivation of a single crop (such as maize) or intensive animal production on a farm, area, or even an entire country. The United Nations' Food and Agriculture Organization (FAO) estimates that about 75% of the genetic diversity of crops has been lost since the beginning of the 20th century [2]. Diverse systems are more resilient to shocks such as drought, pests, and diseases. Monocultures are vulnerable to shocks and rely heavily on expensive inputs such as synthetic fertiliser, often driving farmers into debt.

INDUSTRIAL AGRICULTURE JEOPARDISING HUMAN HEALTH

Industrial agriculture has also impaired human health. Many scientists and lay-people blame pesticides and herbicides for the global rise in food allergies and intolerances, autoimmune diseases, and cancers. Industrial agriculture has also led to a change in diets characterised by higher consumption of simple carbohydrates and industrially raised meat, and lower consumption of fruit, vegetables, legumes, root and tuber crops, herbs, fermented foods, and wild or grass-raised animal products. A global rise in obesity, diabetes, cardiovascular diseases, and some cancers has been coupled with vitamin and mineral deficiencies typical of a diet limited in this way. One example is the high prevalence of iron-deficiency anaemia, affecting millions of children and women of reproductive age.

[2] *Food and Agriculture Organisation to the United Nations, n.d. What is agrobiodiversity?* http://www.fao.org/3/y5609e/y5609e02.htm#TopOfPage

A WAR ON SOIL

Industrial agriculture tends to treat soil as an inert medium for growing plants rather than as a complex living system maintained by billions of organisms. Ploughing, agricultural chemicals, and bare fallow have almost destroyed the biological processes that stabilise soil structure and maintain its fertility, temperature, and water-holding capacity. This makes soil vulnerable to erosion and highly dependent on a cocktail of synthetic chemicals to maintain production levels. A three-year study published in 2018 concluded that 75% of the Earth's land areas are substantially degraded, undermining the well-being of 3.2 billion people[3]. The study warns that 95% of the Earth's land could be degraded by 2050, forcing hundreds of millions of people to migrate as food production collapses. In his book, Dirt: The Erosion of Civilisations, David Montgomery shows how throughout history, civilisations have collapsed due to neglect of the soil. In the past, people could settle in new territories- but today there is no new land to exploit[4].

Our life on Earth depends on the life and health of our soils

AFRICAN SOILS

The Soil Atlas of Africa shows that most African soils are fragile and often lack essential nutrients and organic matter. About half the continent's land is arid or desert, and much of the remainder has old, highly weathered soils with high acidity levels that require careful management[5]. The most recent assessment of soil degradation in Africa (1991) found that 227 million hectares (16%) of the continent is affected by water erosion, while wind erosion affects 186 million hectares, loss of nutrients affects at least 45 million hectares, and soil salinisation affects around 15 million hectares. About 26% of African soils are vulnerable to desertification caused by climate change or human mismanagement, such as deforestation, overgrazing, and soil structure deterioration[6].

[3] *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2018. Assessment Report on Land Degradation and Restoration.* https://www.ipbes.net/assessment-reports/ldr

[4] *Montgomery, D. 2007. Dirt the Erosion of Civilizations. University of California Press.* https://www.amazon.com/Dirt-Civilizations-David-R-Montgomery/dp/0520248708

[5] *Jones, A., Breuning-Madsen, H., Brossard, M., Dampha, A., Deckers, J., Dewitte, O., Gallali, T., Hallett, S., Jones, R., Kilasara, M., Le Roux, P., Micheli, E., Montanarella, L., Spaargaren, O., Thiombiano, L., Van Ranst, E., Yemefack, M., Zougmoré R., (eds.), 2013, Soil Atlas of Africa. European Commission, Publications Office of the European Union, Luxembourg. 176 pp* https://esdac.jrc.ec.europa.eu/content/soil-map-soil-atlas-africa

[6] *Jones, A., Breuning-Madsen, H., Brossard, M., Dampha, A., Deckers, J., Dewitte, O., Gallali, T., Hallett, S., Jones, R., Kilasara, M., Le Roux, P., Micheli, E., Montanarella, L., Spaargaren, O., Thiombiano, L., Van Ranst, E., Yemefack, M. , Zougmoré R., (eds.), 2013, Soil Atlas of Africa. European Commission, Publications Office of the European Union,*

Plants feed the soil and the soil feeds plants in a symbiotic exchange

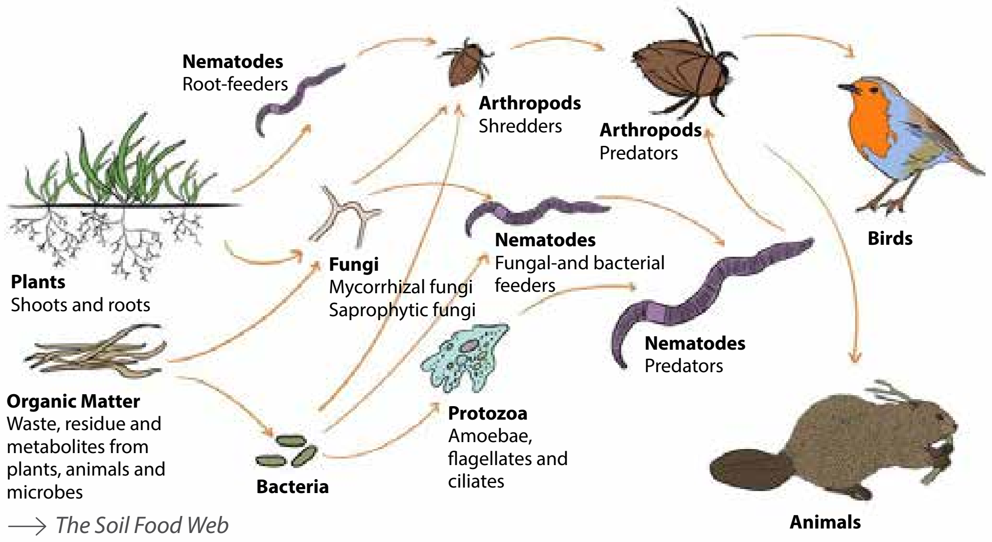
SOIL MICROBES

Although they are tiny, soil microbes such as bacteria, fungi, and viruses are the most important part of the soil food web. In one handful of soil there are more microbes than there are people on the planet. Microbes help water infiltrate into the soil, maintain soil structure, water-holding capacity and make nutrients available to plants.

LIVING SOIL

The soil is a natural system made up of living and non-living parts. The non-living parts include rock particles, water, and air. The living part includes plant roots, fungi, invertebrates, and billions of microbes.

All living things in the soil interact in a complex food web. Plants use the sun's energy, water, and carbon dioxide from the air to produce their food-sugars and carbohydrates-and feed close to half of it to the soil's microbes in a kind of nutritious syrup known as root exudates. In return, these microbes maintain soil health and make minerals, nitrogen, and water available to plants. In this way, plants feed the soil, and the soil feeds plants in a symbiotic exchange.



→ *The Soil Food Web*

SOIL TYPES

There are different types of soil broadly categorised according to the size of their mineral particles. Clay soil has the smallest particles and is good at storing nutrients and water. It is heavy to work and tends to become water-logged. Sandy soil is made up of large particles with large spaces in between them. Sandy soil is poor at storing water and nutrients but is easy to work. Soil with medium-sized particles is known as silt. The ratio of sand, silt, and clay in soils influence soil texture and water holding capacity. Loam soil has a balance of sand, silt and clay that is considered ideal for agriculture.

SOIL FORMATION

Soil is formed in layers. At the surface of natural soil is a layer of dead, decaying leaves called duff. Below this is the topsoil which is usually dark in colour and contains organic matter and large fungi populations. Below this is the subsoil layer which is paler and contains more moisture. And further below this layer is bedrock.

ORGANIC MATTER

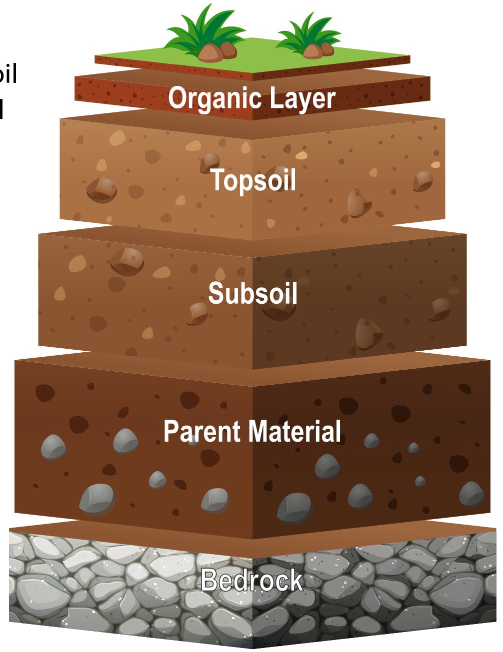
Many processes that maintain soil depend on organic matter. Organic matter provides food for microbes and improves the soil's ability to store nutrients and water. The duff layer is broken down by various soil creatures (including arthropods, earthworms, and fungi) to form a dark, stable substance called humus. Nutrient particles become stuck to the humus and stored in the soil. With the help of microbes, plant roots can retrieve the nutrients from the soil when they are needed.

SOIL STRUCTURE

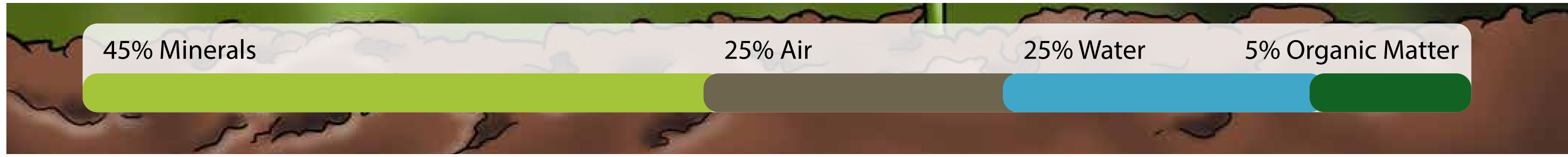
Ideally, soil should be about half solid (including living organisms and soil particles) and half tiny spaces containing water and air. Well-structured soil has a crumbly, spongy texture that makes digging easy. It can soak up water like a sponge and does not fall apart when it is wet or when the wind blows.

The sponge-like structure is constantly created by life in the soil:

- Plant roots, bacteria, fungi, and worms make slimes and glues that stick soil particles into clumps called soil aggregates, leaving space for air and water in between;
- Plant root hairs and fungi tie those clumps together with tiny threads, strengthening the structure;
- Roots, worms, insects, arthropods, and nematodes make tunnels and spaces through the soil.



→ *Typical Soil Composition*



> *Soil is the foundation of life. Our life on Earth depends on the life and health of our soil. No aspect of human life is more dependent on soil than agriculture. A farming system that doesn't care and nourish the soil will collapse agricultural productivity and contribute to climate change.*
>
> ***Dr Million Belay, General Co-ordinator of AFSA***

Soil life needs the air and water that collect in the spaces between aggregates. Ploughing destroys aggregates and collapses the spaces for air and water, disrupting the habitat of micro-organisms. Without these aggregates and the pore spaces between them, rainfall mostly runs off rather than infiltrating the soil. This leads to flooding, soil erosion, and reduced water in soils-ultimately causing drought and desertification.

SPONGE EXPERIMENT

You can get an idea of the function of the soil sponge by doing a flour and bread experiment: Put a pile of wheat flour on a plate. Put two slices of bread, one on top of the other, on another plate. Take a cup or plastic bottle and make small holes in its base so that if you pour water into it, it comes out like rain. Make rain over the two plates. You will notice that when you water the pile of flour, the water does not penetrate easily but flows over the surface, causing flooding and erosion, and the edges of the plate become filled with cloudy water. This is what happens in degraded soil where the aggregates are not held together because the living organisms have been damaged by tillage, chemicals, or other stresses.

On the other plate, you will notice how the water soaks into the bread slices as if they were a sponge. Eventually, water flows down through the bread and comes out onto the bottom of the plate-but the water is clear and does not contain any bread particles. This is how well-functioning soil looks and behaves. When rain falls on healthy soil, it sinks into the earth, supplying plant roots, soil life, and refilling natural springs and wells for humans and animals.

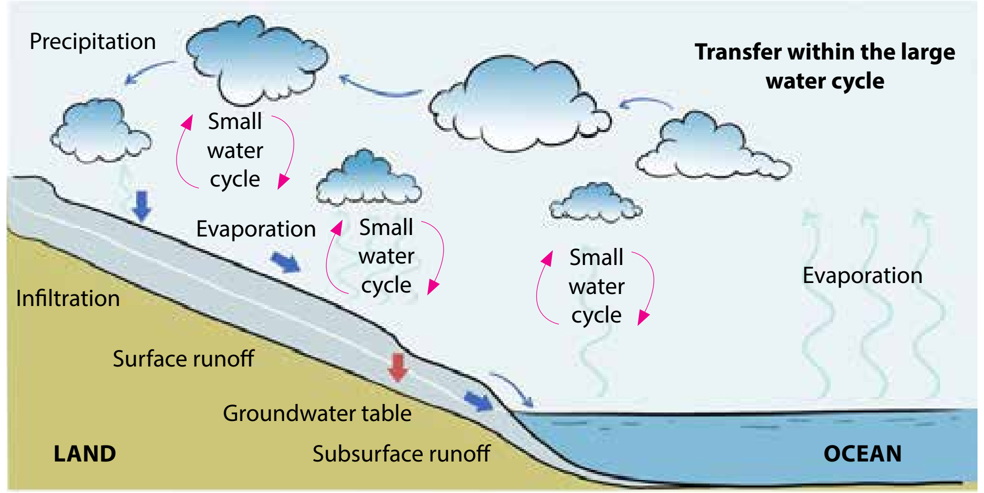
HEALTHY SOIL

Soil health is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans[7]. A healthy soil maintains the biodiversity of plants, animals, and other living creatures. It stores a wide variety of nutrients for plants and makes them available when needed while preventing loss of nutrients due to leaching. These nutrients create more resilient plants that resist pests and diseases. The plants are more nutritious to people and other animals that eat them. Soil can also store large amounts of carbon dioxide, one of the major greenhouse gases responsible for climate change. Plants and soil microbes remove carbon from the atmosphere and turn it into carbon compounds stored in various organic materials in the soil.

Healthy soil can also help farmers adapt to unfavourable climatic conditions. Well-structured soil filters and cleans water as it flows underground into springs, wells, streams, lakes, and rivers. It helps water infiltrate, reducing run-off and replenishing the underground water store. Healthy soil maintains its structural integrity limiting erosion, which reduces dust pollution, and keeps rivers clean. This helps protects land from the worst impacts of drought, floods, and cyclones.

HEALTHY COMMUNITIES

It is well-accepted that human health depends on a balanced, diverse, and nutritious diet, but it is only recently that the connection has been made between healthy soils and healthy communities. The food we eat provides us with the nutrients we need to grow, work and think. Nutrients also play an essential role in maintaining the immune system, protecting us from disease, and helping the body to maintain and repair itself. Almost all our food comes from plants, or animals that eat plants, and is therefore produced through the soil. Because of this, the way we treat the soil has a direct impact on our health.



Big and small water cycles

Credit: Adapted: from Water for the Recovery of the Climate - A New Water Paradigm by M. Kravcík, J. Pokorný, J. Kohutiar, M. Kovác, E. Tóth, 2007, page 20

[7] The United States Department of Agriculture's Natural Resources Conservation Service https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/

LINKS BETWEEN THE SOIL AND THE WATER CYCLE

There are two kinds of water cycle-a big one and a small one. The big water cycle brings water from the oceans to the land. But there are also small water cycles everywhere. In a healthy, inland environment, away from the sea, up to 40% of rainfall comes from transpiration from plants and inland water bodies. If the soil is healthy its structure will allow vast amounts of rainwater to infiltrate instead of running off. This gives plants a good supply of water over a long period, especially if the ground is also covered. Any extra water goes underground and can be accessed by wells and boreholes, or into streams and rivers and can be used by plants and animals. Getting water into the soil is the beginning of land recovery. It depends on the health of the soil, and the extent that it is covered by plant life. The less trees, grasses, crops and other plants, the less water is absorbed from rain. Furthermore, tiny bacteria being carried up into the sky from plant leaves create surfaces on which water vapour condenses into raindrops. Healthy landscapes thus help create their own rain.

WAYS TO MANAGE THE SOIL

Healthy soil is the foundation of nutritious food production

Nutritious and good quality food and animal fodder can only be produced if our soils are healthy. Healthy living soil is, therefore, a crucial ally to food security and nutrition.

FAO 2015

Fundamental soil management principles:

Instead of trying to amend the soil for agriculture, our focus should be on regenerating the soil into a thriving, natural system. The first step is to get to know your land-find out about the type of soil in your area and what it needs to become healthy. When working with soil, follow these core principles:

- Disturb the soil as little as possible, avoiding excessive turning, digging, and ploughing (see Chapter 4);
- Encourage a diverse range of plants (see Chapters 4, 5, 6);
- Keep living roots in the soil as much as possible (see Chapters 4, 5, 6);
- Keep the soil covered with living plants or their residue at all times (see Chapters 4, 5, 6);
- Avoid synthetic inputs (see Chapters 2 and 3);
- Integrate grazing animals and their urine and dung (see Chapter 7).

These core principles are rooted in agroecology-a combination of ecology, the science of how organisms interact with one another and with their physical environment, and agriculture. At heart, agroecology is a holistic, environmentally and socially aware approach to farming, concerned with the production of food and preserving natural resources, the sustainability of land-use systems, and the communities that depend on them.

Agroecology is also an integrated science considering agronomy, ecology, sociology, economics and politics, from the local to the global level. And lastly, agroecology is also a movement of like-minded people who aim to transform food systems and societies towards increased sustainability and food sovereignty.

This book looks at various possible agroecological ways to manage the soil in Africa. Many of these approaches involve feeding and nurturing soil micro-organisms, using compost, biofertilisers, bio-stimulants, bio-inoculants, or even living plants and animals to improve content and structure. We also present approaches that bring these different methods together to be used by large numbers of farmers, such as the Community-managed Natural Farming approach from India and the Participatory Farmer Research approach initiated by the Collaborative Crop Research Program of the McKnight Foundation.

RESOURCES

Nichols, K., 2011. The Biology of the Soil. https://vimeo.com/21310772
Stika, J., 2016. A Soil Owner's Manual: How to Restore and Maintain Soil Health.
Pershouse, D., 2017. Understanding Soil Health and Watershed Function. A Teacher's Manual.
https://www.landandleadership.org/soil-health-manual.html
http://www.fao.org/agroecology/knowledge/definitions/en/
http://www.fao.org/agroecology/knowledge/10-elements/en/
Soil Health Human Health Conference 2018 Soil Health Institute/ https://www.youtube.com/watch?v=igczuA_cX4w&list=PLdFVkeklZuqzXJwiWGU2j1WjiA2F5daFP&index=2

Agroecology is the future to cool the planet, nourish our soils and feed the world with healthy and nutritious food.

Dr Million Belay, General Co-ordinator of AFSA

The Art and Science of Compost-Making

2

This chapter is based on a learning and sharing session facilitated by SAT with input from Gerry Gillespie.

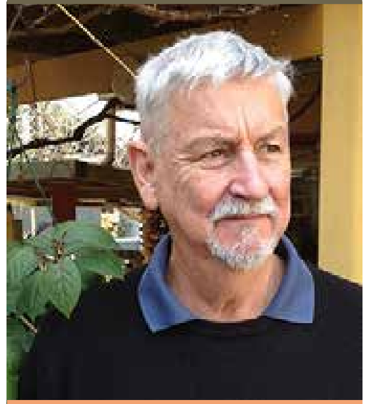
As soils have become stripped of organic matter through ploughing, deforestation, burning to clear fields, and the use of synthetic fertilisers, they have lost the ability to store water and nutrients and no longer provide an attractive habitat for soil organisms. Compost is key to restoring what has been lost.

WHAT IS COMPOST?

Compost is a cheap, easy-to-make, natural food for your soil-an organic fertiliser. It is a dark and crumbly material made up of old plant and animal matter that is so decomposed you cannot recognise the original ingredients.

Composting has been practiced across the world for thousands of years. It involves making a heap from carefully selected organic materials (like food scraps, leaves, and animal products) and adding water. The decomposition of material occurs through the action of micro-organisms in two phases. First, certain organisms break the material down into simpler components. Then other organisms bind the material into stable substances that prevent them from being lost to air or water. Composting is faster, reaches higher temperatures, and results in a higher quality product than decomposition in natural conditions. The high temperatures generated during composting kill pests, diseases, and weed seeds.

Compost is rich in nutrients, organic matter, and micro-organisms. It improves the fertility, water-holding capacity, and structure of the soil and also balances soil pH with effects that are much longer-lasting than those of synthetic fertilisers. Compost saves farmers money because it can be made using locally available materials. Many people make compost, but often it is of low quality and therefore not an effective soil conditioner. This is because proper compost-making can be labour-intensive and needs attention to detail. Also, people in many African farming communities



***Gerry Gillespie** has been involved in organic materials recovery and reuse in soils for 30 years in Australia and other countries. He helped refine the SPICE composting method, an inoculant-based, odour-free, no-turn compost process based on the work of M. E. Bruce and Sir Albert Howard.*
Gerry works as an Organics Consultant to local business, farmers groups and councils.

***Sustainable Agriculture Tanzania (SAT)** is dedicated to promoting agroecology among Tanzanian smallholder farmers to improve their livelihoods, conserve the environment and reduce pressure on natural resources. SAT promotes compost-making and use through farmer-field schools. https://kilimo.org.*

lack a wide range of materials and water, especially during the dry season. However, by paying attention to the principles of compost making, a high-quality product can be achieved in a short space of time.

TYPES OF COMPOST AND HOW THEY ARE MADE

There are many different types of compost made in many different ways:

CONTINUOUSLY FED PILES: These do not heat-up much and take a long time to decompose as material is continuously added to the piles. They are useful for getting rid of waste but can attract rats and flies and do not give a high-quality product.

PIT COMPOST: If little water is available, composting in pits may be best since moisture is conserved better in pits than in heaps. However, the lack of air created by the pit may slow down the composting process, and the pit makes turning the compost difficult.

VERMICOMPOST: Earthworms are used to decompose the material, which speeds up the composting process producing a high-quality product.

THERMAL COMPOST: Raw organic materials are collected and then layered into a heap. Once the heap has been made, no extra material is added unless needed to correct a problem, such as lack of air or too much nitrogen, which causes the heap to smell bad.

Thermal compost goes through three phases of decomposition-the first phase happens during the first day or two as temperatures begin to rise. The second phase of very hot temperatures lasts several days to a week. During the last phase, temperatures start to reduce again. To speed up the composting process, the heap should be turned as often as possible (preferably daily but at least weekly) to mix the different layers. If turned regularly, thermal compost can be ready to use in under two months. After the active composting process, the material goes through a curing phase where it stabilises into material that can be stored under-cover for several months before use.

TIPS FOR MAKING THERMAL COMPOST

Getting the right balance or ratio of green to dry materials is important for the composting process to work well. The heap should be about 30 parts carbon-rich material (dry grass, straw, dry leaves, maize stalks, groundnut/cowpea shells) to one-part nitrogen-rich material (green leaves, grass, weeds, kitchen waste, livestock manure).

Using a wide variety of materials helps to produce a better product. You can add phosphorus-rich material such as bone meal, rock phosphate, sea bird or bat manure, tithonia sp. and amaranthus sp. leaves and calcium-rich material such as shells, bone meal, hooves, horns and lime. Processing them through a compost heap makes them more biologically available to plants than if you apply them directly to the soil.

Having the right amount of water in the heap is very important. Too little water and the compost does not heat up, while too much water prevents the microbes from breaking down the material and causes bad smells. An effective way to make sure there is enough water in the heap is to dip the materials in a drum of water before adding them to the heap.

Compost should be seen as more than a way of adding nutrients to the soil. Properly made, mature compost acts as a microbial inoculant that can ultimately improve crop growth much more than by adding nutrients to the soil.

Gerry Gillespie

HOW THE COMPOST SPICE RETAINS MOISTURE

To increase water retention a dip is made in the cover at the top of the pile. The breakdown of materials causes respiration which increases moisture content. The moisture moves towards the top of the pile on the inside of the cover and drops back into pile thanks to the dip. Intense biological activity during the fermentative second stage means output from one process is input for another. This means no gas and no odour from the heap.

STATIC PILE INOCULATED COMPOST EXTENSION (SPICE): The SPICE composting method was developed in Australia to process large amounts of organic waste in urban areas. It has been successfully taken to many countries across the globe, including countries in Africa. The SPICE method is similar to thermal compost but instead of turning the heap for aeration, the heap is covered to prevent moisture loss and reduce air entering the heap. The heap is also inoculated with specialised microbes using simple methods such as the one described below. The composting process uses an initial aerobic phase (with air present) and a fermentation phase with low oxygen levels. The end-product is a dark-brown compost with high levels of humus. This method's benefits include that it saves labour and water and can process large amounts of waste very quickly while producing a high-quality end product. Less material is lost to the atmosphere than in the normal uncovered thermal process.

THE SPICE INOCULANT

Inoculants are products that contain beneficial microbes such as bacteria and fungi. Inoculants are often added to soil to improve plant growth or speed up microbial processes. One type of SPICE inoculant is made using a preparation of rice soaked in water for three to five days to attract the beneficial microbes. The water is then added to milk. After two days, it separates into cheese and serum. Molasses and water are added to this serum which can then be stored for several years until needed. When it is time to inoculate the compost, the serum is diluted in a barrel of water with a sack containing molasses, rice bran, fresh green plant material, and sea salt suspended in it. The mixture is left to activate for five days. This finished product is then added to the compost at the rate of one litre per 10 cubic metres of material.

APPLICATION OF COMPOST

Compost should be used only when fully mature and works better when applied to the surface rather than being incorporated into the soil. For field crops, compost can be put in the planting basin. It can be applied to newly prepared vegetable beds and directly to heavy-feeder crops at the flowering stage. Compost can be applied to fruit trees each year at the beginning of the flowering stage.

RESOURCES

SPICE Compost-making method. https://www.gerrygillespie.net/about.html

SPICE Compost Inoculant Fact sheet. https://nutrisoil.com.au/wp-content/uploads/2018/07/SPIC-Compost-Inoculant-Factsheet.pdf

McClintock, M.C. and Diop, A.M., 2005. Soil Fertility Management and Compost Use in Senegal's Peanut Basin. International Journal of Agricultural Sustainability. Vol.3, No.2, 2005. file:///C:/Users/abraz/Downloads/McClintock_Diop_IJAS.pdf

FAO. n.d. The benefits of composting, reusing and recycling nutrients for agricultural productivity. http://www.fao.org/land-water/overview/covid19/composting/fr/

Hettiarachchi H., Bouma J., Caucci S., Zhang L., 2020. Organic Waste Composting Through Nexus Thinking: Linking Soil and Waste as a Substantial Contribution to Sustainable Development. In: Hettiarachchi H., Caucci S., Schwärzel K. (eds) Organic Waste Composting through Nexus Thinking. Springer, Cham. https://doi.org/10.1007/978-3-030-36283-6_1

Compost is key to restoring what has been lost

We can use biofertiliser to both fertilise the soil and nourish the plant. Fertilise means feeding the plants with raw materials such as bokashi which the plant needs to digest to increase its health. When we nourish the plant, we provide food that has already been broken down and can be absorbed directly by the plant. We can envisage the soil as being the digestive system of the plant.

Juanfran Lopez

3

Biofertilisers: Feeding the Soil, Nourishing the Plant

This chapter is based on several AFSA and SKI member organisations' presentations with additional input from Juanfran Lopez.

Biofertilisers are promoted by several organisations across Africa, including Kasisi Agriculture Training Centre in Zambia, Rural Community in Development Organic Agriculture Training College in Uganda, Resources Oriented Development Initiatives and the Organic Agriculture Centre in Kenya, and Eco-Impact Association in Togo. These organisations have trained smallholder farmers to prepare and use several biofertilisers and report that farmers have been very pleased with the increased yields, improved plant health, and resistance to pests and diseases. Farmers have found the fertilisers easy, safe and economical to make. Many are also manufacturing them for sale to other farmers. The biofertilisers have been used successfully on a range of commercial crops, including tea, coffee and strawberries. The main challenges reported have been a lack of support from government, competition with government-subsidised inputs, and in some instances, not being able to access the materials or equipment needed.

Building up soil organic matter with compost is undoubtedly beneficial but does not provide all the substances necessary for plants to grow properly, defend themselves against pests and diseases, or provide the ideal nutrition for the humans and livestock that eat them. Biofertilisers go that extra mile. Think of it as a tonic, booster, or superfood for soils and plants.

Biofertilisers are concentrated fermented liquid preparations that create food and a beneficial environment for soil microbes which in turn make organic matter, increase the amount and availability of plant nutrients, and improve root growth. They improve long-term soil fertility and strengthen plants against pests and diseases.

Biofertilisers are cheap and usually quicker to make than compost, and because they are diluted, they can be used to improve the fertility of large areas of land. Liquid biofertilisers can be stored for a year or more without losing strength or going off. Different types of biofertiliser can be used to complement one another by providing different nutrients.

***Juanfran Lopez** is an agronomist working with regenerative farming techniques and using locally available resources to create low-cost sustainable solutions for farmers. He is currently doing a PhD in Ecosystem Restoration and Soil Regeneration. Juanfran has travelled the world learning different approaches to land management. He works with smallholder farmers, large scale farms, universities and government bodies. Juanfran currently teaches in more than 30 countries in Europe, Asia, Africa and South America, and is an adviser on several research projects for international foundations and universities.*

By using Bokashi we are building long term health into our soil system. We encourage the proper conditions so that the plant can digest the food that is in the soil. So bokashi is more like an inoculant for the soil as it introduces microbes in the soil and feeds the existing living organisms in the soil.

Juanfran Lopez

Some biofertilisers are made in the presence of air (aerobic), and others are made without air (anaerobic). All biofertilisers undergo fermentation which breaks down complex substances into simpler forms for plants to use more easily. Biofertilisers can also be fortified with extra minerals by adding rock dust or mineral salts.

The base substances of all biofertilisers are either fresh cow dung or duff collected from the forest floor, which are used to breed and multiply native microbes. Molasses (or diluted sugar) is added as an energy source to enable alcoholic fermentation, while milk is used as a source of protein for lactic fermentation. Different processes are used to produce different biofertilisers depending on the soil needs and farmer requirements. Two of the most common biofertilisers are Bokashi and liquid fermented biofertilisers.

BOKASHI

Technically Bokashi is something between compost and biofertiliser. Bokashi adds organic matter as well as beneficial microbes and nutrients to the soil. It is prepared with specific ingredients, including manure, dry material, soil, biochar, bran, molasses or diluted sugar, yeast, water, and minerals from ash, bone meal, or rock dust. These are decomposed through fermentation to produce a nutrient-rich substance that can be applied to a wide range of crops. Like thermal compost, it is made by layering the different materials. These are then mixed twice a day until the material is ready for use. During the fermentation process, the heap gets very hot then the temperature gradually reduces.

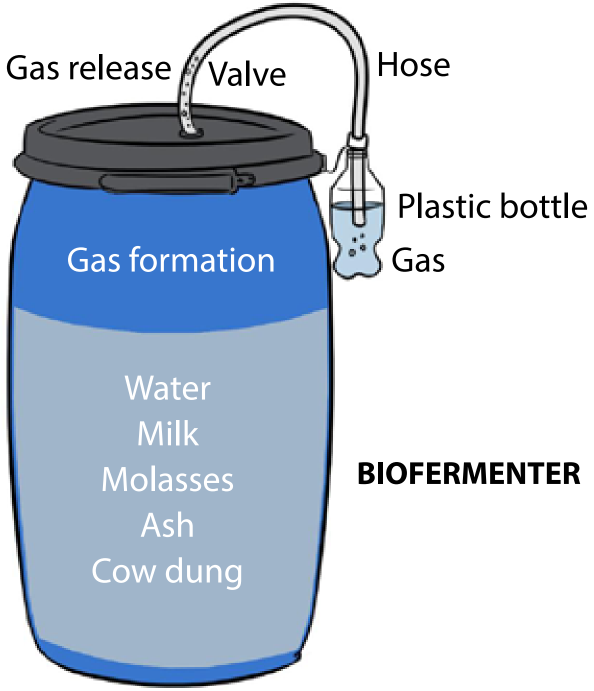
Bokashi can be ready to use in 12 to 15 days. However, it can't be stored for more than a month, so it should be used soon after it is made. It is an excellent promoter of general soil health and can be applied to fruit trees, vegetable crops, and nursery plants.

LIQUID FERMENTED BIOFERTILISERS

Liquid fermented biofertilisers are made in an anaerobic environment. Their production requires a special container that excludes air (see diagram). This can be made using a 200L plastic barrel with a tight-fitting lid, a valve, and an air outlet made with a hosepipe and plastic bottle.

A basic liquid fermented biofertiliser can be made with cow manure, wood ash, molasses, yeast, and milk. The mixture is placed in the barrel with a sealed lid and left for around 30 days. During this time, gas is released through the valve into the plastic bottle. When no more bubbles appear, the biofertiliser is ready for use. The mixture can be decanted into smaller plastic containers and stored for up to one year.

When applied to crops, the biofertiliser is diluted one part fertiliser to 20 parts water and sprayed onto the underside of crop leaves about once a week. It is an excellent all-round tonic for both the plants and the soil.



BIOFERMENTER

RESOURCES

Booklets:https://www.seedandknowledge.org/biofertilisers-come-to-africa-4-how-to-biofertiliser-booklets/
Videos:https://www.seedandknowledge.org/biofertilisers-come-to-africa-4-short-training-videos/
Living Agriculture website https://juanfranlopez.com/
Rural Community in Development Organic Agriculture Training College website http://www.rucid.org/
Kasisi Agricultural Training Centre website https://www.katczm.org/
Resources Oriented Development Initiatives website https://www.rodikenya.org/
Organic Agriculture Centre of Kenya website http://oack.or.ke/sample-page/

Liquid biofertilisers nourish the plant. They provide short-term fertility, making minerals available to the plant and boosting the plants' immune response.

Juanfran Lopez

One of the biggest mistakes of soil science is teaching that plants and soil are separate ecosystems when in reality they are the same ecosystem. Without plants, you cannot call soil…soil.

Kofi Boa

4

Covering-up with Green Manure and Cover Crops

This chapter is based on a learning and sharing session facilitated by SFHC and TSURO and a presentation from Dr Kofi Boa.

Clearing fields is usually the first activity of the planting season in conventional agricultural practice. Farmers remove all vegetation and crop residues (often through burning) to create a 'clean' environment for ploughing, sowing and applying fertiliser. But bare soil rapidly loses nutrients and moisture to the air and is highly prone to erosion from wind and rain and damage to its structure from the direct impact of raindrops. This effect is even more intense on sloping land.

On the other hand, covered soil keeps nutrients and moisture in place, reduces temperatures, suppresses weeds, and improves the ability of rainwater to infiltrate. Covering the soil provides food and a beneficial environment for soil organisms. This increases the long-term fertility and productivity of the soil. Creating a permanent soil cover (whether through mulch or living plants) is one of the most important steps to improving soil health. While leaving crop residues and other organic material on the soil surface is beneficial, having a living cover crop is even more effective.

WHAT ARE COVER CROPS?

Cover crops can be grown in between or in rotation with the main crop to provide year-round cover for the soil. Green manures are a type of cover crop that is cut or slashed at a certain point in their life cycle and left on the soil surface to break down and feed the soil organisms, thereby improving soil structure and fertility. Some cover crops are also grown for food, livestock fodder, or other products. Many different species can be used, but common ones are lablab bean, velvet bean, cowpeas, jack bean, and pigeon pea. Some trees such as *Acacia galpinii and Gliricidia sepium* can also be used as green manures. Perennials and livestock can also be integrated effectively into the system, as described in later chapters.

***Kofi Boa** studied agricultural science at Kwame Nkruma University of Science and Technology in Kumasi, Ghana and agronomy at the University of Nebraska. He worked as an on-farm research scientist at the Crops Research Institute of the Council for Industrial and Scientific Research in Ghana. Kofi has a passion for agroecology and creating healthy soil for food production. He founded the Centre for No-Till Agriculture to demonstrate the benefits and evidence of conservation agriculture, and promote this technology to farmers and the general public.*

The Soils, Food and Healthy Communities (SFHC) *project is a participatory, farmer-led organisation which promotes agroecological methods to improve food security and nutrition in Malawi.*
https://soilandfood.org/

Towards Sustainable Use of Resources Organisation (TSURO) *is a community-based organisation working with small-scale farming communities in the Chimanimani district of Eastern Zimbabwe.*
http://www.tsuro-chimanimani.org.zw/

Bare soil rapidly loses nutrients and moisture and is highly prone to erosion and structural damage

When choosing which crops to use it is important to increase plant diversity wherever possible to supply different soil nutrients and micro-organisms. Increasing diversity also reduces pest and disease problems. Ideally, cropping systems should include 10 to 15 species, and farmers should begin to work towards this goal when transitioning from monocropping.

In Africa, cover cropping used to be common in the past, but monocultures have largely displaced the practice. Cereals such as millet, sorghum, and more recently maize were traditionally grown with legumes, pumpkins, melons, and squash. The cereal was usually planted first to avoid the other crops shading it out. The cover crops (typically runner-types) were planted a few weeks later and would quickly grow over the soil suppressing weeds and reducing evaporation. The cover crop would provide the family with a wide range of nutritious food, and the legume would add nutrients to the soil. The system saved labour by reducing the need for weeding, although farmers sometimes had to cut back the cover crop to avoid competition with the cereal.

RESEARCH INTO THE USE OF COVER CROPS AND ZERO TILLAGE

At the Centre for No-Till Agriculture, Amanchia, Ghana, Dr Kofi Boa has been conducting research comparing the effects of full tillage and no cover crop systems with minimum tillage and cover crop systems. His findings show that soil loss from tilled-no-cover fields is two hundred times that of no-till-with-cover fields. After one week of 127mm of rainfall, average soil temperatures were 13°C cooler and soil moisture was 23% higher on the no-till-with-cover fields. Yields of maize and legumes were significantly higher (up to five-fold for maize in some years) on the no-till-with-cover fields, even in low-rainfall years.

Soil cover is vital to the effectiveness of minimum tillage systems. Crop yields are low in minimum tillage systems without soil cover.

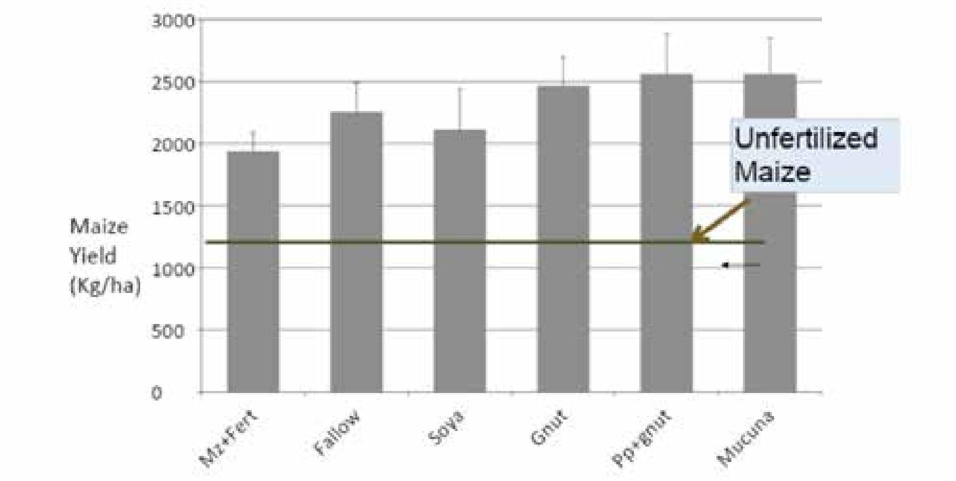
Dr Kofi Boa

DOUBLING UP ON LEGUMES GIVES CEREALS A BOOST IN MALAWI

SFHC uses participatory approaches, incorporating indigenous knowledge to promote agroecological practices. One of these practices is the promotion of green manure and cover crops for soil cover, food, organic matter, nitrogen fixation and to provide animal forage. A particularly successful combination is the double-up legume system where pigeon pea (a perennial) is intercropped with early-maturing groundnuts. The residue from both legumes is left in the field and incorporated into the soil. In the second year the pigeon pea is cut back and a cereal is planted in place of the groundnuts. SFHC conducted participatory research with farmers and published a paper which shows that planting maize with cover crops can give higher maize yields than unfertilised maize or maize-plus-synthetic fertiliser fields. The cover crop that produced the highest maize yields was velvet bean followed by the pigeon pea/ groundnut combination.

The challenges farmers faced include: livestock grazing on the cover crop fields, pests attacking pigeon pea and jack bean, and farmer-resistance to using cover crops that are not edible such as velvet bean and tephrosia. To address these communities have instituted byelaws and penalties for grazing livestock in cover crop fields. They are also trying organic pest control measures learned from other farmers. SFHC is putting more emphasis on training farmers on the benefits of different cover crops, encouraging farmer-to-farmer learning and exchange of ideas.

Reference: Snap S.S., M.J. Blackie, R.A. Gilbert, R. Bezner Kerr, G.Y. Kanyama-Phiri. 2010. Biodiversity can support a greener revolution in Africa. Proceedings of the National Academy of Sciences 107(48):20840-20845



Source: S. S., M.J. Blackie, R.A. Gilbert, R. Bezner Kerr, G.Y. Kanyama-Phiri. 2010. 'Biodiversity can support a greener revolution in Africa' *Proceedings of the National Academy of Sciences* 107(48):20840-20845

TESTING COVER CROPS IN CHIMANIMANI

TSURO has a membership of 171 village groups with an average of 15 households per group in Chimanimani. TSURO uses diverse approaches to reach smallholder farmers with different farming interests. In a cover crops and green manure trial, eighteen farmers established 0.5 hectare demonstration plots with cover crops (lablab, velvet bean, jack bean and pigeon pea) planted with maize or sorghum. Some farmers tried a three-tier system such as maize or sorghum with lablab or cowpeas and pigeon pea while others preferred a two-tier system with maize and velvet bean or jack bean.

The farmers noted that, compared to their conventionally planted fields, the demonstration plots had less soil erosion, more organic matter in the soil, increased water conservation and improved biodiversity of insects and birds. The plots were better able to withstand drought, and had higher yields for all crops, particularly legumes. Farmers also felt that the cover crop system supressed witchweed, a devastating weed for cereal crops, and attracted beneficial insects which helped control fall army worm. There was increased food for the family, fodder for livestock, and a saving on labour as less weeding was needed.

There were also challenges including sourcing cover crop seed and aphids attacking cowpeas. Overall farmer interest was high and TSURO plans to upscale the project although they will invest more in helping farmers research the best crop combinations, scaling up local seed production, and farmer training in timing and management.

RESOURCES

California State University. Centre for Regenerative Agriculture and Resilient Ecosystems. https://www.csuchico.edu/regenerativeagriculture/international-research/kofi-boa.shtml

No-till Promotion Among Smallholder Farmers - My Experience Kofi Boa. http://www.notill.org/kofi-boa-0

GMCC: https://www.facebook.com/TSURO-Trust-101287248431004/

Bunch, R., 2019. Restoring the Soil: How to use green manure/cover crops to fertilize the soil and overcome droughts. 2nd Edition. ECHO Inc.

Bunch, R., 2017 Case studies of Regenerative Agriculture: Green manures and cover crops https://www.echocommunity.org/en/resources/aa593147-43e3-42c1-aa81-3b764b4eaa4c

Soil health resource guides http://legacy.greencoverseed.com/

Regreening Mindscapes and Growing Trees

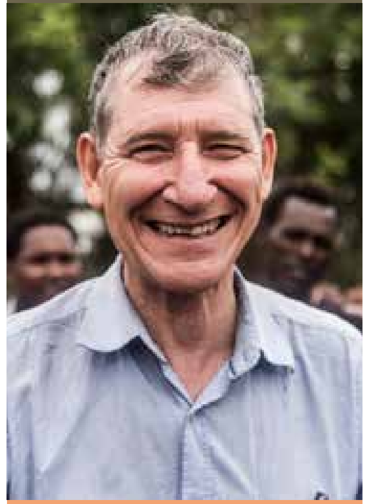
5

This chapter is based on a learning and sharing session facilitated by Groundswell International and a presentation by Tony Rinaudo.

In semi-arid parts of Africa, hot, dry conditions and land clearance for farming and fuelwood have greatly reduced the natural vegetative cover. This has exposed the soil to wind and water erosion; winds of up to 70km an hour blast any new growth with sand. Soil surface temperatures can reach 60°C or more. Desertification and climate change are a double crisis in these areas, causing crop failure, food insecurity, and degradation of the soil, trees, pastures, and water sources on which rural people depend for their lives and livelihoods. Apart from increased droughts and flooding, temperatures are rising 1.5 times faster than the global average. In the Sahel, it is projected that by 2050 average temperatures will be three to five degrees higher. Scientists estimate that for every 1°C of warming, crop yields could decline by up to 10%. This means that by 2050 farmers in the Sahel could see a 20 to 40% decrease in sorghum and millet production.

A NEW APPROACH TO TREES

For many decades, agricultural extensionists have taught farmers that all non-crop plants should be cleared from fields. But recent research shows that tree and vegetative cover is highly effective at halting desertification and lessening the effects of climate change. With appropriate management, trees, shrubs, and grass facilitate crop growth rather than competing with it. Agroforestry can increase crop yields by 30 to 50% or more while providing fuelwood, poles, and fodder. Tree and plant roots hold soil in place while duff and root exudates increase organic matter and microbial life, restoring soil fertility and moisture. Through natural regeneration of trees from old stumps, and newly established trees from seed, farmers can greatly increase the density of trees on their cropping land. If properly pruned before the growing season, these trees reduce wind speed and provide dispersed shade. This creates better conditions for food crops and animals to thrive.



***Tony Rinaudo,** also known as the forest-maker, is an Australian agronomist who lived and worked in West Africa for several decades. He put the concept known as farmer managed natural regeneration (FMNR) into practice as a solution to deforestation and desertification. Tony won the Right Livelihood Award in 2018. He is currently World Vision's Senior Climate Action Advisor, promoting reforestation initiatives globally.*

***Groundswell International** is a partnership of local organisations that strengthens communities to build healthy farming and food systems from the ground up. https://www.groundswellinternational.org/*

> The solution is explaining the truth about the value of trees, encouraging a positive attitude and restorative behaviour. Literally, everything that you needed for restoration was at your feet.
>
> ***Tony Rinaudo***

Producing tree seedlings and transplanting them into fields in arid dryland areas is an almost impossible task. Lack of water, fire, and destruction by free-grazing animals destroys most of the transplanted trees. The survival rate is very low. Tony Rinaudo began using Farmer Managed Natural Regeneration (FMNR) in Niger in the early 1980s. Building on local systems to manage existing trees, Tony found that whole landscapes could be regenerated. He realised that much of the problem lay in people's false attitudes and beliefs about trees. He coined the term "regreening mindscapes" to explain the shift that needs to happen for people to understand the value of trees.

WHAT IS FARMER MANAGED NATURAL REGENERATION (FMNR)?

FMNR is an easy, low-cost way for farmers to increase the number of trees in their fields and grazing areas. It is both a technical practice and a development approach for mobilising and empowering communities to restore their natural environment. It involves encouraging the regrowth and management of existing trees and shrubs from tree stumps, sprouting root systems, or wild seeds. FMNR entails encouraging pollarding and coppicing existing trees. First, the farmer selects locally growing indigenous tree species that they want to keep on their land. Different species may be selected for soil improvement, timber, or livestock fodder. Trees that have been previously stumped and have sprouted are pruned to leave about three to five stems bound together so that it is hard for the wind or livestock to break them. Larger trees are pruned to reduce 30 to 50% of the lower branches. As the stems and branches grow, they provide farmers with fuelwood and timber. Farmers can successively harvest the stems once they grow into a larger tree while allowing a new stem to grow and replace one that has been cut. The number of trees left in an area, the species selected, and the type of pruning all depend on the local context and objectives of the farmer.

FMNR also involves advocacy, awareness-raising, training, mobilising communities to take action, and instituting tree-management by-laws. Creating linkages to markets provides a greater incentive for farmers to regenerate local species of trees.

IMPACTS

FMNR has been applied successfully in various contexts. In Niger, the average tree density on farmlands increased from four trees per hectare to 40+ trees per hectare over 20 years. Niger has five million hectares under FMNR—that's 200 million newly established trees. It is estimated that in the whole of West Africa, 20 million hectares of land are under FMNR. The approach has also been promoted in East and Southern Africa, although its reach has not been documented.

The technique of FMNR has spread from farmer to farmer with little help from external supporters. Every year, without fertiliser, irrigation, or improved seed, the increased density of trees in the landscape has improved the microclimate and soil fertility. In one area, during a drought year, farmers using FMNR were able to grow an additional 500 tons of grain. One study indicated that gross household incomes increased by up to USD1000 per household, benefiting about 4.5 million people across Niger.

In Kenya, FMNR has been used to address bush encroachment where impenetrable thickets are caused by deforestation, overgrazing, and burning. Using selection, thinning, pruning, and management, these lands can be restored to being productive. In Kenya, farmers increased milk production between 200 and 500% using FMNR to encourage grass and tree fodder. The farmers were able to maintain their herds and continue to get milk, even in drought times. They also earned extra income from the sale of fuelwood, poles, and other forest products such as honey.

BENEFITS OF TREES

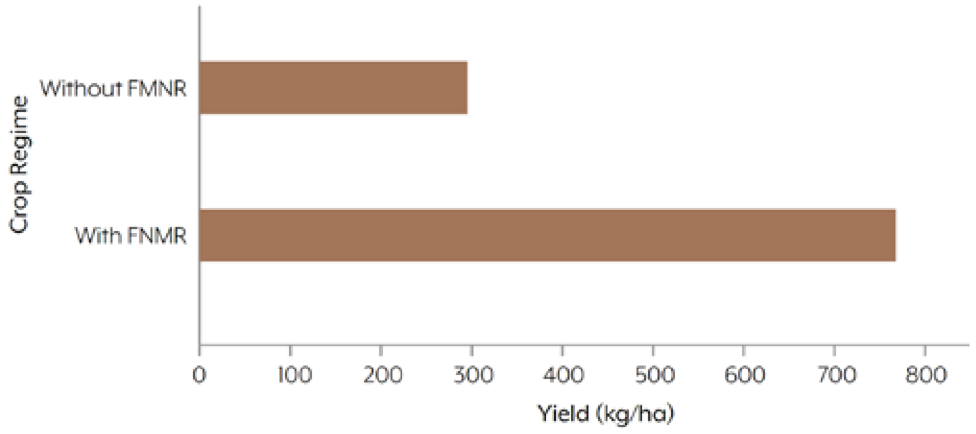
Trees reduce run-off, particularly on sloping land, sinking more water into the soil. Trees increase the amount of organic matter in the soil. This increases the amount of carbon and water stored in the soil and prevents soil erosion due to run-off. Trees also produce a wide range of other benefits for communities, including fuelwood, timber, fibre, shade, shelter, livestock fodder, food, and medicines. A study by FAO found that not only grain yields under the nitrogen-fixing tree Faidherbia albida increased 2.5-fold but that the protein level of the grain also increased three to four-fold because of the additional nitrogen that the crops were attaining from the trees.

Trees on farms and agroecology-these aren't just trendy organic jargon; it's a matter of life and death for many people and the difference between mere survival and actually thriving.

Tony Rinaudo

Other studies have shown that through shade and increased transpiration, trees can reduce air temperatures by 10°C and soil surface temperatures by more than 30°C. This makes the environment hospitable for a wide range of plants and prevents crop losses caused by extreme temperatures. Natural insect predators move in and help to control agricultural pests. Tree roots pull water to the soil surface through hydraulic redistribution. This is called bio-irrigation. At night this gives extra water to crop plants growing close to the tree[8].

Another important benefit of FMNR is that it helps women by providing easily accessible fuelwood from the tree pruning. This means that women spend less time and walk shorter distances sourcing fuelwood. Analysis of FMNR projects has found that women involved are more empowered, have greater social status and more significant roles in community decision-making, and greater income-generating potential.



→ *Institut Sénégalais de Recherches Agricoles (ISRA) and World Vision International.*

[8]Bogie N. A., Bayala R, Ibrahima, D. Conklin M. H., Fogel M. L., Dick R. P., Ghezzehei T. A. 2018. Hydraulic Redistribution by Native Sahelian Shrubs: Bioirrigation to Resist In-Season Drought. Front Env. Sc Vol 6, 18. Sep18.
https://www.frontiersin.org/article/10.3389/fenvs.2018.00098

EXPERIENCES IN WEST AFRICA

Groundswell International works in four countries in West Africa with a focus on spreading useful technologies such as FMNR. They have found that FMNR addresses multiple problems of land degradation, food insecurity, fuel wood, and timber and fodder shortages simultaneously. FMNR is seen as the foundation upon which other techniques such as compost, cover crops and dry season gardening are added. This gives farmers the basis for transition to a full-scale agroecological system. To take FMNR to scale, it must be based on community engagement and ownership.

But changing the 'mindscape' has been incredibly challenging. In many countries cultivation methods that include the removal and burning of most trees from fields, are deeply engrained. Farmers have been told by agronomists for decades that trees compete with crops and must be removed from fields. When FMNR is initially introduced, farmers imagine that it involves just leaving a few high value fruit trees in fields, on hillsides and in pastures. They are shocked at the suggestion of leaving 200 trees per hectare. It takes a lot of time to explain about pruning the trees so that they do not compete. Another major challenge is unsupportive policies which take responsibility and ownership for tree resources away from those who depend on them.

Farmers complain about mixed extension messages. In the past they were advised to cut down the trees and now in the same villages we are telling them to let the trees grow. But there are no trees left. This shows how policies play a major role in desertification. The enemy of farming in many cases is the agronomist who does not have the right advice. Tsuamba Bourgou, Groundswell, Burkina Faso.

An European Union funded study1 in Lawra District, Ghana to assess the impact of FMNR after five years found that crop revenue increased up to 86% for farmers using FMNR with other sustainable land use techniques and the revenue increased as the trees matured. These are very rapid benefits. FMNR farmers were receiving on average an extra Euro 102 per hectare income from crops and non-tree products especially during the lean season. The study concluded that FMNR farm households are considerably more food secure and climate resilient than non FMNR farmers.

Westerberg, V., Doku, A., Damnyag, L., Kranjac-Berisavljevic, G., Owusu, S., Jasaw, G., Di Falco, S., (2019). Reversing Land Degradation in Dry lands: The Case for Farmer Managed Natural Regeneration (FMNR) in the Upper West Region of Ghana.

RESOURCES

FMNR Hub https://fmnrhub.com.au/
How to do FMNR Pruning: https://www.youtube.com/watch?v=0xF27ROVrbg
Evergreening Global Alliance. https://www.evergreening.org/evergreening/fmnr/
Great Non-profits: Groundswell International https://greatnonprofits.org/org/groundswell-international-inc

Agroforestry can increase crop yields by 30 to 50% or more

> Since the 1950's farmers have been told to remove all shrubs and trees from fields because they were thought to compete with crops.
>
> **Prof Richard Dick**

6

Bio-Irrigation: Optimising the Use of Native Shrubs

This chapter is based on a learning and sharing session facilitated by Professor Ibrahima Diedhiou and Professor Richard Dick.

An antidote to slash and burn that works particularly well in drier regions is called the optimised shrub-intercropping system, or OSS.

OPTIMISED SHRUB-INTERCROPPING

For the past 19 years, a collaboration of West African, French, and American researchers and farmers has been looking at the impact of native shrubs when left to grow in farmers' fields. The focus has been on the benefits of two native shrubs that are frequently found across the Sahel region, from Senegal to Chad: Guiera senegalensis grows in drier regions (300mm rainfall per annum) on sandy soils and Pliostigma reticulata in higher rainfall regions (750mm rainfall per annum) on clay soils. Under conventional management systems, the leaves and branches of these shrubs usually are slashed and burned in preparation for planting. The shrubs tend to resprout during the growing season, and farmers cut and leave the residues in the fields.

With funding from the US National Science Foundation, Prof Richard Dick, Prof Ibrahim Diedhiou and other scientists have developed an optimised shrub-intercropping system (OSS). OSS increases shrub density in farmers' fields from 1200 to 1500 shrubs per hectare over current levels of less than 200 to 350 shrubs per hectare. In OSS, the coppiced shrub residue is not burned but instead cut into five-to-eight-centimetre pieces and incorporated into the soil to add organic matter in preparation for planting.

Studies of OSS have found that intercropping millet with shrubs in drier areas reduces the time to harvest and produces higher yields than sites without shrubs—even without using fertilisers and drought years.

__Ibrahima Diedhiou__ is a researcher, educator, and formerly the Director of Research & Innovation at the University of Thiès, Senegal. He is the Director of the Higher National School of Agriculture (ENSA).

__Richard Dick__, Professor of Soil Microbiology, University of Ohio, USA, works with the Agro-shrub Alliance, a non-profit organisation that provides training and support to smallholder farmers across the Sahel.

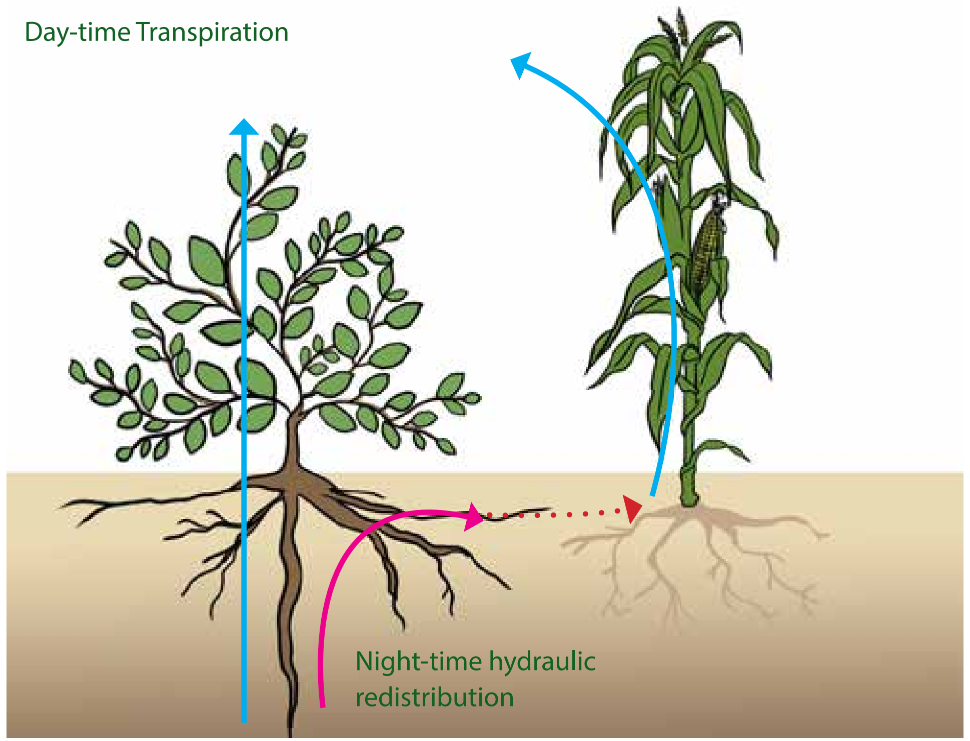
BIO-IRRIGATION EVIDENCE

Shrub roots grow down 10m or more reaching the water table. At night water moves through the shrub roots from the wet subsoil to the dry surface soil. It is easier for the water to move through the plant roots than through the soil. Scientists call this process hydraulic lift. This action has been confirmed through experiments. For example, researchers tracked radioactively labelled water given to shrubs using tissue samples from the shrub and adjacent millet plants. The results showed that the shrubs took up the labelled water and transferred this water to the crop.

BENEFITS OF OSS

The presence of shrubs improves soil quality, plant nutrient uptake, and efficiency while increasing the activity and diversity of beneficial microbes in the soil. Incorporating the residues doubles the amount of organic matter in the soil and sequesters carbon. The shrub residues increase soil nutrient availability and decomposition rates. The shrub root system improves infiltration of rainwater and better water storage in the soil. Researchers have shown that shrubs bio-irrigate adjacent crops by pulling water to the soil surface, making it available for surrounding plants. The shrubs do not compete with crops and can increase yields. They assist crops during drought periods and reduce the time from crop germination to harvest by about 15 days.

High temperatures are known to inhibit germination and seedling growth of crops. Another important benefit of having shrubs in fields is that they reduce soil temperatures by as much as 5°C. This is thought to be due to hydraulic lift, evapotranspiration, and organic matter's insulating effect.



CHALLENGES

OSS is not without challenges. Propagating, planting, coppicing the shrubs, and protecting seedlings from livestock creates more work. The researchers are working on developing mechanised choppers to reduce the amount of labour. It is hard to convince some farmers to plant trees or shrubs that don't give immediate economic or production benefits. However, the researchers have found that working through strong farmer groups helps to overcome these challenges.

SCALING UP IN THE SENEGALESE GROUNDNUT BASIN

OSS researchers are scaling up to pilot work with farmers, but first investigated potential obstacles to OSS adoption using a participatory multi stakeholder approach. Current partnerships with farmer organisations, agricultural advisory services and local authorities are underway and include farmer demonstrations. Participating male and female farmers have been trained in growing shrub seedlings, using both vegetative and seed propagation methods. The shrubs are planted in fields during the rainy season with no further management or irrigation that results in a more than 80% survival rate. Various focus sessions and workshops have been conducted, as well as field days at long term OSS demonstration sites where farmers can see the dramatic OSS crop response for themselves.

These farmers are now involved in a pilot study supported by a grant from USAID to determine OSS performance under their management. There are two sets of farmers in Senegal's peanut basin involved in this study-one in the northern region testing the local shrub, Guiera senegalensis; and one in the southern region testing, Piliostigma reticulatum. Each farmer has a small field where OSS has been implemented adjacent to a field with traditional shrub management (200-300 shrub per hectare and burning of shrub residue). Both management systems are being monitored for at least three years to determine the impacts of OSS on family food production and socio-economics, including gender impacts. Preliminary results are promising and local neighbours are adopting OSS in their fields too.

RESOURCES

Floyd, A. 2019. Wild shrub could help peanut farmers in Senegal. College of Agricultural and Environmental Sciences. University of Georgia Cooperative Extension. https://newswire.caes.uga.edu/story.html?storyid=8176&story=Shrub-helpers

Native Shrub Intercropping Symposium - 15 Years of Research - Innovation in Agroecology. https://wasi.osu.edu/events/native-shrub-intercropping-symposium-15-years-research-innovation-agroecology

Optimized Shrub System: Improving Cowpea Yields and Strengthening Smallholder Resilience. https://www.canr.msu.edu/legumelab/project/optimized-shrub-system-improving-cowpea-yields-and-strengthening-smallholder-resilience

Bogie, N.A., Bayala, R., Diedhiou, I. et al. 2019. Intercropping with two native woody shrubs improves water status and development of interplanted groundnut and pearl millet in the Sahel. Plant Soil 435, 143–159. https://doi.org/10.1007/s11104-018-3882-4

"The response is more dramatic the drier and more degraded the soil. Where rainfall is higher and there is more clay, the benefits of the shrubs are diminished."

Prof Richard Dick

> Ultimately, the only wealth that can sustain any community, economy or nation is derived from the photosynthetic process-green plants growing on regenerating soil.
>
> **Allan Savory**

7

It's not the Cow, it's the how: Regenerating Land with Livestock

This chapter is based on a learning and sharing session facilitated by Precious Phiri.

***Precious Phiri** is an accredited holistic management facilitator. She is a steering committee member and African Co-ordinator for Regeneration International. Her work involves networking and bringing communal work to global platforms. Precious has worked with agro-pastoral and pastoralist communities implementing holistic management tools for rangeland and crop field regeneration.*

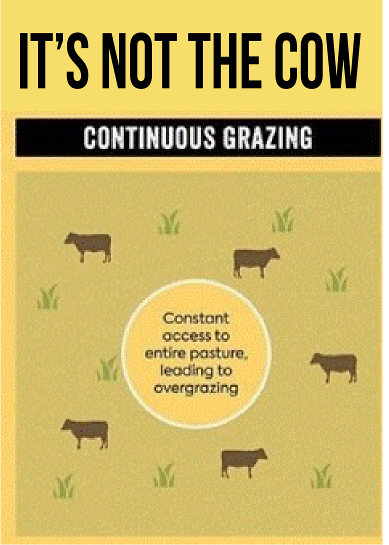
Grassland management deserves special attention because grasslands, which make up 40% of the Earth's surface, can store more carbon in their soils than any other environment. Better livestock management leads to better grassland management and thus better carbon sinking.

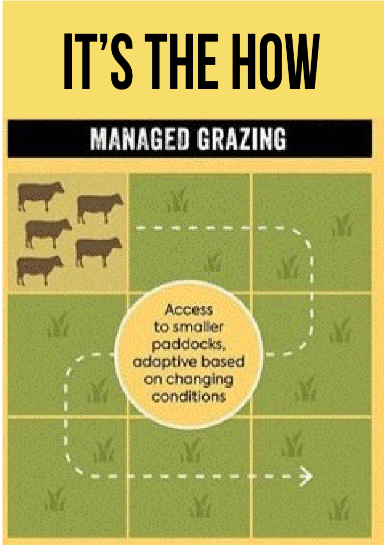
Inappropriate land management is a significant cause of food insecurity in Sub-Saharan Africa. In semi-arid areas, where livestock production is more viable than crop production, desertification is a major threat. In these areas, resource depletion is causing human-wildlife conflict as well as violent conflicts between communities. Resource protection is hard to achieve, particularly where grazing areas are communal. Whole communities now depend on food aid for human and livestock survival. But food handouts create more dependency and undermine people's sense of agency-so they give up even trying.

> *Many people blame climate change but climate change is a natural feedback response to an existing land degradation problem*

FROM REDUCTIONISM TO HOLISM

Because science encourages breaking problems into small components, we have lost the ability to appreciate complex natural systems. We try to address symptoms but rarely identify and analyse the root causes of problems. Industrial agriculture has been based on this reductionist science involving manipulating parts of our environment to extract products (crops and livestock). To manage our land effectively we must relearn the holistic approach and begin connecting the dots again.





HOLISTIC LAND AND LIVESTOCK MANAGEMENT

Holistic management is a decision-making framework that considers ecological, economic, and social complexities. It is a whole-system approach to managing resources. The framework was developed by Zimbabwean born ecologist Allan Savory while trying to understand the causes of massive land degradation on the world's grasslands. Savory realised that rather than causing land degradation, livestock is an essential tool for regenerating landscapes.

Holistic planned grazing and animal impact is a land management tool that involves all community members' participation in developing an agreed plan of how to move livestock across the land. Community livestock is combined into large herds to harness the power of their hooves to break up hard ground so that air and water can penetrate. The animals trample old grass, so the soil is covered and less prone to the drying effects of sun and wind. Their dung and urine help enrich the hoof-prepared soil. Their grazing (which is timed to prevent overgrazing) keeps perennial grasses healthy and growing over a longer period – this is what is called recovery. This minimises the need to burn grasslands and expose soil.

The tools (grazing, trampling, dunging, urination, and recovery) are used differently during the growing and non-growing season. In the dry, non-growing season, plant growth slows down, so managers must help the land prepare to receive and store the following growing season's rain while taking care not to overrun or damage the land before the rains begin. Trampling, dung, and urine introduce beneficial micro-organisms back into the soil to maintain soil health.

Recovery time is different depending on the nature of the environment. In a place with a long dry spell, it takes longer before livestock are allowed to graze the plants again, and the opposite is true for areas with more rainfall.
Crop fields can be prepared using movable livestock enclosures during the dry season. The animals deposit dung and urine and break up the soil with their hooves. When the growing season and planting time arrives, ploughing is unnecessary, and farmers can simply make small planting holes and sow the seeds. Crop harvests of two to four times higher than fields using fertilisers or other methods have been achieved.

BARRIERS

Although highly effective, the holistic grazing management system is not simple to implement and needs to be carefully tailored to each context. The main barriers are linked to mindset both at local community and government level. In communally owned land, unless there is strong leadership, the system is hard to implement successfully due to the commitment and mindset shift it requires. People blame livestock for degrading the land when actually it is livestock management techniques that are at fault.

There is evidence that the implementation of Holistic Management tools throughout Africa will improve ecosystem services, economic and social status. But to be successful requires a change in mindset, and this takes time. However, the approach has gained a great deal of acceptance globally since it was first proposed in the early 1980s. The success stories in Africa are inspiring communities across the continent to try out the tools.

RESOURCES

Savory Institute to access peer-reviewed materials and more - https://savory.global/resource-library/

Holistic management handbook resource book 3rd edition

Kiss the Ground - Film on Netflix

> *We have a desperate need for mindset change-transformation-to rebuild our reverence for the Earth and natural processes.*
>
> ***Precious Phiri***

8

A growing Partnership: Farmer-led Agroecological Research

This chapter is based on a learning and sharing session facilitated by Dr Batamaka Somé with presentations by Farmer Research Networks colleagues from Tanzania and Niger.

Formal education is often valued far above knowledge gained from experience- and the agricultural world is no different. Agricultural scientists, extension officers, government officials, development workers, and even sales representatives often claim the expert role and treat farmers as ignorant at worst, and worthy recipients at best. Swathes of valid local knowledge have been dismissed or buried under science-based theories, methods, and policies, trampling farmer confidence, agency, and networks along with it.

This not only disempowers farmers but calls the validity and relevance of research into question-mainly where that research is conducted without taking the conditions and needs of the intended beneficiaries into account.

Also, vast amounts of agricultural research funding come from multinational companies marketing agro-inputs to farmers, creating a serious conflict of interest. However, there is another paradigm possible: Farmers and researchers forge a respectful and effective partnership that builds on each other's strengths.

FARMER RESEARCH NETWORKS

Farmer Research Networks (FRNs) are groups of farmers that carry out agroecological research relevant to their members. FRNs often involve partnerships between farmer organisations, development organisations, and research institutions.

Batamaka Somé *is CCRP's regional representative for West Africa. Batamaka is a practicing anthropologist and research consultant based in Burkina Faso. He has conducted research in agriculture and gender, mainly focusing on rural livelihoods strategies, food security, agricultural productivity and market access, and cash crop farming in Africa.*

The Collaborative Crop Research Programme (CCRP) *works to ensure a world where all have access to nutritious food that is sustainably produced by local people. This is done through collaborative agroecological systems research and knowledge-sharing that strengthens the capacities of smallholder farmers, research institutions, and development organisations.*

https://www.mcknight.org/programs/international/collaborative-crop-research/

Since 2012, the CCRP has been developing the idea and practice of Farmer Research Networks (FRNs), or a set of farmer groups that conducts agroecological research of relevance to their members.

https://www.ccrp.org/communities-of-practice/frn/

BOTANICAL FOLIAR SPRAY RESEARCH IN TANZANIA

Pesticides against common bean pests. Tithonia and Tephrosia have been used as pesticides by farmers who have reported that they also enhance crop growth. Several glasshouse experiments were set up to test this claim. Botanical extracts were applied to leaves and soil in controlled trials on common beans. The researchers sprayed the botanical extracts every two weeks and measured the growth, yield and metabolites in the crop leaves. They confirmed that indeed the botanicals have dual functions of pest management and growth promotion. The study found that when the spray is applied to the leaves it gives better results than application to the soil. This is because the surface area is higher on the leaves and nutrients can be absorbed more quickly. The study found that after spraying the leaves there was an increase in secondary metabolites (amino acids) which increase the plants ability to resist pests and diseases. Farmers have started growing tephrosia in their banana fields in order to make the foliar sprays and they have reported that this improves soil fertility because tephrosia is a legume.

"The farmer research network concept is very effective. We sit together plan, give feedback and learn together giving new insights and new research points." Dr Angela Mkindi, FRN researcher, Tanzania.

FRN PRINCIPLES

Initiated in 2012 by the Collaborative Crop Research Programme (CCRP) which has been working in sub-Saharan Africa and Latin America for more than 25 years, FRNs are based on the following principles:

Diverse **farmers** participate in the whole research process. They:

- Co-create the research agenda;
- Engage throughout the research process;
- Have meaningful representation of marginalised groups;
- Strengthen their capacity to learn together.

Research is rigorous, democratized, and useful, focused on agroecology knowledge creation that provides practical benefits to farmers based on their social and biophysical context. Research:

- Effectively addresses farmers' problems and opportunities and is continually adapted based on reflection on experiences by FRN members;
- Is based on co-developed plans formalised through an agreement of all parties that covers principles, rules of engagement, and responsibilities;
- Is based on sound, appropriate, and participatory designs and protocols;
- Is fully integrated with relevant local, indigenous, and farmer knowledge.

Networks are collaborative and facilitate learning and knowledge sharing. The networks:

- Support learning and knowledge sharing among all members;
- Are made up of connections among differently positioned actors and encourage the flow of learning throughout the network;
- Facilitate learning and knowledge sharing among farmer groups and within communities;
- Engage members in iterative reflection and planning to guide network activities.

FRN PROJECTS

The Collaborative Crop Research Programme supports about 30 FRN projects, each of which focuses on different agroecological topics, engages various stakeholders, and is led by a different research institute, NGO, or farmer organisation. CCRP has two communities of practice in Africa, one in East and Southern Africa and one in West Africa. In addition to promoting horizontal learning, the communities of practice develop actions and activities and initiate research projects.

The FRN Toolkit also provides a site for learning and knowledge sharing among projects. The toolkit contains a range of capacity building materials, tools, templates and ideas to help carry out research and enhance the quality of community research activities. The FUMA Gaskiya FRN in Niger created an app that allows them to collect and store data from remote villages and farms electronically and return useful information for actions to their members. FRNs are also involved in soil health data collection and analysis using a soil health assessment toolkit and soil assessment forms completed on a cell phone survey app.

FRN AND THE FUTURE

The farmer research network approach is gaining importance as it proves its effectiveness and has shown that it is not only possible but vital for farmers to drive the agricultural research process. FRNs enables farmers to recapture their agency through active involvement in the research process. Farmers are cocreators of the research agenda and can move from isolated groups into a network where they learn together and share.

RESOURCES

FRN community of practice https://www.ccrp.org/communities-of-practice/frn/

FRN Toolkit testing site https://staging-frn.stats4sd.org/

Soil health assessment toolkit https://smallholder-sha.org

Soils data collection platform https://soils.stats4sd.org

Nelson, R.J. and Coe, R. 2014. Transforming research and development practice to support agroecological intensification of smallholder farming. Journal of International Affairs, 67(2):107–127. https://www.jstor.org/stable/24461738

Nelson, R.J., R. Coe, B.I.G. Haussmann, 2016. "Farmer Research Networks as a Strategy for Matching Diverse Options and Contexts in Smallholder Agriculture" in Experimental Agriculture, 55, S1:125-144. https://www.cambridge.org/core/journals/experimental-agriculture/article/farmer-research-networks-as-a-strategy-for-matching-diverse-options-and-contexts-in-smallholder-agriculture/2AB07C19377D4C43AA41D4C90191E8E9

Bettina I. G. Haussmann, A.M. Aminou, K. Descheemeaker, E. Weltzien, B. Somé, M. Richardson, R. Coe. 2020. "Tackling Key Issues for Smallholder Farmers: The Farmer Research Network (FRN) Approach" in Sorghum in the 21st Century: Food – Fodder -Feed- Fuel for a Rapidly Changing World. ed Vilas A. Tonapi, Harvinder Singh Talwar, Ashok Kumar Are, B. Venkatesh Bhat. Pages 315-329. https://sway.office.com/AA4PgdUex5Iur8un?ref=Link

van Etten, J., de Sousa, K., Aguilar, A., Barrios, M., Coto, A., Dell'Acqua, M., Steinke, J. 2019. Crop variety management for climate adaptation supported by citizen science. Proceedings of the National Academy of Sciences of the United States of America. https://doi.org/10.1073/pnas.1813720116

HUMAN URINE FERTILISER RESEARCH IN NIGER

In Niger a federation of 17000 farmers was awarded a research grant and created their own research process. They investigated the effects of using sanitized human urine as fertiliser and have now created a market for human urine in their area. Apart from studying the effects on crops, the farmers included social aspects in their research such as checking acceptability by consulting religious, health, and community leaders. The group developed several highly effective research methods involving thousands of farmers. They have even developed an app to help with data collection. The farmers are generating data for themselves-not for a researcher-and this is changing the power dynamics of research.

Scaling up Success: Andhra Pradesh Community-Managed Natural Farming Movement

9

This chapter is based on a learning and sharing session facilitated by Vijay Kumar Thallam.

A farmers' movement from Andhra Pradesh, one of India's driest states, provides an exciting model for scaling up agroecology across Africa.

The Andhra Pradesh Community-managed Natural Farming Movement (APCNF) focuses on regenerating soil and water systems, enhancing biodiversity, increasing incomes, improving nutrition and health, empowering women, supporting the landless and providing opportunities for young people. It has already attracted nearly a million farmers and gained the support of the government, philanthropic organisations and an international bank.

This programme promotes farming approaches in harmony with nature and builds on ecological science rather than 'input-economics'. One of their fundamental principles is that a healthy soil microbiome is the key to retaining and enhancing soil organic matter. The microbiome is the term given to the community of micro-organisms, such as fungi, bacteria and viruses, living in particular environment. Bio-stimulants are used to stimulate soil micro-organisms' natural activity, increasing the availability and uptake of nutrients by plants. To this end, APCNF promotes:

- **Microbial seed coatings,** a fermented mixture of cow urine, cow dung and lime. Seeds are coated with the mixture then left to dry in the shade. This stimulates germination.
- **Microbial soil enrichment**, a fermented mixture of cow dung, cow urine, soil, jaggery (unrefined cane sugar) and pulses flour. The mixture is dried and made into cakes for storage. The cakes are crushed into powder and spread on fields as a basal dose.

__Vijay Kumar Thallam__ is the Executive Vice Chairman of the not-for-profit company Ry.S.S. (Rythu Sadhikara Samstha) managing the Community-Managed Natural Farming programme on behalf of the Andhra Pradesh government, and the Ex-Officio Special Chief Secretary to the Agriculture and Cooperation Department of the Government of Andhra Pradesh. He has spent over 25 years in large scale community mobilisation of rural women, tribal communities and farmers, helping 11 million women to form self-help groups. For the past five years he has been leading the climate resilient Andhra Pradesh Community-managed Natural Farming (formerly Zero Budget Natural Farming) programme whose vision is to cover all six million farmers and farm workers in the state by 2027.

- **Liquid inoculant,** a diluted version of the solid microbial enrichment which is sprayed onto young crops.

SCALING-UP

The APCNF movement grew from 40,000 farmers in 2016 to almost 800,000 farmers in 2020. Their remarkable success in scaling-up is due primarily to building their movement on existing rural women's self-help groups. These groups are typically characterised by strong leadership, good organisation, transparency, accountability, and care for the most vulnerable. Women's groups are also highly credit-worthy and more successful in borrowing money to finance individual farmers' transition to natural farming methods. With women's groups at the helm of the community mobilisation process, entire villages can successfully be drawn in.

EXTENSION METHODS

The APCNF movement's practices have been developed into a package that is easy to teach and disperse. The most effective dissemination method is farmer to farmer, and the programme has trained farmer heroes, community resource people and lead farmers to train and mentor others who wish to try the approach. Farmers new to natural methods are encouraged to start gradually on small pieces of land using only a few of the techniques to begin with. As they become more accomplished, additional techniques are introduced and the scale of natural farming increased.

The use of information technology has also contributed to building the movement. Smartphones and WhatsApp groups are used for sharing experiences, collecting data, monitoring, learning, extension and capacity building, finance and marketing.

THE RESULTS

There is a general belief that yields dramatically decrease in natural farming. However, an independent assessment of the APCNF programme by the Centre for Economics and Social Studies over three seasons has shown no yield penalty – in fact many crops did better. There was a significant reduction in production costs and, thus, a substantial increase in net income. The assessment also found that the APCNF farms have better soil health, better crop health, and better resilience to climate and other shocks. Farmers were more economically empowered and there was improved dignity of labour on the farms. Women farmers report that they are healthier since converting to natural farming.

PRE-MONSOON DRY SOWING

One of the biggest breakthroughs in the APCNF programme is the practice of drought-proofing through a pre-monsoon dry sowing process. Instead of waiting for the first monsoon rains in June, farmers start sowing between 12 to 15 different kinds of seeds in dry soils from April onwards. More than 80,000 farmers farming about 50,000 acres across approximately 3000 programme villages in the state are implementing this practice.

Where previously they harvested only one crop a year if weather conditions were favourable, farmers are now successfully harvesting two to three crops in a year-despite farming in semi-arid, drought-prone districts. The method is a breakthrough for climate-resilient agriculture across the world. It holds great potential for Asia and Africa, where vast portions of land are not irrigated and have little rainfall and high temperatures.

YOUTH OPPORTUNITIES

Worldwide there are 1.5 billion jobs in agriculture, compared with 14 million in information technology and 12 million in the automobile industry. The APCNF programme has developed different high return integrated crop and livestock models as incentives to encourage youth to stay in rural communities and not migrate to cities. The programme encourages young farmers to become role models and recruits young agriculture graduates as natural farming fellows. Fellows stay in a village for three years where they must practice farming and motivate others.

If you want to change one farmer, you must change the entire village-it has to be a community effort. It takes five to seven years for the whole village to transform.

Vijay Kumar Thallam

Every farmer holds the future of the planet in HER hands.

Vijay Kumar Thallam

THE SECRETS OF SUCCESS

The APCNF movement has become extremely popular in a very short time. They have identified the following components as crucial to their success:

- **Farmer to farmer extension system** is the most effective way of teaching and learning;
- Farming is **knowledge-intensive** and not input-intensive;
- **Women self-help groups** play a critical role in collective action, knowledge dissemination, supporting each other during the transition, financing members to purchase the inputs required for natural farming, monitoring and managing the programme;
- **Long term handholding support is necessary for each farmer**. A farmer requires three to five years to make the transition;
- A **whole village approach** builds impact and sustainability. Convert all the farmers in a village into natural farming practitioners;
- **Support from the Agriculture Department** in the transition process has been very positive and vital to the success of the programme;
- **Government investments** in APCNF have been for capacity building, knowledge dissemination and long-term handholding. The programme estimates that it costs around 340 USD per farmer, over six years to transform 80% of the farmers in a village to natural farming;
- **Building strong evidence** in favour of natural farming is critical. Several studies by reputed national and international institutions have been commissioned.

The APCNF experience shows that natural farming is not only highly beneficial, but it is also scalable in a reasonable period of time.

RESOURCES

Video: Community-Managed Natural Farming - Vijay Kumar https://www.youtube.com/watch?v=gtIQ6aBT9iI&feature=share

Zero Budget Natural Farming http://apzbnf.in/

Healthy Soils for Healthy Communities

Healthy soils can reduce current and future climate impacts by sequestering carbon, improving water quality and supply, moderating temperatures, filtering pollutants, supporting plant growth, enhancing food production, and maintaining healthy communities.

Looking after our soils and restoring their health need not be a complicated or expensive exercise. This book outlines practical, low-cost things you can do to enrich soils and the food you grow in them. Healthy soils produce healthy plants, meaning your food will be more nutritious and your health enhanced.

This book also highlights the power of working together, of collaborating with family, friends, neighbours and others near and far, who like you, want to make the world a better place. Let's begin by seeing soil as a living system maintained by billions of organisms and then letting this new perspective lead us to adopt good soil care principles and practices.

Soil is the foundation of life. The life and health of our communities depends on the life and health of our soil.

GLOSSARY

Aeration	Supplying air.
Aggregates	Clumps of soil particles stuck together by slimes and glues produced by living organisms.
Agroecology	Agroecology promotes agricultural practices based on the science of ecology to enhance the sustainability of land-use systems and the livelihoods of the communities that depend on them. Agroecology is also a movement of like-minded people who aim to transform food systems and societies towards increased sustainability and food sovereignty.
Agroforestry	A method of land management involving the integration of beneficial trees into crop and livestock systems.
Bare fallow	Land left without crops for a season and kept free from vegetation by cultivation.
Biofertiliser	Concentrated, fermented, liquid-preparations that create food and a beneficial environment for soil microbes which in turn make organic matter, increase the amount and availability of plant nutrients, and improve root growth.
Bio-irrigation	The ability of plants to pull water to the soil's surface making it available for surrounding plants.
Community-managed natural farming (CMNF)	A farming movement developed in Andhra Pradesh, India.
Coppicing	Pruning a shrub to ground level periodically to stimulate shoot growth.
Cover crop	Crops grown in between or in rotation with a main crop to provide year-round cover for the soil.
Decomposition	The process of transformation of dead organic materials into simpler materials often through the action of living organisms.
Duff	Dead plant material that has fallen to the ground. Also called plant litter.
Ecosystem services	The many and varied benefits to humans provided by the natural environment and healthy ecosystems. Ecosystems can be agroecosystems, forest ecosystems, grassland ecosystems and aquatic ecosystems. Examples of services provided by ecosystems to humans include natural pollination of crops, purification of air and drinking water, decomposition of wastes, provision of soil nutrients for food crop production, carbon sequestration, cultural and recreational experiences contributing to our well-being.

Evapotranspiration	The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.
Exudates	Substances secreted by the roots of living plants and absorbed by soil micro-organisms with food and communication purposes between the plant and the soil microbiome.
Farmer managed natural regeneration (FMNR)	An easy, low-cost system for farmers to increase the number of trees in their fields and grazing areas to benefit crops, soil and livestock.
Farmer research networks (FRN)	Groups of farmers that carry out agroecological research relevant to their members through partnerships between farmer organisations, development organisations, and research institutions.
Green manure	A type of cover crop that is cut or slashed at a certain point in its life cycle and left on the soil surface to feed soil organisms, thereby improving soil structure and fertility.
Holistic management	A decision-making framework that considers ecological, economic, and social complexities for managing whole systems.
Humus	A dark, stable substance formed by the decay of organic matter.
Microbiome	Communities of micro-organisms (such as fungi, bacteria and viruses) living in a particular environment.
Monoculture	The cultivation of a single crop in a given area.
Optimised shrub intercropping system (OSS)	The practice of increasing the density of native shrubs in fields or grazing areas through planting or protecting shrubs to benefit soil, crops and livestock.
Organic matter	Decomposed formally living material (such as leaves, bones, twigs).
Ph	Ph is a scale used to rate the acidity of a water solution.
Pollarding	Pruning a shrub or tree by removing the top branches to encourage it to grow in a more compact way.
Sequestering carbon	The removal and storage of carbon from the atmosphere in carbon sinks (such as oceans, forests or soils) through physical or biological processes, such as photosynthesis.
Soil health	The continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

ENDORSEMENTS

"This book provides hope for illuminating the fundamental relationship between a healthy soil and the life that grows from that. It illustrates practical technologies to build healthy soils and thoughtfully comments on the challenges of the competing agricultural paradigms to agroecological approaches. The diversity of inputs paints a picture of hope for building healthy soils that are part of moving us toward an equitable and vibrant future".
Jane Maland Cady, International program director – McKnight Foundation, co-director Collaborative Crop Research Program

"As a public health physician who has been in the health development space for over 35 years, I have come to realize and appreciate that without healthy soils we cannot achieve human health; the two ecosystems are two sides of the same coin...hence the apt title of this book 'Healthy Soils for Healthy Communities – An introduction to soil health practices for Africa".
Dr. Peter Ogera Mokaya, Public Health Physician and Agroecology Food Systems Advocate

"This enlightening book does an excellent job highlighting the close relationship between soil health and healthy food, and using a non-technical and accessible language to raise awareness about healthy soil as a precondition to healthy food. It comes in handy at a crucial time as Africa awakens to the potential of agroecology."
Dr Batamaka Somé, CCRP's regional representative for West Africa

"This book contains some incredible offerings from people whose heart and mind is set on building soil health for the health of the people of Africa. It will be a helpful tool to advance the movement, science and citizen-led change".
Dr. Walter Jehne, world renowned climate scientist and microbiologist

"Go for this book - It will provide you with an invaluable experience on building healthy soil for sustainable agriculture".
Dr Kofi Boa, founder for Centre for No-Till Agriculture in Ghana

"This guide provides a compilation of evidence based information on how the condition of agricultural soils is being rapidly degraded through abuse and articulates its negative influence on human health. The case for adopting agroecology by all agricultural practitioners, scientists, policy makers, and influencers worldwide is clearly justified and shown as the most practical and achievable option to restore functionality of natural systems that ensure sustainability and thereby averting continued soil degradation, collapse of food systems, climate change, poor soil health and poor health of communities dependant on food grown under such suboptimal conditions".
Dr. Isiah Mharapara, Director of the Agricultural Research Council in Zimbabwe

"Through the soil and seed we produce the food we eat. These patterns of consumption and production may conserve the environment or they may result in its degradation . This timely publication points us in the direction of food sovereignty and its clarion call for climate change mitigation and adaptation".
Dr Dan Taylor, former Director of 'Find your Feet'

ALLIANCE FOR FOOD SOVEREIGNTY IN AFRICA

Seed and Knowledge Initiative

ISBN: 978-9970-595-12-9