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IT'S SOILICIOUS!

How to prepare healthy meals from healthy soils

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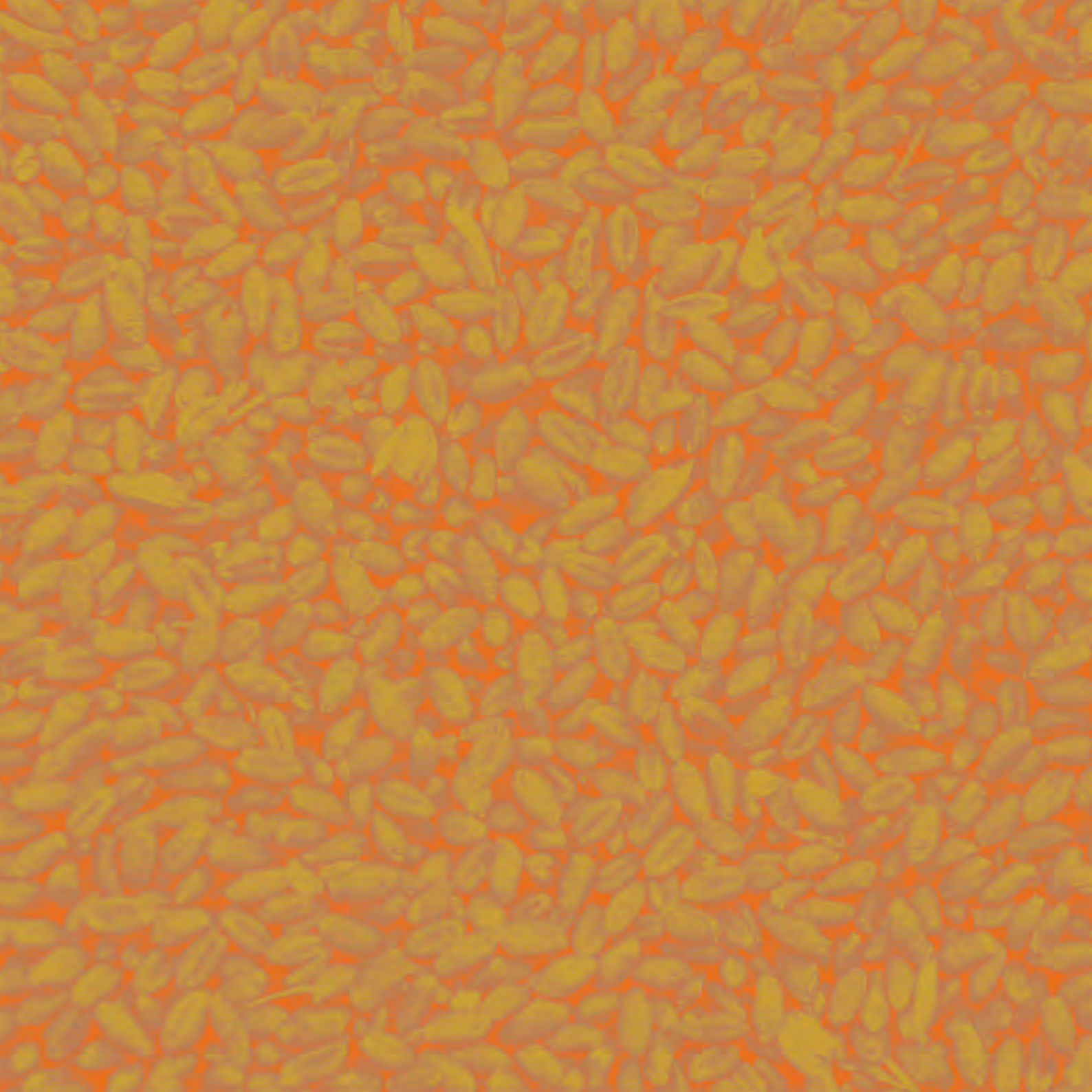

EDITORIAL

DEAR FOOD AND SOIL ENTHUSIASTS,

“You are what you eat” is a saying that comes with a true essence: How and what you eat has great impact on your daily life. Why not try and make your diet as good as possible? There are so many reasons to care about food: it nourishes body and soul, has the power to connect and inspire us and is often at the very heart of culture and social life.

Yet long before preparing our meals, the foundation for healthy food can be found in the ground, to be exact in our soils, since they provide the basis for over 95 per cent of our food. This makes soils a vital part of our food system. However, they are under threat: On a global scale, more and more soils face degradation. And while the amount of land available for agriculture is shrinking, the number of people who need to be fed and well-nourished is growing.

To protect our soils and ensure food security we need innovative tools. This is where the Global Programme “Soil Protection and Rehabilitation for Food Security” (ProSoil) implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH steps in. Commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and co-funded by the European Union (EU), ProSoil supports local, national and international partners in implementing and exchanging knowledge on agroecological soil protection and rehabilitation measures tobuild resilience against multiple crises and ensure food security. This applies in particular to the EU-cofunded part of ProSoil “Enhancing soils and agroecology for resilient agricultural and food systems in Sub-Saharan Arica” (ProSilience). This cookbook is our way of sharing this knowledge with you. We invite you to flip through the pages and try some of our delicious recipes from all around the world.

Before letting you dive in, we would like to thank everyone who was involved in this cookbook.
A special thanks goes to the colleagues in our partner countries who collected the recipes.
Without their profound knowledge of local foods and crops, this book would not have been possible.

With that being said, we wish you a joyful and insightful reading.
Now: Enjoy and taste what comes from healthy soils!

INTRODUCTION

At a first glance, healthy soils may not attract your attention, when in reality they should! Soil is the foundation of our life, our food, our biodiversity. Healthy soil provides nutritious foods and more stable yields as well as clean water and fresh air to breathe, allowing not only humankind but animals and plants to live healthy lives. Hence, soil fertility is crucial in ensuring a decent life for all of us.

Yet the sad truth is that nowadays more than 40 per cent of global soils are degraded.[1] And if business continues as usual, up to 90 per cent of our soils might be degraded by 2050.[2/3] Soil fertility is declining mainly due to human activity, in particular the use of unsustainable and harmful agricultural practices. The changing climate with more frequent and extreme weather events such as heavy rain or droughts is further increasing the pressure on agricultural soils and crop quality.[4/5] Additionally, current global and local incidents like conflicts and wars are constantly stressing and shocking our food systems. These disruptions cause collapsing supply chains, restricted movement of workforce and limited access to resources.

To protect soils, build resilience and hence food security, ProSoil is active in Benin, Burkina Faso, Ethiopia, India, Kenya, Madagascar and Tunisia. There, it cooperates with farmers – the main decision makers, when it comes to soil management – following a bottom-up approach, while promoting soil health and good practices at policy level.

ProSoil also organises national and international fora focussing on South-South exchange on agroecological and other practices. Agroecology is key to building resilience against current crises. It contributes to the much-needed transformation of agricultural and food systems and follows a holistic and socio-ecological approach going far beyond conventional agricultural practices. For example, agroecology aims to link producers and consumers – a purpose that this cookbook also serves.

Another game changer for food security and regional development is local production. While the global division of labour makes a lot of sense for some parts of the agricultural and food system, local production means, for example, being less dependent on imports. When food is produced locally, it provides a higher nutritious value due to shorter transport distances – which in turn means fewer emissions. Another strong argument for local production is that it can contribute to greater biodiversity. And more people can be employed at local level, leading to higher incomes within a community.

Building resilience also requires looking at those most affected by degraded soils, like women. Women make a significant contribution to the livelihoods and food security of their families. They are primarily responsible for food production at home and thus depend on healthy soils. However, all too often they bear the consequences of crises to a much greater extent than men as they experience discrimination in accessing resources (such as financial resources), their rights (such as land rights) and representation (such as participation in decision-making). Following the systematic disadvantages and discrimination due to their gender, women and girls are also more likely to suffer from hunger and malnutrition. Addressing specifically women is therefore key for the transition to sustainable agricultural and food systems.
Knowing how and what to cook and eat is essential for a good life. But knowing which ingredients to use, how to prepare and grow them and how to build resilience is a superpower that empowers entire communities.

Ultimately, this cookbook aims to provide you, dear reader, with healthy and diverse recipes collected by GIZ colleagues within their respective countries. At the same time, you receive valuable information on good agricultural practices aiming at maintaining healthy soils and building resilience against the many crises we will face in the coming years and decades.

The Global Programme "Soil Protection and Rehabilitation for Food Security" (ProSoil) is part of the Special Initiative "Transformation of Agricultural and Food Systems". It is commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and co-funded by the European Union and the Bill and Melinda Gates Foundation. It contributes to accomplishing Sustainable Development Goal 2 (SDG 2): Zero hunger. ProSoil is active in Benin, Burkina Faso, Ethiopia, India, Kenya, Madagascar, and Tunisia. Since its inception in 2014, the programme was able to rehabilitate more than 812,000 hectares of land. In the same time, the average yields achieved by smallholder farmers in the intervention areas have increased by nearly 40 per cent. Thanks to these measures, the food security of over one million people has improved.

Visit the programme online:

https://www.giz.de/en/worldwide/129677.html

SOWING THE SEEDS OF CHANGE: HOW AGROECOLOGY HELPS PROTECT OUR SOILS AND SECURE HEALTHY HARVESTS

Beneath our feet lies a precious treasure: the soil. Without it, life as we know it, would not be possible. To understand the importance of soil, we need to learn about the various ways through which this substance supports a healthy life.

To begin with, soil is defined as the natural material that covers the earth's surface, consisting of mineral and organic matter, water, and air.[6/7] In technical terms, soil health is influenced by chemical, physical and biological factors. It serves as the foundation for plants and trees to grow. Healthy soil produces high quality and healthy food, has the capacity to store water and carbon and plays an important role in nutrient conversion. **Ultimately, healthy soils are key in maintaining functioning ecosystems and to protect biodiversity.**[8] In short, soil is at the very heart of human, animal and plant livelihoods.

HEALTHY SOILS: SOIL PROTECTION AND AGROECOLOGY

To ensure healthy and functioning soils, farmers apply soil protection and rehabilitation practices.[9] **Soil protection refers to the prevention of any degradation, whereas rehabilitation aims to turn unproductive land back into flourishing land.** Soil protection and rehabilitation measures and approaches include integrated land use planning, changes in plant production management, use of (organic) soil enhancers, minimum soil tillage, integrated soil fertility management, conservation agriculture and many more.
Soil protection and rehabilitation also tackles the negative effects of unsustainable agricultural practices such as nutrient imbalance, land and ecosystem degradation, biodiversity loss, climate change and food insecurity.
It enables environmental improvements with economic and social benefits. Improved soil health boosts resilience to pests and extreme weather, leading to higher yields.

Higher yields improve food availability and heighten incomes, therefore improving food accessibility. Rural communities benefit from improved soil function as incomes and food supply stabilise. Moreover, the application of soil protection and rehabilitation measures increases the nutritional value of regional diets since the rotation of agricultural products leads to the consumption of more diverse and nutrient-richer crops including vegetables and protein-rich pulses. **Overall, soil protection and rehabilitation support food production, environment conservation, healthy diets and economic stability.**

ProSoil combines soil protection and rehabilitation measures with the concept of agroecology. In fact, soil protection and rehabilitation are pivotal to the agroecological transition. **Nine out of 13 agroecological principles**, set out by the Committee on World Food Security, directly or indirectly **build upon soil protection**. This connection lies at the heart of the programme and is reflected in its mission statement on agroecology.[10] Due to this connection, agroecological transformation can be considered a path for the development towards sustainable agriculture without being an all-or-nothing approach. Likewise, not only maximum solutions in soil protection contribute to change. To put it another way: Often the most sustainable solutions lie in simple techniques, that can be easily implemented and financed by farmers. These techniques can be implemented step by step, or even partially they will still yield success.
Soil protection is important for everyone, for conventional and organic farming, for small and large-scale farms, for subsistence and market-oriented farms. This includes consumer, policy and cultural aspects.[11]
Agroecolgy helps maintain and create fertile soils, regenerate ecosystems and increase biodiversity. As part of soil protection it is a cornerstone of climate protection in agriculture increasing the resilience of agricultural systems and their actors to the effects of climate change.
It combines traditional knowledge and modern technologies that have the capacity to unlock this potential.

FOOD FOR TOMORROW: GOING A STEP FURTHER – FROM FOOD SECURITY TO HEALTHY AND SUSTAINABLE DIETS

A healthy diet, at all stages of life, helps to prevent malnutrition and diseases as well as any conditions which may result from it. In fact, the UN Committee on Economic, Social and Cultural Rights (CESCR) has recognised that achieving healthy diets for all is crucial to the fulfilment of all human rights. Yet, in 2022, up to 828 million people worldwide suffered from hunger, and another two billion were chronically malnourished.[12] Most people affected by malnutrition live in Africa and Asia. Malnutrition decreases their capability and opportunities for development thus affecting the development prospects of entire countries. Yet, the availability of and access to any food alone does not suffice. To not only ensure food security but promote a healthy way of eating, it is essential to talk about balanced nutrition, hygiene and where your food comes from. Within these efforts we must specifically address women and children: During the first 1,000 days – from pregnancy up to the child's second birthday – the so-called "window of opportunity", a lack of micronutrients, will stunt growth and impair cognitive and physical development in children. **Malnutrition and hunger in early life will therefore have a lifelong impact on the health and well-being of children and entire societies.**

A balanced supply of energy and essential nutrients ensures health and performance of our bodies. Macronutrients, which include carbohydrates, fats and proteins, play a crucial role in providing that energy. To grow and thrive, micronutrients such as iron, vitamin A and zinc are essential. A diverse selection of food helps to obtain the right amount of essential nutrients. A healthy diet consists of a wide variety of minimally processed foods. These fresh foods should not be polluted by contaminants or pesticides. A diet should be based around minimally processed tubers, whole grains, legumes, fruits and vegetables – robust and locally grown to reduce transport.[13] Fats and oils, as well as salt and sugar, should be consumed in moderate amounts.[14]

Caused by gender inequalities and assigned roles by social structures, women and girls are disproportionately exposed to hunger and all forms of malnutrition. Thus, ensuring access, availability and actual consumption of a healthy diet for women and adolescent girls is crucial to improve food and nutrition security. The minimum for a diverse diet for these groups consists of a daily dose of at least five out of ten food groups: Cereals, roots and tubers; pulses, nuts and seeds; dairy; meat, poultry and fish; eggs; dark, leafy greens and vegetables; other vitamin-A-rich vegetables; other vegetables in general and other fruits.[15]

To erase all forms of malnutrition and reduce hunger, the availability and access to food alone is not sufficient. We need holistic approaches to address the multiple causes of malnutrition and provide a healthy and sustainable diet for everybody.
This cookbook gives insights into what a healthy diet could look like. It showcases a selection of popular traditional recipes that are rich in vitamins, proteins, and minerals ready to be tried out!

HOW TO NAVIGATE THIS COOKBOOK

1. INTRODUCTION TO SOIL AND NUTRITION:

To get you, dear reader, in the right mood and help you learn about healthy soil and healthy eating, this book introduces each topic in one chapter. These are designed to provide you with enough information and tools to apply the key findings of this cookbook in your daily life.

2. CROPS AND RECIPES:

For this book, we have selected eight crops cultivated by farmers in India, Benin, Burkina Faso, Ethiopia, Kenya, Madagascar and Tunisia. They are classified into three groups: trees, pulses and cereals.

In each chapter, you will find information about their nutritional use, how to combine them with other crops and the conditions under which they grow well. If you are keen on learning about the agri-cultural practice in depth, there is always more to be found in the last chapter of the book.

When it comes to cooking, most crops can be replaced by similar ones. For example, millet is widely used in India. Sorghum, which is a variety of millet, is grown a lot in Madagascar. Anything you can cook with millet you can cook with sorghum, and vice versa!

Finally, the recipes – the heart and essence of each cookbook. For each crop, we have collected a variety of different recipes. They are not necessarily from the same region or country, offering you a fun and diverse cooking experience. You can combine them, swap ingredients or just be creative with what you have, as some ingredients, especially herbs, may not be available depending in what region of our planet you live in. As the dishes often represent cultural heritage there are as many ways to cooking them as there are to any national dish in the world – nearly as many as there are households. And while we did our best to provide you with exact measurements, you are best advised to follow your gut and sound judgement when preparing these unique dishes. Find out by yourself: The best recipes are created through experimentation and with individual creativity anyway.

3. CULTIVATION PRACTICES:

This chapter serves as an overview of agroecological practices such as agroforestry, intercropping, vermicompost, alley cropping, giving you some insight into the implementation of these practices. Please keep in mind that this section is not exhaustive!

4. GLOSSARY WITH TECHNICAL INFORMATION ON THE CROPS:

If you are interested in growing any of the crops mentioned, this is where to look for it. Here, you'll find information on how to cultivate the crops, how to spread the seeds, what the plants like and dislike or what they look like.

You are now equipped to navigate this cookbook and find the information you are looking for. Have fun exploring!

RECIPES

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→ **MAHUA** P. 18

→ **MORINGA** P. 24

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→ **DURUM WHEAT** P. 60

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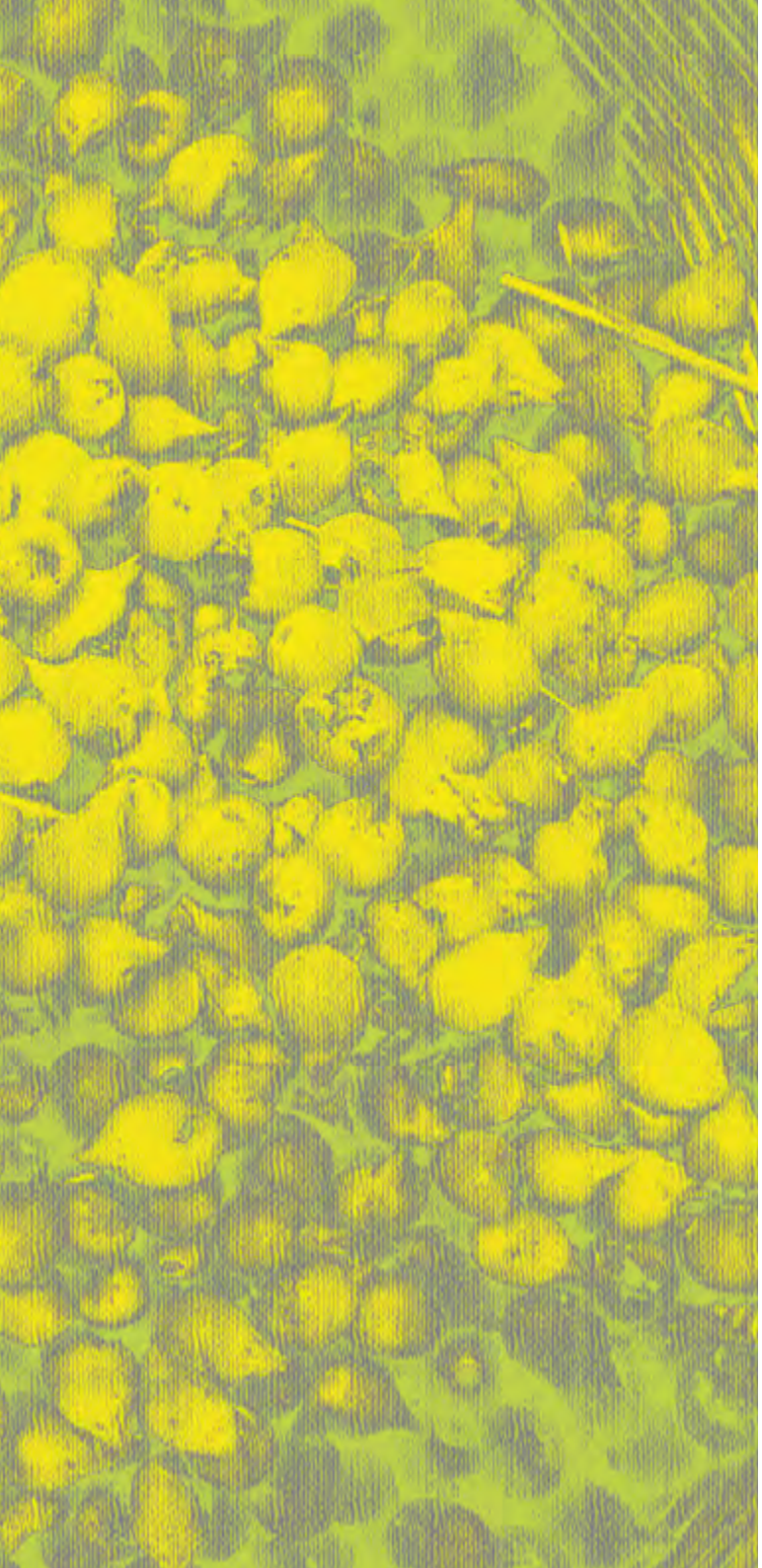
→ **SORGHUM** P. 70

RECIPES

TREES



1.1 MAHUA

1.2 MORINGA

TREES

MAHUA

Madhuca longifolia, commonly known as “butter” or “mahua tree”, is a perennial plant that originated in India. This medium- to large-sized deciduous tree typically grows to heights of 15 to 20 metres. It has a short trunk with 80 centimetres in diameter and the crown is round with multiple branches. Its leaves are long and narrow, giving rise to the specific epithet longifolia. The plant is characterised by its drought tolerance and ability to grow in arid and semi-arid climates. As a multipurpose tree, it has a wide geographical distribution, found in tropical and subtropical regions regions across Asia, including Afghanistan, India, Iran and Pakistan. The main production region for ***Madhuca longifolia*** is the arid and semi-arid regions of northwestern India.[16/17] Here, the mahua tree also has cultural significance. It is considered sacred by many indigenous communities and is associated with the goddess Durga.

MORE ABOUT MAHUA

→ GLOSSARY, p. 94

AGROECOLOGICAL USE AND BENEFIT

In agroecology, mahua plays a crucial role in soil protection, erosion control and as a forage crop. Apart from providing shade for other plants, thus limiting evaporation of humidity from the soil, mahua's biggest asset is prevention of soil erosion with its large spreading superficial root system. Like legumes, the tree binds nitrogen in the soil and therefore contributes towards local climate regulation and biodiversity. Additionally, its oil cakes, the biproduct in the process of extracting the oil from the seeds,are an excellent fertiliser and reduce harmful nematodes. After rinsing it to reduce high saponin levels, it can be used for fodder but should never exceed 20 per cent of the mix.[18]

Furthermore, mahua has been used for centuries by indigenous communities for its numerous benefits as the tree provides resources for different products. Its wood is used for construction while its leaves, flowers and fruits can be consumed by humans and animals. *Madhuca longifo*lia is also valued for its oil-rich seeds, which are commonly processed to mahua butter or oil used in industrial settings, like for cosmetics, but also for lighting lamps.

NUTRITIONAL AND HEALTH VALUE

Mahua flowers have antibacterial effects and are used to make a variety of traditional medicines, including treatments for respiratory ailments, fever, inflammation, headaches and swellings. They provide high amounts of vitamin A and C and relevant levels of calcium, phosphorus and antioxidants. The flowers are rich in sugar, and you can use their nectar as a sweetener. The fleshy outer coat of the fruit is used as a vegetable. The seeds are high in fat and if freshly extracted it can be used for cooking.

INDIAN MAHUA KI SABZI

INDIAN MAHUA KI SABZI IS A TRADITIONAL DISH MADE WITH THE MAHUA TREE FRUITS. IT IS A POPULAR DISH IN MANY PARTS OF INDIA, ESPECIALLY IN TRIBAL COMMUNITIES THAT HAVE BEEN USING MAHUA TREE PRODUCTS FOR CENTURIES. THE DISH HAS A SLIGHTLY BITTER TASTE AND IS OFTEN MIXED WITH OTHER VEGETABLES TO BALANCE OUT THIS FLAVOUR.

IT IS CONSIDERED TO HAVE SEVERAL HEALTH BENEFITS, INCLUDING IMPROVING DIGESTION AND PROMOTING OVERALL WELLNESS. INDIAN MAHUA KI SABZI CAN BE SERVED WITH A VARIETY OF INDIAN BREADS SUCH AS CHAPATI, NAAN OR ROTI, AS WELL AS WITH STEAMED RICE OR BIRYANI (FRIED RICE DISH). IT IS ALSO COMMONLY SERVED AS A SIDE DISH WITH DAAL (LENTIL SOUP) OR OTHER VEGETABLE DISHES. IN TRIBAL COMMUNITIES, MAHUA KI SABZI IS OFTEN EATEN WITH TRADITIONAL FOODS MADE FROM MAHUA, SUCH AS MAHUA DAAL (SOUP) AND MAHUA PURI (FLAT BREAD).

INDIAN MAHUA KI SABZI

INGREDIENTS (3–4 SERVINGS)

- **500 g mahua fruit**, washed
- **100 g green chilli**
- **25 g ginger**, finely chopped/ground
- **50 g garlic**, finely chopped/ground
- **100 g onion, finely chopped/ground**
- **100 g tomatoes**, washed and cut finely
- **1 tsp turmeric**
- **2 tbsp coriander powder**
- **10 g dry red chilli**
- **20 g dry coriander**
- **10 g rai** (black mustard seeds)
- **coriander leaves**, chopped
- **mustard oil**
- **garam masala**, ground
- **water**
- **salt**

ALTERNATIVE INGREDIENTS TO SUBSTITUTE MAHUA:

Any kind of beans or vegetables (e.g. sweet potato) growing in your area

PREPARATION

- Collect fresh mahua fruits that recently fell from the tree.
- Wash the fruits and bring them to a boil.
- Afterwards, get rid of the access water and squeeze the remaining water out of the fruits.
- Next, fry the mahua fruits with a bit of oil in a pan and put it aside for later.
- In another pan, heat the mustard oil and add the coarse spices.
- After a short while add the onion and stir.
- Next, add the ginger, garlic, turmeric, coriander and red chilli powder.
- Add the fried mahua fruits and mix with the spices until evenly coated.
- Now, add the tomatoes and a bit of salt to the pan, cover with a lid and let it cook for roughly 15 minutes.
- To finish, add the freshly chopped coriander and the Mahua ki Sabzi is ready to enjoy.

tsp = teaspoon

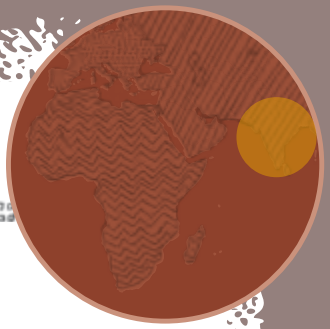
tbsp = tablespoon *(≈ 3 tsp)*

INDIAN MAHUA PICKLE

INDIAN MAHUA PICKLE, ALSO KNOWN AS MADHUCA PICKLE, IS A TRADITIONAL PICKLE MADE FROM THE FLOWERS OF THE MAHUA TREE. IT IS COMMONLY CONSUMED IN TRIBAL COMMUNITIES IN INDIA AND IS KNOWN FOR ITS UNIQUE SWEET AND SOUR TASTE.

THE FLOWERS ARE PICKLED IN A MIXTURE OF OIL, VINEGAR, AND SPICES, AND YOU CAN ENJOY IT AS A CONDIMENT WITH A VARIETY OF DISHES, SUCH AS RICE, BREADS OR CURRIES.

INDIAN MAHUA PICKLE



INGREDIENTS (SERVES 1–2 JARS)

500 g mahua flowers
100 g green chilli, finely chopped
50 g ginger, finely chopped
100 g garlic, finely chopped
10 g red chilli, dried and ground
10 g coriander seeds, ground
10 g rai (black mustard seeds)
1 tbsp carom seeds, ground
½ tsp fenugreek
20 g mango powder
10 g cumin seeds, ground
150 g mustard oil
salt

ALTERNATIVE INGREDIENTS TO SUBSTITUTE MAHUA:

Your local fruits and vegetables free of spoilage

BEFORE COOKING

- Spread a mat or a big cloth under the mahua tree to collect the falling mahua flowers.
- Clean and wash the mahua flowers with water and keep them in the hot sun for 3 days.
- After this, wash green chillies, ginger and garlic with water and keep them in the sunlight until the water dries up and all moisture is extracted, only then should they be used.

PREPARATION

- Grind all spices and red chillies.
- Add the mahua flowers, spices, onion, garlic and ginger to a jar/airtight container. The jar or container must be sanitized and dried before using it to store the pickle.
- Heat the mustard oil and add it to the jar.
- Let it cool down and after mixing well, close the lid.
- Keep the jar in the sun for two days. After five days the pickle will be ready to eat.

tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

TREES

MORINGA

Moringa oleifera, commonly referred to as “drumstick” or “miracle tree”, has garnered this name due to its exceptional nutritional and medicinal properties. Native to the foothills of the Himalayas, ***Moringa*** can now be found across various regions with tropical and subtropical climates, including Asia, Africa, and South America.
Moringa oleifera grows up to 12 metres in height but is often smallerin tropical and subtropical regions because of pruning the shrub. It grows fast and can already be harvested after six to eight months. It is highly adaptable and has a productive lifetime of 30 to 40 years.

MORE ABOUT MORINGA

→ GLOSSARY, P. 95

AGROECOLOGICAL USE AND BENEFIT

Moringa is highly valued for its multipurpose agroecological properties, such as its ability to thrive in diverse soil conditions, its nitrogen-fixing capabilities, and its contribution to sustainable farming practices as it can support livestock.[19/20]

You can use this versatile plant in hedges, for soil and water conservation as well as alley cropping as it provides shade for vegetables and crops.

NUTRITIONAL AND HEALTH VALUE

This tree is a foundation for food and health with high amounts of vitamin A and C as well as potassium.[21/22] You can eat its leaves, seeds, pods, shoots, and roots with the leaves being especially high in protein. Due to its high nutritional value, it has a lot of health benefits beyond solely satisfying basic needs.

MORINGA POWDER

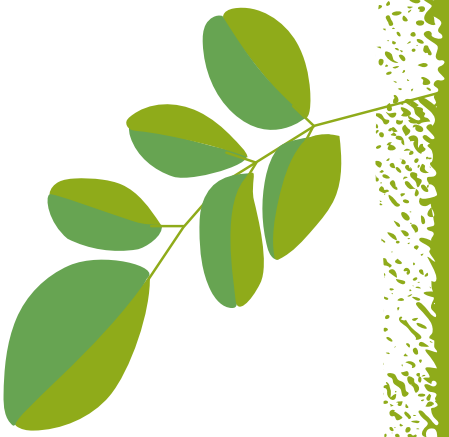
INGREDIENTS

***Moringa* leaves**

PREPARATION

- Wash your *Moringa* leaves thoroughly.
- Spread them on a clean cloth and pad them dry with another cloth.
- Once they are dry, remove the leaves from the stems. It is okay if you are left with tiny stems in between the leaves. Just make sure, you got rid of the harsher, bigger stems.
- Then, put them in a bowl/on a cloth and place them somewhere, where the sun does not reach them as we do not want to sun-dry them.
- After one day, cover the bowl with another clean cloth and let sit for another 2–7 days (depending on where you live) until you can hear a crispy sound when touching them.
- Now grind the leaves until you have a fine powder.
  You are now left with your own homemade *Moringa* powder!

Moringa leaves are typically harvested, washed, and then dried in the shade to preserve their nutrients. You can add the powder made from those leaves as a nutritional supplement to many dishes to diversify your vitamin intake. Put it on top of your porridge, salads or smoothies!



MORINGA TEA

INGREDIENTS

1 bunch *Moringa* leaves
1 l water
sugar (optional)

PREPARATION

- Wash the leaves thoroughly and discard any damaged or bad looking parts.
- Boil the water in a pot and add the leaves until the water has a light green colour. Strain the liquid into a teapot and add sugar to taste.

tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

INDIAN DRUMSTICK CURRY

INDIAN DRUMSTICK CURRY, ALSO KNOWN AS MURUNGAKKAI CURRY, IS A POPULAR SOUTH INDIAN DISH MADE WITH THE MORINGA SEED PODS, CALLED DRUMSTICKS.

THE CURRY HAS A MILD, SLIGHTLY SWEET TASTE AND A TENDER TEXTURE THAT COMPLEMENTS THE SPICY AND TANGY FLAVOURS OF SOUTH INDIAN CUISINE.

INDIAN DRUMSTICK CURRY IS TYPICALLY SERVED WITH STEAMED RICE OR ROTI (INDIAN FLATBREAD) AND IS OFTEN ACCOMPANIED BY OTHER DISHES SUCH AS DAAL (LENTIL SOUP), RAITA (YOGURT-BASED SIDE DISH), AND A VARIETY OF VEGETABLE DISHES.

IN SOUTH INDIA, THE CURRY IS ALSO COMMONLY PAIRED WITH DOSA (A TYPE OF FERMENTED CREPE MADE FROM RICE AND LENTILS) OR IDLI (STEAMED RICE CAKES).

INDIAN DRUMSTICK CURRY

INGREDIENTS (4 SERVINGS)

8–10 medium size drumstick pods*, washed & cut into 2,5-cm pieces
2–3 potatoes, washed, peeled & diced
10 cloves of garlic, crushed
2,5-cm piece ginger
4–5 green chillies, washed & chopped
2 tbsp coriander leaves, washed & chopped
½ tsp coriander powder
1 tsp turmeric powder
2–3 tomatoes, washed & diced
2 tsp mustard seeds
1 tsp cumin seeds or jeera *(type of cumin seed, typical in India)*
cooking oil
water
salt

ALTERNATIVE INGREDIENTS TO SUBSTITUTE DRUMSTICK:

You can consider using other vegetables or cereals that provide a similar texture and nutritional profile

· celery (peeled)
· green beans

For the extra touch:
· cashew *(roasted together with onions)*

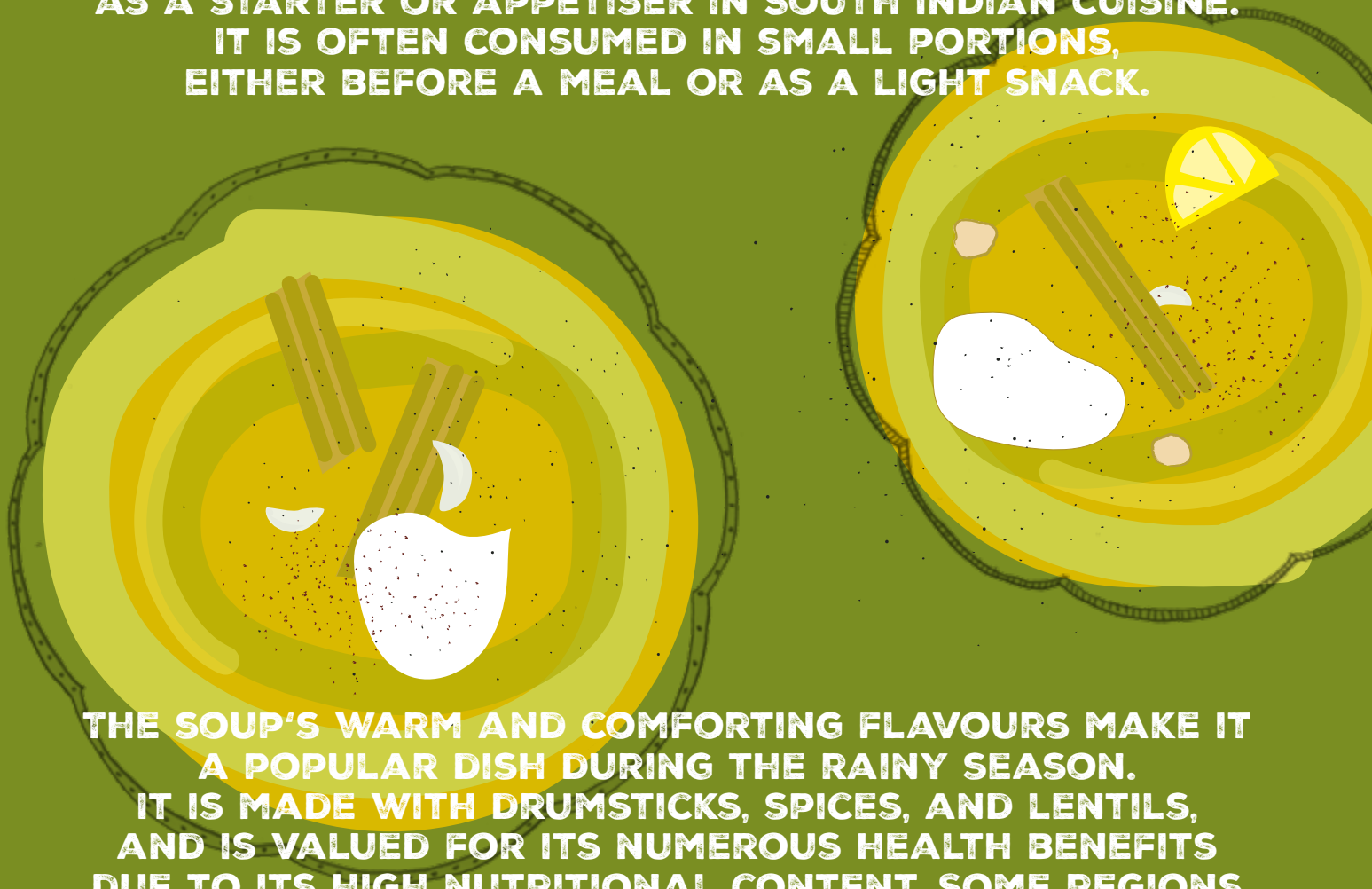
PREPARATION

- Peel and cut the potatoes into pieces and boil them.
- In the meantime, prepare a mustard paste by crushing the seeds and mixing them with water.
- Next, sauté the cumin seeds and potatoes in some oil for 5 minutes.
- Add the drumsticks and stir. Then add all other ingredients except the mustard paste and fry for 5 more minutes.
- Now add the mustard paste with 350 ml of water.
- Cover the pan and let it cook until the drumsticks are cooked.
- Garnish with freshly chopped coriander and serve with rice or bread.

tsp = teaspoon tbsp = tablespoon *(≈ 3 tsp)*

INDIAN DRUMSTICK SOUP

INDIAN DRUMSTICK SOUP IS COMMONLY SERVED AS A STARTER OR APPETISER IN SOUTH INDIAN CUISINE. IT IS OFTEN CONSUMED IN SMALL PORTIONS, EITHER BEFORE A MEAL OR AS A LIGHT SNACK.



THE SOUP'S WARM AND COMFORTING FLAVOURS MAKE IT A POPULAR DISH DURING THE RAINY SEASON. IT IS MADE WITH DRUMSTICKS, SPICES, AND LENTILS, AND IS VALUED FOR ITS NUMEROUS HEALTH BENEFITS DUE TO ITS HIGH NUTRITIONAL CONTENT. SOME REGIONS AWARD IT MEDICINAL PROPERTIES SUCH AS BOOSTING IMMUNITY, AIDING DIGESTION AND ALLEVIATING COLD AND FLU SYMPTOMS. THE SOUP HAS A SUBTLE, EARTHY FLAVOUR AND A SLIGHTLY THICK CONSISTENCY, WHICH MAKES IT A HEARTY AND FILLING DISH.

INDIAN DRUMSTICK SOUP

INGREDIENTS (4 SERVINGS)

1 kg drumstick pods, washed & cut into 2,5-cm pieces
4-5 garlic cloves, chopped finely
1-cm piece ginger, chopped finely
3 tsp pepper powder
1 tsp cumin seeds, ground
50 g cream
2 large lemons
cooking oil
water
salt

ALTERNATIVE INGREDIENTS TO SUBSTITUTE DRUMSTICK:

You can consider using other vegetables or cereals that provide a similar texture and nutritional profile

· celery (peeled)
· green beans

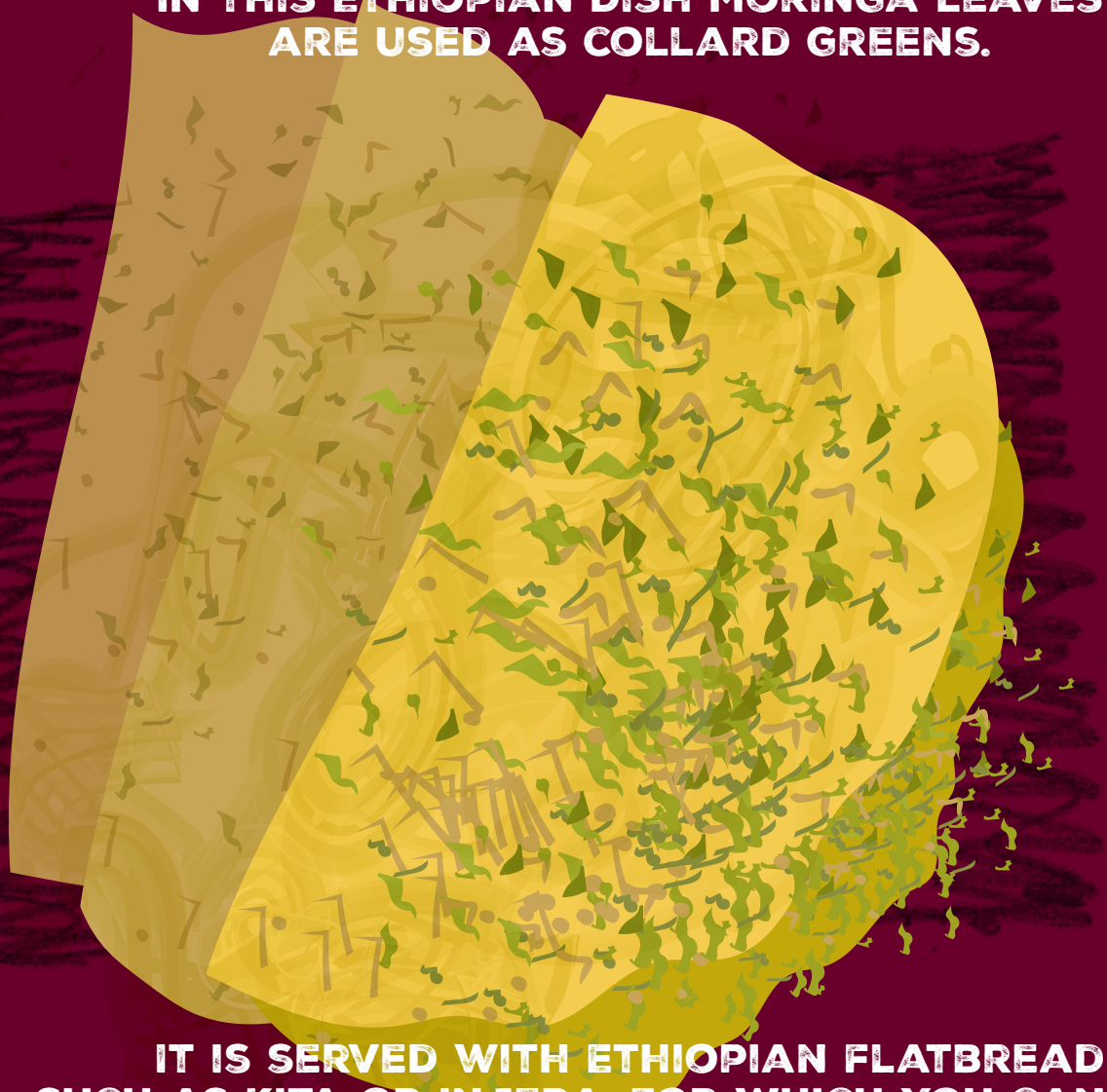
PREPARATION

- Heat oil in a big pan, then add ginger, garlic and onions and fry them.
- Add chopped drumsticks and fry everything for a few minutes.
- Add 2 litres of water and cook everything on high heat for 5–10 minutes.
- Let the mixture cool down, puree in a mixer and strain.
- Cook the soup for another 3–5 minutes.
- Garnish with pepper powder, roasted cumin seed, rock salt, lemon juice and cream.

tsp = teaspoon tbsp = tablespoon *(≈ 3 tsp)*

MORINGA WITH FLATBREAD FROM ETHIOPIA

IN THIS ETHIOPIAN DISH MORINGA LEAVES ARE USED AS COLLARD GREENS.



IT IS SERVED WITH ETHIOPIAN FLATBREAD SUCH AS KITA OR INJERA, FOR WHICH YOU CAN FIND THE RECIPES IN CHAPTER 3.2 (P. 75).

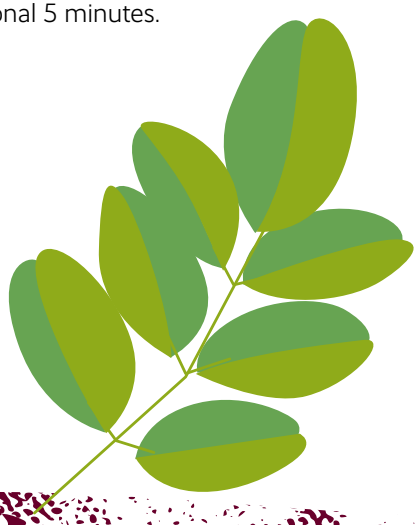
MORINGA WITH FLATBREAD

INGREDIENTS (3–4 SERVINGS)

4–5 bunches *Moringa* leaves
Kita/Injera
onion, diced
garlic, chopped
cooking oil
salt
water

PREPARATION

- In a pot, bring water to a boil.
- Add 4–5 handful of thoroughly washed *Moringa* leaves to the boiling water, close the lid and let it simmer for 10–15 minutes.
- Add onion, garlic, salt and a little bit of oil and cook for additional 5 minutes.
- Serve it warm with Kita or Injera.



tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

RECIPES

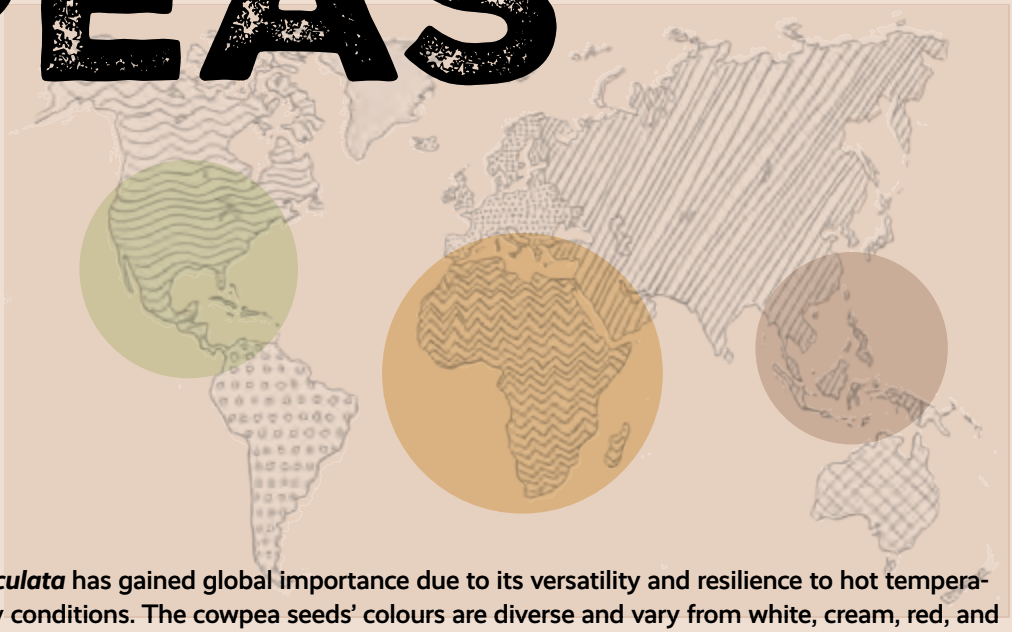
PULSES


2.1
COWPEAS


2.2
MUNG BEANS


2.3
VELVET BEANS

COW-PEAS



Vigna unguiculata has gained global importance due to its versatility and resilience to hot temperatures and dry conditions. The cowpea seeds' colours are diverse and vary from white, cream, red, and black to mottled.[23] This is why this annual legume is known by various names, such as "black-eyed pea", "southern pea" or "crowder pea", depending on the variety and region. ***Vigna unguiculata*** is widely distributed in warm and tropical regions, including sub-Saharan Africa, Asia, the Americas, and the Caribbean – with Western Africa showing the highest production share of roughly 96 per cent of the annual global cowpea production.[24] The plant typically has trailing or climbing stems and produces clusters of small, white, lavender or purple flowers. With its ability to thrive in challenging environments and adapt to diverse agroecological conditions, cowpea today serves as a vital source of sustenance and income for more than 110 million people worldwide.[25/26]

MORE ABOUT COWPEAS

→ GLOSSARY, p. 96

AGROECOLOGICAL USE AND BENEFIT

Vigna unguiculata has excellent agroecological potential due to its ability to fix atmospheric nitrogen thus enhancing soil fertility and reducing the need for mineral fertilisers. It is well-suited for intercropping with maize, sorghum, and millet because it suppresses weed and benefits the soil structure. The plant's deep taproot system enables efficient nutrient uptake and water utilisation, making it resilient to drought conditions. Additionally, its ability to tolerate low soil fertility and adapt to diverse climatic conditions makes it a valuable component of sustainable farming systems. Furthermore, after harvesting the pods, the remaining trunk and leaves are highly appreciated by livestock as fodder.[27]

DID YOU KNOW?

In some parts of Asia, cowpea is called "asparagus bean".

NUTRITIONAL AND HEALTH VALUE

Playing an important role in the traditional African cuisine, cowpea has been consumed primarily as a staple food, providing protein-rich seeds and nutritious leaves. It is therefore a valuable addition to your diet, which is both true for human as well as animal consumption. The seeds are a rich source of protein, dietary fibre, vitamins, such as folate, niacin and thiamine, and minerals, including calcium, iron and potassium. Cowpea can undergo various processing practices to enhance its culinary versatility and nutritional value. Common methods include dehulling, soaking, boiling, fermentation, and grinding. Dehulling involves removing the outer seed coat to improve digestibility and reduce cooking time. Soaking and boiling help soften the seeds and eliminate antinutritional factors. Fermentation is employed to produce traditional cowpea-based products like „akara" (deep-fried cowpea fritters) or „kose" (deep-fried cowpea balls), which improve protein digestibility and enhance flavour. The consumption of cowpea has been associated with various health benefits, including improved blood sugar control, reduced risk of chronic diseases like heart disease and certain cancers as well as enhanced digestive health due to its amount of fibre.[28/29]

OUAKÉ FROM BENIN

OUAKÉ IN THE BARIBA LANGUAGE[1], ALSO CALLED ATASSI IN THE FON LANGUAGE[2] AND AYIMONLOU IN THE MINA LANGUAGE[3], IS A POPULAR DISH IN BENIN.

IT IS PREPARED WITH RICE AND COWPEAS AND IS COMMONLY SERVED WITH STEW, MEAT OR SOUPS.

1 *Bariba is the language of the Bariba people of Benin and Nigeria.*
2 *Fon is spoken in Benin, Nigeria, Togo, Ghana and Gabon by approximately 1.7 million speakers, and is the language of the Fon people.*
3 *The Mina language is a Gbe language spoken in the southeast of Togo, but also in parts of Benin.*

OUAKÉ

INGREDIENTS (20 SERVINGS)

1 kg cowpeas
1 kg rice
potash (salt with potassium)
chilli
salt
cooking oil

ALTERNATIVE INGREDIENTS TO SUBSTITUTE COWPEAS:

- black beans, navy beans, soybean, pinto-, lima- or kidney beans
- any other firm beans

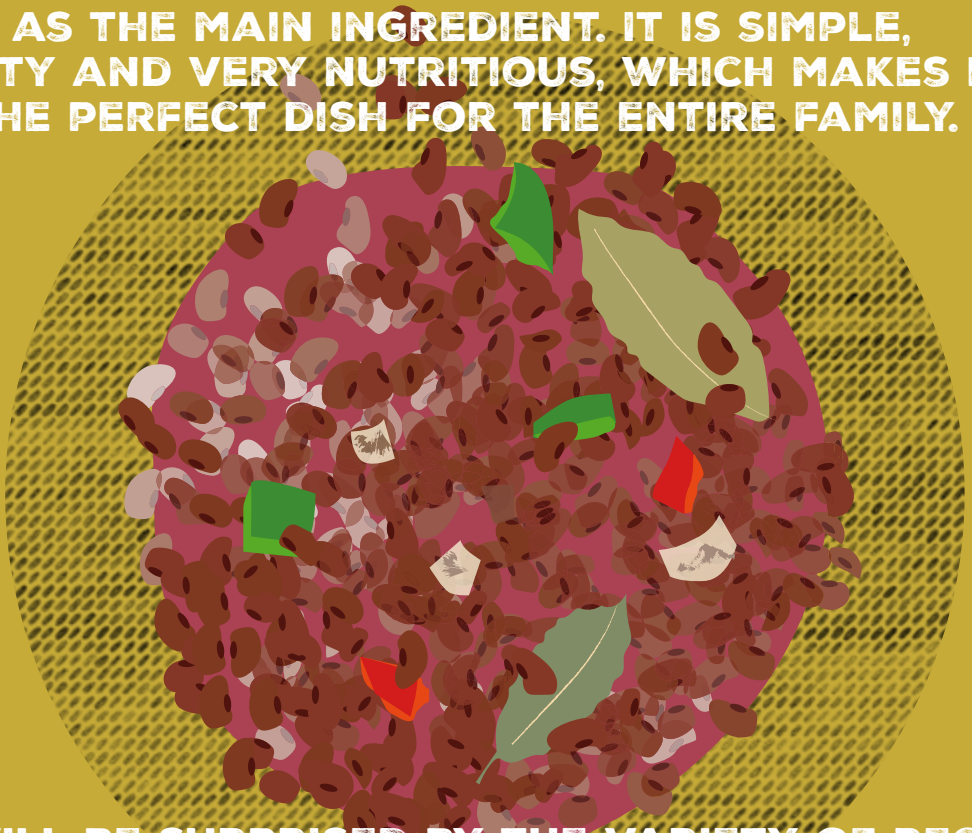
PREPARATION

- Prepare the cowpeas by sorting out any stones or bad grains and wash them.
- Then heat water in a pot on the stove and add the sorted and rinsed cowpeas.
- Add the potash and leave to simmer until the beans become al dente as the potash softens the cowpea.
- Next pour the cowpeas into a sieve and replace the water.
- Stir the cowpeas and add rice.
- Add salt and leave to simmer for 30–45 minutes or until the water has been completely absorbed by the cowpeas and rice.
- You can serve the Ouaké with a little oil and chilli.

tsp = teaspoon tbsp = tablespoon *(≈ 3 tsp)*

BENGA (MOORÉ)[4] OR SÔSÔ (DIOULA)[5] FROM BURKINA FASO

BENGA IS A TRADITIONAL DISH WITH COWPEAS AS THE MAIN INGREDIENT. IT IS SIMPLE, TASTY AND VERY NUTRITIOUS, WHICH MAKES IT THE PERFECT DISH FOR THE ENTIRE FAMILY.



YOU WILL BE SURPRISED BY THE VARIETY OF RECIPES EXISTING! WHEN ASKING FOR THE RECIPE, EVERY PERSON WILL GIVE YOU ANOTHER VERSION OF THE DISH. IT VARIES OF COURSE FROM REGION TO REGION, BUT EVEN ON THE HOUSEHOLD LEVEL, EVERYBODY HAS ITS SECRET INGREDIENT OR METHOD TO MAKE THE PERFECT BENGA TO THEIR TASTE.

4 *Mooré is one of four official regional languages of Burkina Faso. It is the language of the Mossi people, is spoken as a first or second language by over 50 percent of Burkina Faso's population and is the main language in the capital city of Ouagadougou.*

5 *Dioula is a language of the Mande language family spoken mainly in Burkina Faso, Ivory Coast and Mali, and also in some other countries, including Ghana, Guinea and Guinea-Bissau. It is a trade language in West Africa and is spoken by millions of people, either as a first or second language.*

BENGA (MOORÉ) / SÔSÔ (DIOULA)

INGREDIENTS (4 SERVINGS)

1 tsp potash (salt with potassium)/baking soda, dissolved in 60 ml water
120 g cowpeas
30 g pearl millet/maize kernels/rice
1 onion, diced
1 tomato, diced
½ green bell pepper, sliced
1 tsp garlic-parsley-ginger puree
2 bay leaves
hot pepper puree
cooking oil
salt
water
***optional:* 1 tbsp tomato paste**, diluted in 120 ml water

ALTERNATIVE INGREDIENTS TO SUBSTITUTE COWPEAS:

- black beans, navy beans, soybean, pinto-, lima- or kidney beans
- any other firm beans

PREPARATION

- Thoroughly wash the cowpeas and rice/pearl millet/maize in separate bowls of water. Let the cowpeas soak in fresh water for about 2 hours.
- Pour 1,5 litres of water in a cooking pot and bring to a boil.
- Put the beans in the boiling water and let them boil for 30 minutes or more until cooked.
- Add the diluted potash or baking soda and let it cook for 5 more minutes.
- Add the pearl millet/rice. The remaining water should be sufficient to cook the pearl millet/rice for about 20 minutes. If not, add more. If not, add the needed quantity of water more.
- Let the mixture of beans and pearl millet/rice cook for 20 minutes until all ingredients are cooked. All the water should have evaporated. Turn off the heat.
- Serve the cowpeas and grains with the sauce and hot pepper puree to taste.

tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

PULSES

MUNG BEANS

Vigna radiata's origins can be traced back to India. Commonly known as mung bean, this drought-resistant crop is susceptible to waterlogging, and therefore usually cultivated from sea-level up to heights of 1800 m, in regions where precipitation is too scarce for rice – the more dominant crop in India. Introduced early into southern China and Southeast Asia, its cultivation recently spread to regions with suitable climatic conditions worldwide, such as Ethiopia. Mung bean is an annual legume characterised by the erect growth of its numerous branches and leaves, conspicuous and short, white hairs across the plant and a deep root system. The leaves are trifoliate with long petioles and broad ovate leaflets. The pods are short-haired and contain greenish beans, in contrast to the closely related urad bean, Vigna mungo (false friend!), which is blackish and grows in long-haired pods.[30]

MORE ABOUT MUNG BEANS

→ GLOSSARY, P. 97

AGROECOLOGICAL USE AND BENEFIT

Within the legume family, *Vigna radiata* has one of the shortest growth cycles. It merely takes up to 60 days until the first pods can be harvested. Alternatively, sprout and to a lesser degree even leave consumption is common, as well as its use as pasture and green manure. Its fast growth and its ability to fix nitrogen in soils makes it suitable as a cover crop and for intercropping, for example in combination with maize, millet or cotton. Here, mung bean also supresses weeds and retains water in the soil. Apart from whole grains, split up Mung Dal and flour are used in dishes.[31]

NUTRITIONAL AND HEALTH VALUE

Mung beans are esteemed as the most wholesome among the pulses, free from the heaviness and tendency to flatulence associated with other pulses. Even among legumes, they stand out due to high protein contents. They contain the vitamins A, B1, B2, C and E, as well as folate, and is a good source for micronutrients, especially iron and zinc. Due to these attributes, it not only secures a healthy nutrition for many people but is used in traditional medicine in different cultures.

ETHIOPIAN FITFIT

FITFIT IS A TRADITIONAL ETHIOPIAN DISH REGULARLY SERVED DURING FASTING PERIODS BECAUSE IT IS MOSTLY SERVED VEGAN. THE RECIPE PRESENTED HERE IS AN EXOTIC VARIATION OF THE DISH WITH A FAIRLY NEW CROP: THE MUNG BEAN.

THIS DISH IS THEREFORE ONE OF MANY EXAMPLES OF HOW THE MUNG BEAN CAN BE INCLUDED IN LOCAL DISHES. MUNG BEAN IS GROWN IN ETHIOPIA ON SMALL SCALE, HOWEVER, ONLY A SMALL SHARE IS CONSUMED IN THE COUNTRY WHILE THE MAJORITY IS EXPORTED TO INDIA.

ETHIOPIAN FITFIT

INGREDIENTS (4 SERVINGS)

200 g mung beans, cleaned and sprouted
1–2 carrots, washed and diced
2 large potatoes, peeled and diced
1 onion, diced
2 garlic cloves, chopped
20 g ginger, chopped
1 leek rod, sliced
1 small celery, diced
2–3 tomatoes, diced
1–2 tsp turmeric
vegetable oil
salt
pepper

ALTERNATIVE INGREDIENTS TO SUBSTITUTE MUNG BEANS:

You can consider using other legumes or grains that provide a similar texture and nutritional profile

· lentils
· chickpeas, black-eyed peas or green peas
· quinoa
· barley

BEFORE COOKING

- Screw holes in the lid of an old jar big enough for water to flow out but small enough for the mung beans to not fit through.
- Fill mung beans into the jar and let them soak in water for 12 hours.
- Drain out/shake off the water. Fill the jar with water again, let the jar sit for 12 hours and drain it again.
- Repeat for four days or until you can see your beans sprouting.

PREPARATION

- Heat oil in a pot and add the onions.
- Then add the celery and turmeric and stir.
- Let it simmer for a short while and then add the carrots.
- After a while add the tomatoes, stir and put a lid on.
- Stir again and add the garlic, leek and mung beans.
- Then add diced potatoes and cover with water.
- Let it cook until tender, then add pepper and salt.
- Serve with Injera (flatbread, see p. 75) and top of with some more mung beans and herbs to decorate.

tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

PULSES

VELVET BEANS

Mucuna pruriens is a leguminous plant cultivated across tropical regions of Africa, Asia and Latin America. It is native to South and Southeast Asia, specifically in the region encompassing India and Thailand. It has a long history of traditional use in ayurvedic and other traditional medicine approaches in India. The plant is characterised by its climbing habit, the white to dark purple pendent inflorescences and trifoliate leaves with large, pointy leaflets. The plant is further notorious for the strong itchiness caused by the velvet cover of young plants and the pods, which is why its seeds, the pulses, are called velvet beans. The main production regions include India and parts of Africa, predominantly Western Africa.[32/33/34]

MORE ABOUT VELVET BEANS

→ GLOSSARY, P. 98

AGROECOLOGICAL USE AND BENEFIT

Mucuna pruriens is a legume used for green manure, cover crop and fodder production. It suppresses weeds and nematodes, improves soil structure and eventually breaks up crusted hard pans thus controlling water infiltration and erosion. Additionally, the crop is popular for improving soil fertility through nitrogen fixation and is known for its pest and disease resistance.[35] It is commonly intercropped with maize, pearl millet and sorghum. In the dry season, it might also be paired with bananas but must be pruned to prevent overgrowing of the banana plant. As an invasive legume, it can invade ecosystems instead of benefitting them if not managed well.

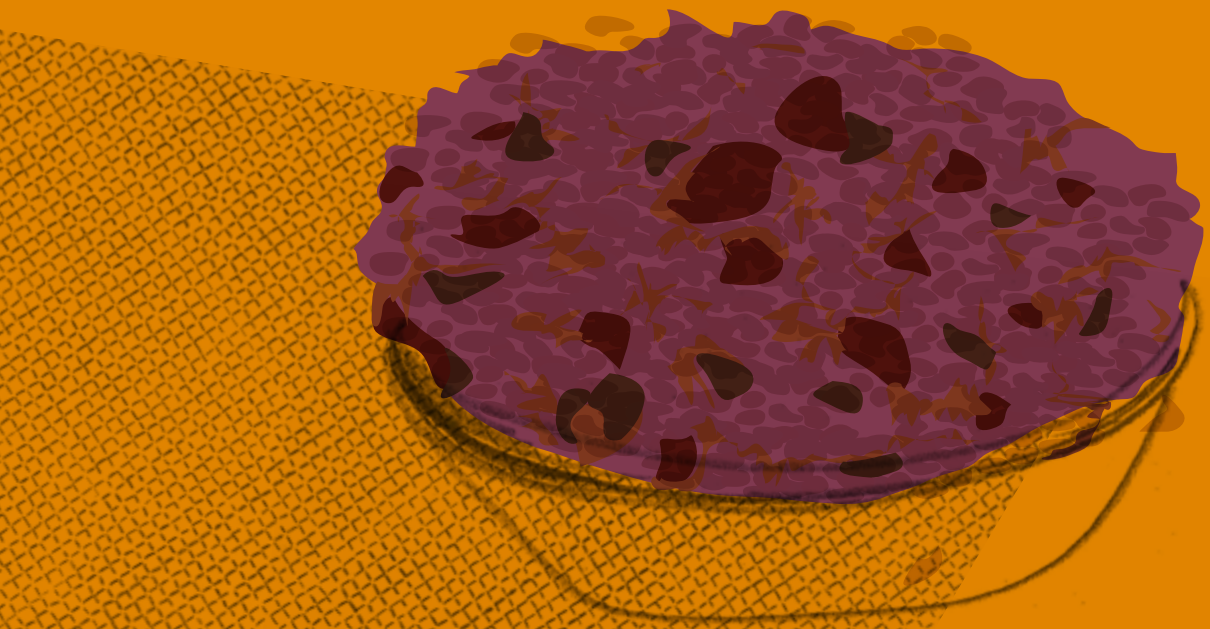
NUTRITIONAL AND HEALTH VALUE

Mucuna is a source for various minerals including calcium, iron and zinc. As a legume it also provides high amounts of proteins. Moreover, *Mucuna* provides you with many health benefits based on traditional medicine and finds a lot of application within the pharmaceutical industry due to its restorative antioxidant, antidiabetic and anti-inflammatory characteristics.[36] *Mucuna pruriens* has recently gained attention due to its high levels of L-DOPA, a precursor to dopamine, making it a potential treatment for certain neurological disorders like Parkinson's disease.

WITHOUT PROCESSING THE BEANS BY ROASTING,COOKING OR FERMENTING THEM BEFOREHAND, CONSUMPTION IS POISONOUS.

AFITIN FROM BENIN

YOU CAN USE AFITIN AS A CONDIMENT FOR YOUR DISHES LIKE MUSTARD.



IT IS TYPICALLY MADE FROM NÉRÉ (AFRICAN LOCUST BEAN) BUT CAN ALSO BE MADE OF FERMENTED MUCUNA BEANS.

AFITIN

INGREDIENTS

***Mucuna* beans**, dried
potash (salt with potassium)
water

ALTERNATIVE INGREDIENTS TO SUBSTITUTE MUCUNA:

Any kind of bean local to your area (e.g black beans, navy beans, black eyed peas, cranberry beans or any other firm bean)
· cowpea or soybean

PREPARATION

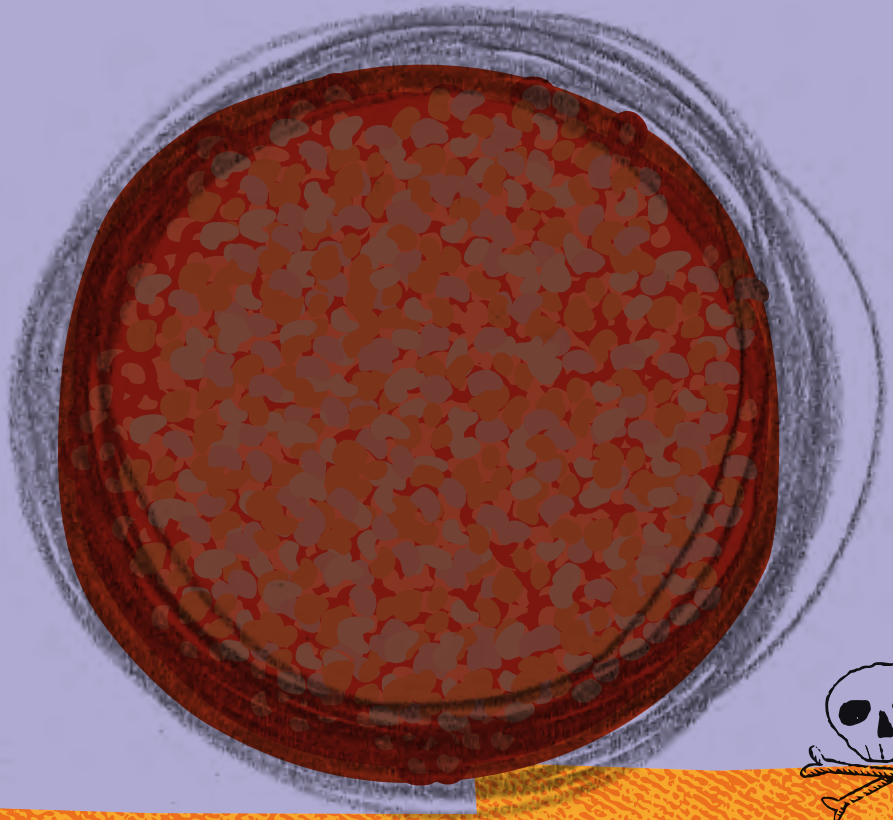
- Clean and sort the dried beans.
- Roast the beans for 15 minutes to get rid of the toxic substance and to improve the flavour.
- Crush the roasted beans using an appropriate grinder that is strong enough to remove the skin. The grinder should be cleaned immediately after.
- Add water and cook the beans for 9 hours (you can let it simmer overnight).
- Drain the water and cook again for another 10 minutes.
- Add potash and cook for 5 more minutes.
- Drain the water and spread the cooked mucuna beans on a woven cotton cloth or bag and cover with other bags. This creates anaerobic conditions and facilitates the fermentation of the beans for 24–48 hours. Alternatively put the seeds in a fermentation tank and let them rest for the same amount of time.
- The result of this process is the mucuna-based Afitin.
  For better preservation you can spread out the mucuna-based Afitin in a thin layer in the sun and dry it for 48–72 hours depending on the degree of sunlight.
  The dried Afitin is then ground and packaged.

tsp = teaspoon tbsp = tablespoon *(≈ 3 tsp)*

MUCUNA ABOBO FROM BENIN

ABOBO ITSELF IS NOT REALLY A DISH BUT RATHER JUST THE COOKED BEANS.

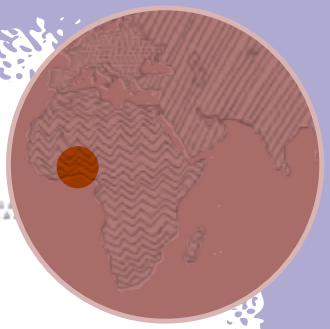
YOU CAN USE ALL VARIATIONS OF BEANS TO CREATE ABOBO BUT SINCE WE ARE USING MUCUNA,



IT IS IMPORTANT TO FOLLOW THE STEPS PRECISELY AS MUCUNA BEANS CONTAIN TOXIC SUBSTANCES IF THEY ARE NOT PREPARED IN THE RIGHT WAY.

ABOBO IS TYPICALLY SERVED WITH GARI (CASSAVA FLOUR) AND VEGETABLE OIL.

MUCUNA ABOBO



INGREDIENTS

***Mucuna* beans**, dried

water

ALTERNATIVE INGREDIENTS TO SUBSTITUTE MUCUNA:

Any kind of bean local to your area

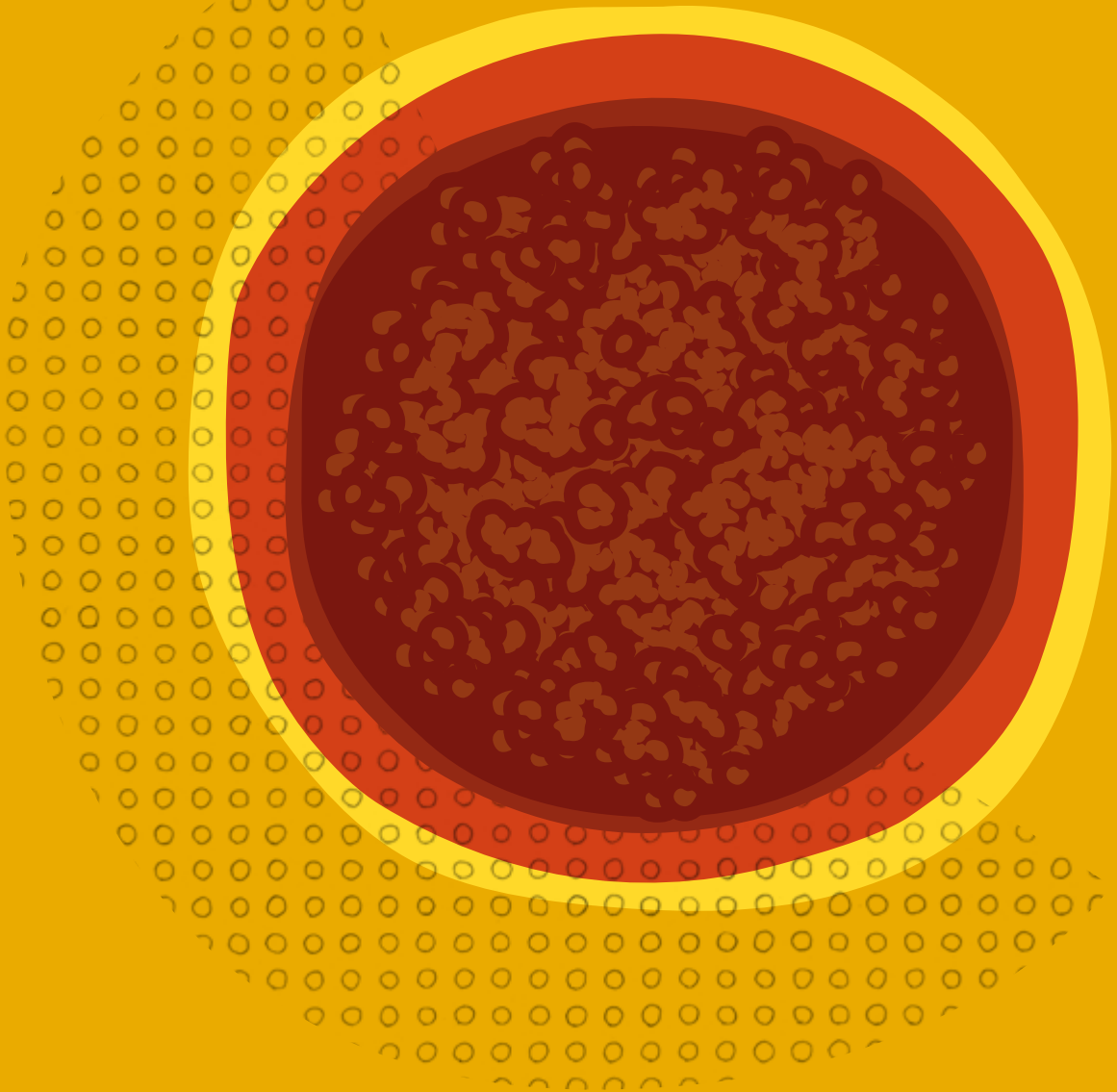
PREPARATION

- Sort out and clean the dried beans.
- Soak the beans in water for 12 hours and drain afterwards.
- For the skin to remove easily preboil the beans for about 15 minutes.
- Drain the water and let them cool for a few minutes.
- Remove the skin by carefully rubbing the beans between your hands. Rinse the beans to get rid of skins.
- Put the beans back on the stove with fresh water and boil for 10 minutes. Then drain the water and repeat with fresh water 3–4 times until the colour of the beans has changed.
- Now cook the beans for one more hour without changing the water.
- Drain the water, season the beans with salt or other spices of your choice, and enjoy.

tsp = teaspoon tbsp = tablespoon *(≈ 3 tsp)*

ZANKPITI FROM BENIN

ZANKPITI IS AN EASY DISH MADE FROM ROASTED MAIZE FLOUR AND MUCUNA BEANS WITH RED OIL.



ZANKPITI

INGREDIENTS (4 SERVINGS)

500 g *Mucuna* beans, cooked (Abobo)
500 g maize flour
vegetable oil
water

ALTERNATIVE INGREDIENTS TO SUBSTITUTE MUCUNA:

Any kind of bean local to your area (e.g. black beans, navy beans, black eyed peas, cranberry beans or any other firm bean)
· cowpea bean

PREPARATION

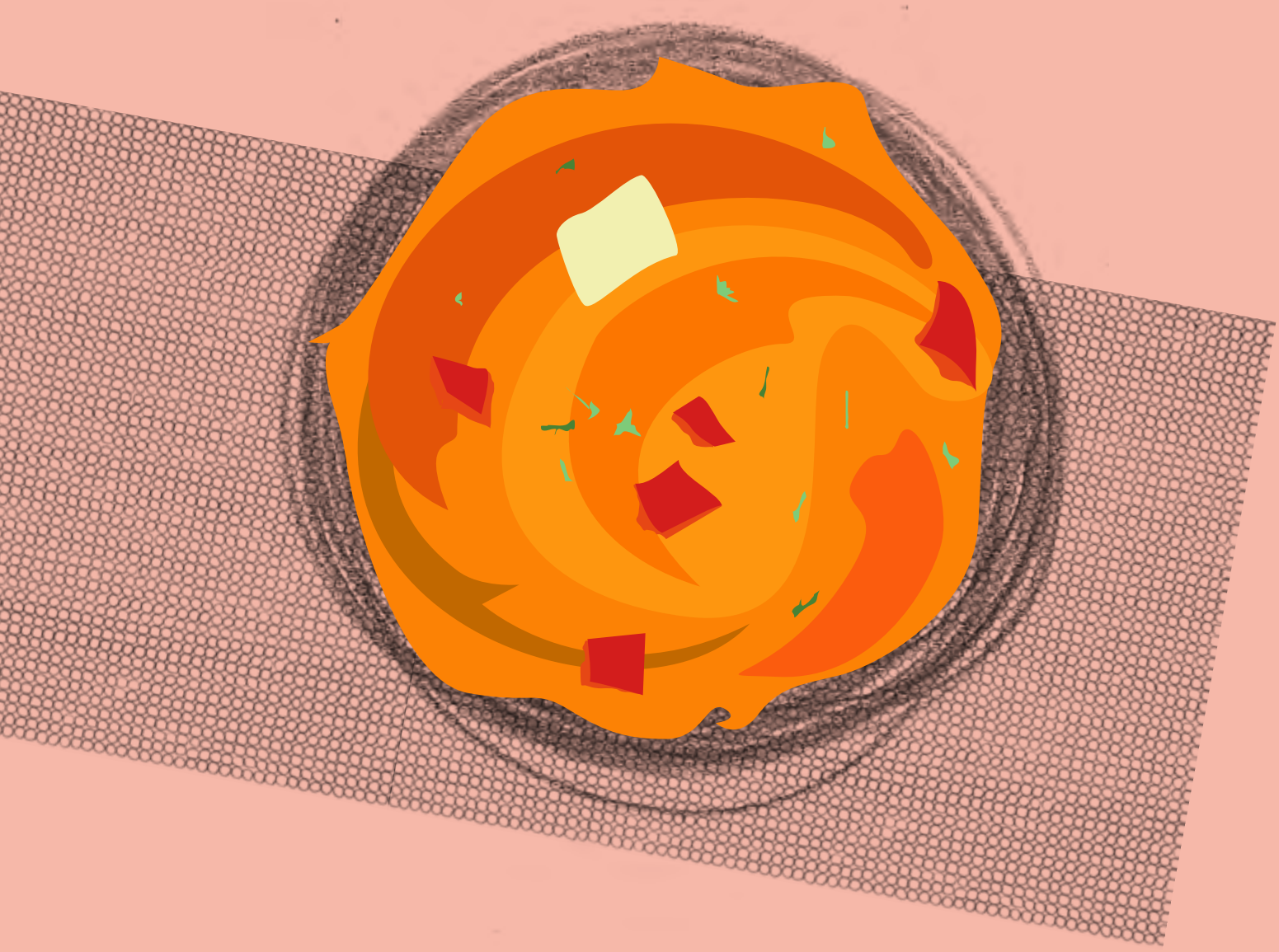
- Roast the maize flour for 15 minutes in a pan to improve its flavour.
- Mix together the Abobo, roasted maize flour and some red palm oil in a pot with water and cook for 30 minutes.

tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

KENYAN MUCUNA MASH

THIS IS AN EASY-TO-MAKE DISH AND PERFECT IF YOU HAVE SOME PLAIN, ALREADY COOKED OR LEFTOVER VEGETABLES – JUST MIX THEM ALL TOGETHER AND ENJOY A QUICK, DELICIOUS MEAL.



KENYAN MUCUNA MASH

INGREDIENTS (4–6 SERVINGS)

6 medium sized sweet potatoes, peeled
60 g Abobo (cooked *Mucuna* beans)
1 onion, diced
2 tomatoes, washed and diced
2 bunches of pumpkin leaves/sweet potato leaves/ pigweed (amaranth leaves), chopped
1 tbsp of margarine
cooking oil
water
salt

ALTERNATIVE INGREDIENTS TO SUBSTITUTE MUCUNA:

You can consider using other vegetables, pulses or cereals that provide a similar texture and nutritional profile
· potatoes
· maize
· peas

PREPARATION

- Heat the cooking oil in a pan and once it is hot, add the onions and fry until golden.
- Next add the tomatoes and sauté until they are cooked.
- Add the (pumpkin) leaves, sweet potato, Abobo and salt, give it a stir and add some water.
- Boil the mix until all the ingredients are well cooked.
- Then, drain the excess water, add margarine and mash to a smooth texture.
- Serve hot with sour milk, tea or stew.

tsp = teaspoon tbsp = tablespoon *(≈ 3 tsp)*

KENYAN MUCUNA STEW

THIS IS ANOTHER EASY AND QUICK DISH TO MAKE IF YOU HAVE SOME ALREADY PROCESSED MUCUNA BEANS (WHICH YOU CAN ALWAYS SUBSTITUTE WITH OTHER LEGUMES).

HEART-WARMING AND DELICIOUS!

KENYAN MUCUNA STEW

INGREDIENTS (4 SERVINGS)

120 g Abobo (cooked *Mucuna* beans), pounded
2 large onions, chopped
2 garlic cloves, crushed
30 g ginger, crushed
4 large ripe tomatoes, peeled and chopped
1 bunch of coriander, chopped
1 large carrot, grated/medium sweet potato, diced
salt
vegetable oil/ghee
green pepper
water

ALTERNATIVE INGREDIENTS TO SUBSTITUTE MUCUNA:

Any kind of bean native to your area (e.g black beans, navy beans, black eyed peas, cranberry beans or any other firm bean)

- pumpkin
- other starchy vegetables like plantain, breadfruit or cassava (yuca) can also be used

PREPARATION

- Heat oil in a pan, add onions and garlic and sauté until golden.
- Add tomatoes, green pepper and ginger and mix well.
- Then add the pounded mucuna beans and mix thoroughly.
- Add water and grated carrots or sweet potato and let it simmer until everything is tender.
- Lastly add salt and coriander.
- Serve hot with rice, Ugali (maize meal) or flatbread (see p. 75).

tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

RECIPES

CEREALS


3.1
DURUM WHEAT


3.2
PEARL MILLET


3.3
SORGHUM

CEREALS

DURUM

Triticum turgidum subspecies durum has already been cultivated for thousands of years in the oases of the Southern Sahara and especially in the highlands of Ethiopia. Here, a plethora of local varieties have developed endemically from wild emmer ***(Triticum dicoccum)***.[37] Within the EU and Northern America, durum wheat is highly demanded for its use in pasta, bread, couscous and bulgur, which has made durum wheat a cash crop more valuable than the common bread wheat. Despite this major demand, durum wheat production is still marginal compared to the global wheat production, accounting for only 8 per cent.[38] However, the production is predicted to increase greatly in the coming years. This is especially attractive for Africa, whose domestic demand rises, while it depends on imports worth over EUR 4 billion annually and susceptible to trade disturbances.[39]

MORE ABOUT DURUM

→ GLOSSARY, p. 99

AGROECOLOGICAL USE AND BENEFIT

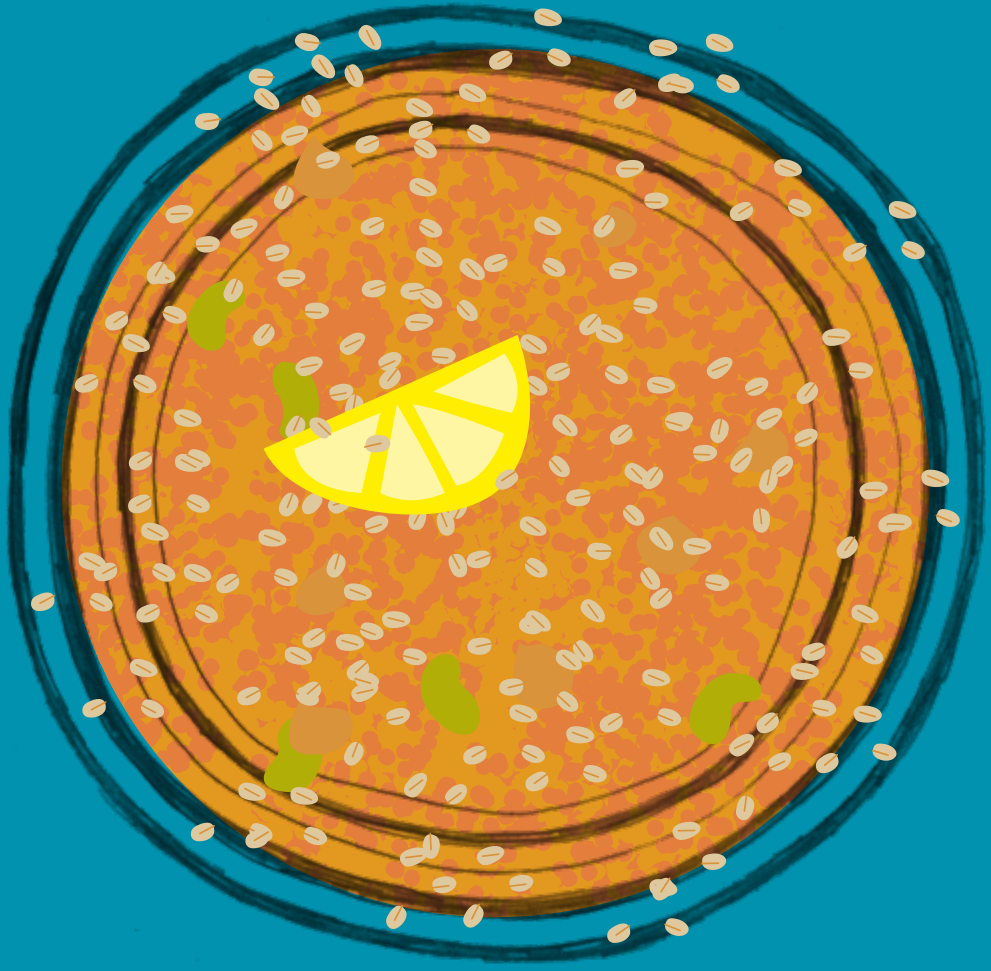
With the exception of fields where rice is cultivated, *Triticum turgidum* subspecies durum is being used as a rotation crop in Western and Eastern Africa, where it is cultivated during the drier winter months, followed by rainfed crops such as legumes or rice. Durum wheat matures early and can tolerate heat. Relay intercropping also proved fruitful when cultivated with legumes such as spring lentils. In comparison to monocrops, this production system contributes to sustainable soil health and increases yields from 164 per cent to up to 648 per cent.[40]

NUTRITIONAL AND HEALTH VALUE

In addition to durum wheat being an important source of energy, it contains a wide range of vitamins, minerals and other nutritional compounds that are essential to the human diet. It is known for its high source of vitamin A, antioxidants, carbohydrates and non-starch polysaccharides. Due to anthocyanin and its antioxidant properties, it is widely recognised as a healthy cereal crop and is recommended for those suffering from allergies, diabetes and high blood cholesterol.[41] Unfortunately, due to the milling process during transformation, a lot of its nutritive value is being lost, which is why whole grain consumption is recommended.[42]

TUNISIAN BORGHOL JARI

BORGHOL JARI IS A DISH BASED ON THE GRAINS OBTAINED FROM THE DURUM WHEAT AFTER THE REMOVAL OF ITS BRAN.



FOR THIS, THE GRAINS ARE PRECOOKED, DRIED AND CAN THEN BE MECHANICALLY SEPARATED FROM THE BRAN. IT IS THEN CRUSHED TO CREATE DURUM WHEAT BULGUR AND PREPARED IN THE FORM OF A SOUP.

TUNISIAN BORGHOL JARI

INGREDIENTS (3–4 SERVINGS)

190 g durum wheat bulgur, washed
60 g fava beans, washed
170 g chickpeas
1,5 l water
1 tsp garlic, minced
2 tsp cumin
2 tbsp tomato paste
½ tbsp harissa (hot chilli pepper paste)
olive oil
lemon
salt

ALTERNATIVE INGREDIENTS TO SUBSTITUTE DURUM WHEAT BULGUR:

You can consider using other cereals that provide a similar texture and nutritional profile.
· couscous
· quinoa
· rice
· other millets (e.g. fonio)

PREPARATION

- Wash the bulgur and cook together with the washed beans, chickpeas, water and a drizzle of olive oil in a pressure cooker for half an hour until the chickpeas and beans are cooked.
- Then mix the harissa with a bit of water and add together with the tomato paste, garlic and salt to the pot.
- Cook another 15 minutes on low heat while stirring frequently to avoid the bulgur sticking to the bottom.
- Add the cumin and let it cool down for a few minutes.
- To serve, add some lemon and a dash of olive oil.

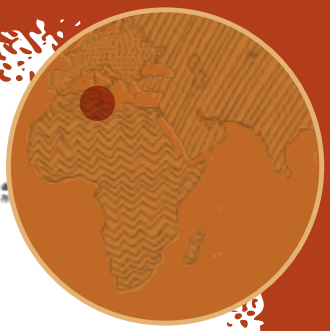
tsp = teaspoon tbsp = tablespoon *(≈ 3 tsp)*

TUNISIAN COUSCOUS كسكسي

ALTHOUGH DURUM WHEAT MIGHT BE UNKNOWN TO YOU, YOU PROBABLY KNOW ONE OF THE PRODUCTS IT IS USED FOR: COUSCOUS!

COUSCOUS IS ALSO THE NAME OF A TRADITIONAL TUNISIAN DISH, POPULAR ON SPECIAL OCCASIONS. THE DISH IS MADE FROM STEAMED COUSCOUS, THE PREPARATION OF WHICH VARIES FROM PLACE TO PLACE.

TUNISIAN COUSCOUS كسكسي



INGREDIENTS (4 SERVINGS)

500 g couscous
1 gigot (lamb leg), sliced
2 tbsp tomato paste
1 onion, chopped
4 potatoes, peeled and diced
3 carrots, sliced
3 green chillies
60 ml olive oil
red pepper powder
tabil (Tunisian spice mix)
salt
pepper

ALTERNATIVE INGREDIENTS TO SUBSTITUTE COUSCOUS:

You can consider using other cereals that provide a similar texture and nutritional profile.

· bulgur
· quinoa
· rice
· other millets (e.g. fonio)

This dish can easily be turned into a vegetarian/vegan dish by leaving out the meat.

PREPARATION

- Finely chop the onion and sauté in some olive oil in a casserole dish.
- When the onion starts to get transparent, add the meat and sauté until it gets some colour.
- Add the tomato paste and stir constantly until the liquid is gone.
- Then add carrots, potatoes and chilies to the casserole dish, mix and cover with water.
- Add the spices, salt and pepper and stir again.
- Cook the meat on medium heat until it falls apart and the vegetables are cooked.
- Meanwhile, place the couscous in a large dish and moisten it with the olive oil. Massage in the oil until it is well mixed and season with salt.
- Put the couscous in the top of the couscousière, a traditional double-chambered food steamer, and steam for 30 minutes, stirring occasionally.
- Then, take the couscous out and sprinkle with water. Mix well so that the grains do not stick together and put it back in the couscousière.
- Alternative if you don't have a couscousière:
- Roast the couscous for a few minutes with 2 tbsp of oil in a pan until the flavour spreads and the grains turn slightly golden. Then add water and salt and cook until it is fully cooked. Use a fork to fluff up the couscous.
- When it has finished cooking, add about 2 spoonfuls of sauce from your cooked vegetables and meat mix to the couscous and stir well.
- Arrange the couscous in a circle on a plate and leave a whole in the middle.
- Put the sauce on top and arrange the carrots like sun rays. Avoid soaking the couscous with too much sauce, since it should already be very tender.

tsp = teaspoon
tbsp = tablespoon *(≈ 3 tsp)*

CEREALS

PEARL MILLET

Cenchrus americanus (former ***Pennisetum glaucum***) is thought to have its roots in the Sahel region of West Africa, encompassing modern-day countries such as Chad, Mali, Niger, Nigeria and Senegal. According to archaeological findings, the domestication of pearl millet dates back to approximately 4,000 BC in this geographical area. During the early development of African civilizations, this crop held immense significance, especially in regions characterised by arid and dry conditions, where the cultivation of other cereal crops presented challenges.[43] Due to the crop's ability to adapt to a wide range of different local environments and climatic conditions it can also be found in Australia, South America, Southern Africa and the U.S.A.

MORE ABOUT PEARL MILLET

→ GLOSSARY, p. 100

Pearl millet is an annual, warm-season grass which typically reaches a height of two to four metres and has a sturdy, erect stem with a well-developed root system. The leaves are long and narrow, with a prominent midrib. Similar to rice, wheat, maize, barley and sorghum, pearl millet is one of the most widespread and cultivated crops in the world today, thus being crucial for feeding the rural population mainly in Africa and India. *Cenchrus americanus* is mainly used for alimentation purposes but also as building material and fuel for cooking in dryland areas.[44]

AGROECOLOGICAL USE AND BENEFIT

Pearl millet has better drought resistance than maize and sorghum and thus provides a valuable alternative in dry areas. It grows best in semi-arid regions as it is a hardy crop, not only being able to survive adverse growing conditions but flourishing best under very hot and dry conditions. Its most valuable agroecological characteristics are soil stabilisation and soil retention. *Cenchrus americanus* can be intercropped with most legumes and is used in preventing pests, such as white grub, when intercropped with pigeon pea, cow pea or sunflower. In addition, a crop rotation with wheat, soybean and potatoes reduces the risk of damage by nematodes and, under the right conditions, can provide a short growing period.

NUTRITIONAL AND HEALTH VALUE

Pearl millet is considered a high-energy and high-protein crop. It contains vitamin A and B, the essential amino acids, lysine and tryptophan, and a wide range of minerals favourable to satisfying our basic nutritional needs.[43]

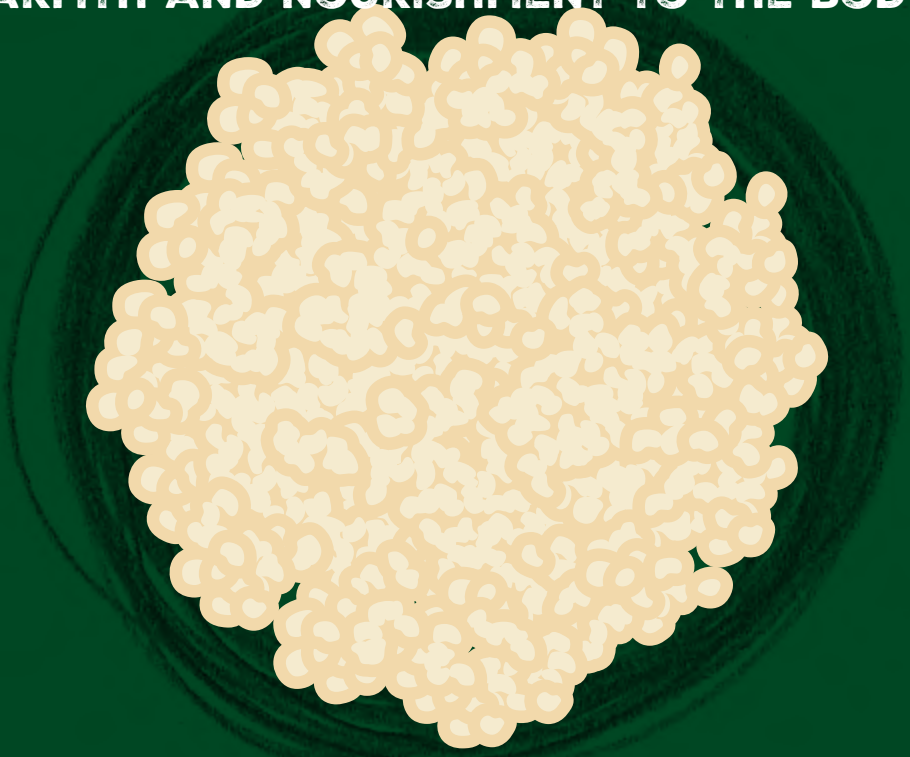
DID YOU KNOW?

2023 was declared as the International Year of Millets to promote its health and nutritional benefits.

Furthermore, integrated agroecological production processes for this crop make it highly interesting for fighting climate change and global hunger. [45]

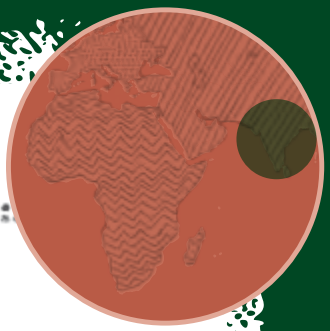
INDIAN MAHERI (PEARL MILLET PORRIDGE)

PEARL MILLET PORRIDGE, ALSO KNOWN AS BAJRA KHEER OR BAJRA KHICHDI, IS A TRADITIONAL INDIAN DISH MADE WITH PEARL MILLET GRAINS, BUTTERMILK AND SUGAR. IT IS OFTEN CONSUMED AS A BREAKFAST FOOD OR AS A SNACK DURING THE WINTER MONTHS, AS IT IS BELIEVED TO PROVIDE WARMTH AND NOURISHMENT TO THE BODY.



THE PORRIDGE HAS A CREAMY TEXTURE AND A SLIGHTLY NUTTY FLAVOUR THAT IS ENHANCED BY SPICES SUCH AS CARDAMOM AND CINNAMON. IT IS COMMONLY CONSUMED IN MANY PARTS OF INDIA, ESPECIALLY IN RURAL AREAS WHERE PEARL MILLET IS A STAPLE CROP.

INDIAN MAHERI



INGREDIENTS (2 SERVINGS)

100 g pearl millet, coarsely pounded
400 ml buttermilk, fresh
salt

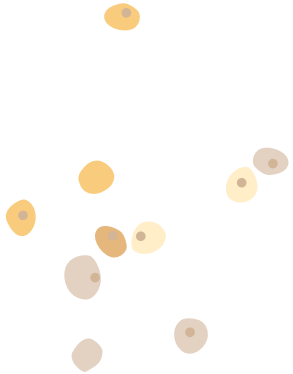
ALTERNATIVE INGREDIENTS TO SUBSTITUTE PEARL MILLET:

You can consider using other cereals that provide a similar texture and nutritional profile.

· Any kind of millet local to your area (e.g finger-, foxtail-, bulrush- or proso-millet, quinoa, fonio)
· whole wheat couscous
· sorghum

PREPARATION

- Clean and grind the pearl millet.
- Mix water and curd, stir well to prepare buttermilk.
- Add 300 ml of water to a pot and bring it to a boil. Gradually add the pearl millet and stir continuously to prevent lumps forming.
- Let simmer for 10 minutes on medium heat.
- When the consistency is like porridge add the buttermilk and bring it to a boil while stirring.
- Then add salt and continue to cook for 3–4 minutes.
- Serve with tomato or coriander chutney.



tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

CEREALS

SORGHUM

Sorghum bicolor is an annual plant that typically grows to a height of up to four meters, depending on the variety and growing conditions. Its roots can reach a depth of up to two metres. Sorghum has a sturdy, upright stem with nodes and internodes, one or more tillers and curving leaves. The leaves are long and narrow and arranged alternately along the stem. The plant produces large, compact inflorescences (panicles). ***Sorghum bicolor*** is the world's fifth most important cereal after maize, rice, wheat, and barley.[46] According to archaeological evidence, the plant's sources of origin lie in sub-Saharan Africa, particularly in Sudan, Ethiopia, and West Africa. To this day it is widely cultivated in this region.

MORE ABOUT SORGHUM

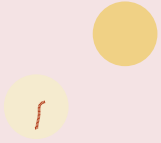
→ GLOSSARY, p. 101

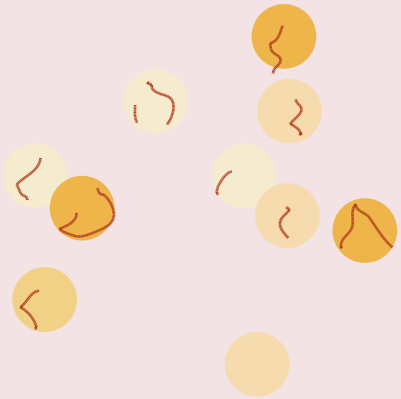
AGROECOLOGICAL USE AND BENEFIT

Popular for its high drought-resistance, *Sorghum bicolor* is commonly cultivated where other crops could not survive, namely in arid regions.[47] Due to the long roots, it aerates the soil and improves the soil structure and can tolerate waterlogging. *Sorghum* can be intercropped with sesame and maize and can also be combined with most types of legumes such as cowpea and peanut.

NUTRITIONAL AND HEALTH VALUE

Sorghum provides high amounts of proteins as well as calcium, iron, phosphor and zinc. Additionally, it supplies various vitamins like vitamin B, D, E and K.





BADJA WITH SORGHUM FROM MADAGASCAR

ALTHOUGH NOT ORIGINALLY FROM MADAGASCAR, THIS DISH HAS BEEN ADAPTED TO THE LOCAL CONTEXT, USING INGREDIENTS FROM THE ISLAND.

BADJA WITH SORGHUM

INGREDIENTS (20 BREADS)

200 g lentils
onion
ginger
leek, sliced
sorghum flour
water
salt
pepper
cooking oil

This recipe does not follow certain quantities as you just cook by gut feeling.

ALTERNATIVE INGREDIENTS TO SUBSTITUTE SORGHUM FLOUR:

You can consider using other cereals that provide a similar texture and nutritional profile.
· whole wheat, buckwheat or rice flour
· chickpea flour
· maize meal

PREPARATION

- Soak dry lentils in plenty of water overnight.
- Drain the water in the morning and, together with the onion and ginger, place the lentils in a mortar.
- Grind it as finely as possible and transfer the mixture to a bowl. Add salt, pepper and finely chopped leeks and mix well.
- Pour the sorghum flour into another large bowl. Slowly pour in water while mixing vigorously with a whisk or wooden spoon until the dough is smooth.
- Next, take a spoon full of the lentil mixture and slowly dip it in the sorghum paste until it is covered.
- In a pan, heat up cooking oil, enough to fry the Badja.
- Pour the sorghum paste covered lentil mix into the hot oil and fry until golden.

tsp = teaspoon tbsp = tablespoon *(≈ 3 tsp)*

ETHIOPIAN INJERA እንጀራ

INJERA IS A ROUND FLATBREAD WITH A SLIGHTLY SOUR TASTE DUE TO THE FERMENTED SORGHUM.

IT IS USED IN MANY DISHES IN ETHIOPIA, ERITREA, SOMALIA AND SUDAN. MOST OFTEN ITS MAIN INGREDIENT IS TEFF BUT IN SOME REGIONS IT IS PREPARED WITH SORGHUM OR PEARL MILLET.

ETHIOPIAN INJERA እንጀራ

INGREDIENTS (20 BREADS)

1,5 kg sorghum/teff flour

1/2 l ersho (fermented fluid saved from previously fermented dough)

or **any other yeast/starter**

water

cooking/rapeseed oil or **rapeseed flour**

ALTERNATIVE INGREDIENTS TO SUBSTITUTE SORGHUM FLOUR:

You can consider using other cereals that provide a similar texture and nutritional profile

- whole wheat, buckwheat or rice flour
- chickpea flour
- cornmeal

PREPARATION

- Sift the flour into a large bowl to remove any foreign materials.
- Add one litre of water and knead well by hand.
- Stir in the Ersho and gradually add another litre of water. Knead well until you have a thin, liquid dough.
- Cover with a lid and let it sit for 48 hours.
- Check the dough now and then to see if the flour has sunk to the bottom of the container. Strain the floating water and throw it away.
- In a pot, bring one litre of water to a boil.
- Add 200 g of your dough to the hot water and let it boil. Stir the mixture for about 5–10 minutes to further dilute the dough.
- Add the mixture back to the original dough, stir it in and wait until it rises, or you start to see bubbles. This speeds up the fermentation process and creates the common texture of the injera with tiny bubbles and soft to touch.
- After half an hour start to heat your meted clay griddle or non-stick pan.
- Sprinkle ground rapeseed (rapeseed flour), rapeseed oil or any other cooking oil over the clay griddle and polish with a folded piece of clean cloth to prevent the dough from sticking to the clay griddle. If using rapeseed flour, dust away the remaining flour after polishing the grid or riddle.
- To bake the injera, pour the batter onto the hot, greased clay griddle or non-stick pan using a circular motion from outside towards the centre creating the round shape of the flatbread. When holes begin to form on top of the injera, cover with a lid (the lid of the Ethiopian clay griddle is called Akenbalo) and bake for 2–3 minutes. Use about half a litre of batter for each injera.
- Grease the clay griddle with rapeseed flour or oil between each baking. Repeat the process until the dough is used up but don't forget to save some dough for next time.
- The yield is 10–12 Injeras that you can serve with wot (stew made from either meat, pulses, vegetables or combinations) or any other stew.

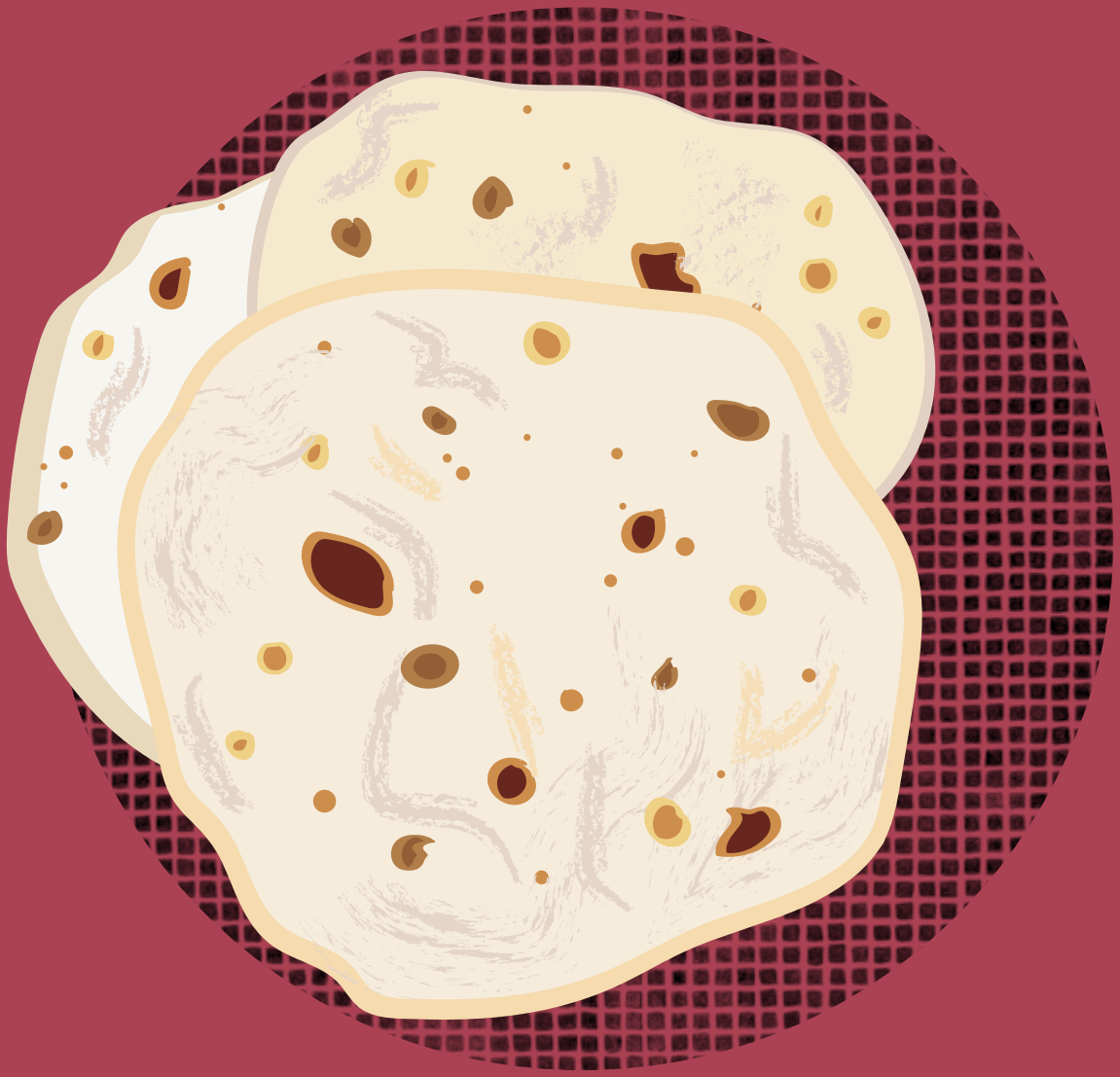
tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

ETHIOPIAN KITA

KITA IS ANOTHER THIN PANCAKE-LIKE BREAD MADE FROM SORGHUM FLOUR.

IT IS A QUICK ALTERNATIVE TO INJERA AS IT IS NOT FERMENTED AND CAN BE USED AS A SNACK, SERVED WITH MILK, TEA OR COFFEE.



ETHIOPIAN KITA

INGREDIENTS (4 BREADS)

250 g sorghum flour
250 ml water
salt
cooking oil

PREPARATION

- Mix the flour and water, stir into a thick paste and add a pinch of salt.
- Let the dough sit for a couple of minutes while heating a pan.
- Add a bit of cooking oil and spread the thick paste on the heated pan like a pancake.
- After 1–3 minutes you can flip the pancake and repeat with the other side.
- Repeat this process until you have used the entire dough.

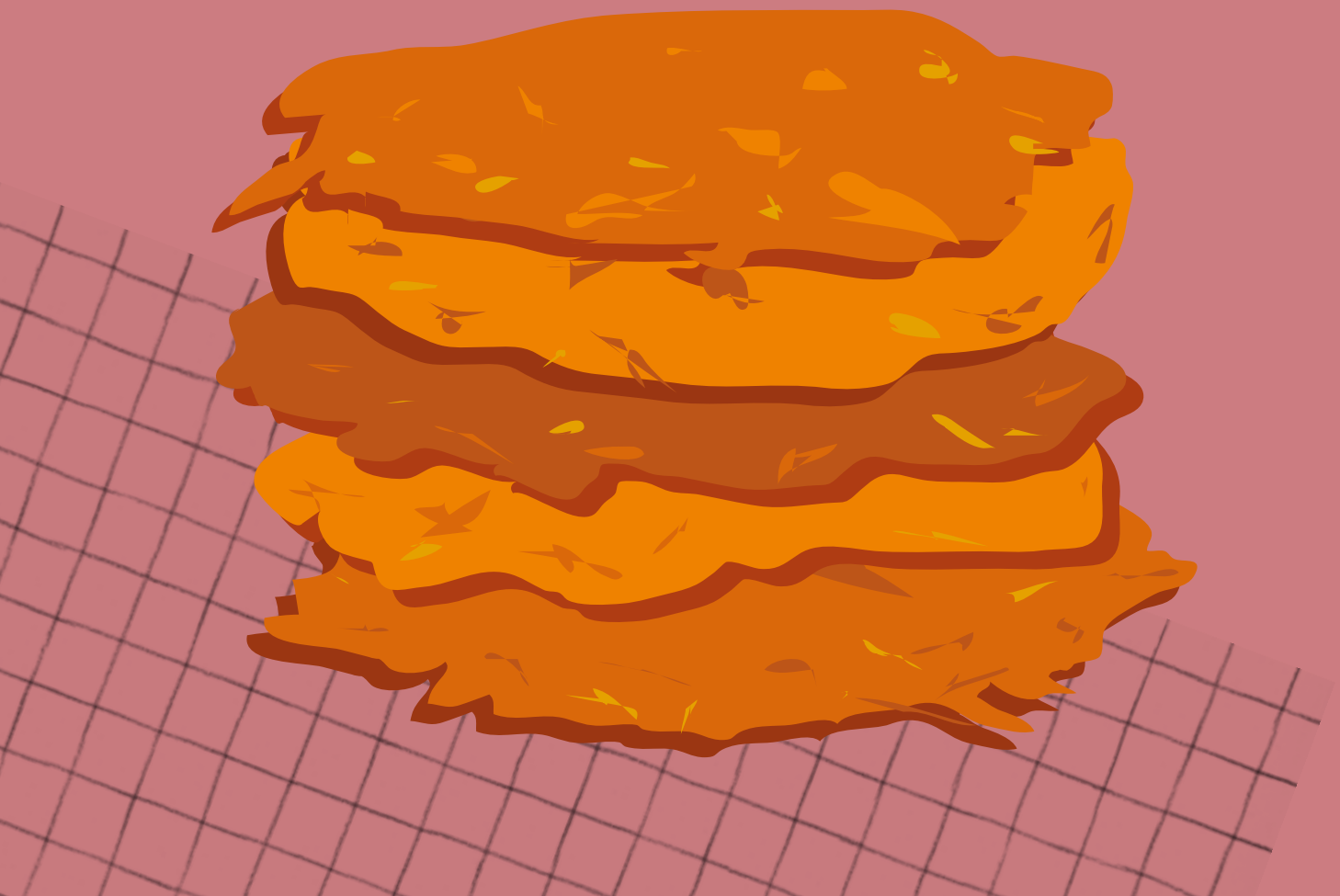
tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*

POTATO FRITTERS WITH SORGHUM FROM MADAGASCAR

POTATO FRITTERS ARE A POPULAR DISH IN MADAGASCAR. THE LOCALS EAT THEM WITH RICE OR JUST AS A SNACK BEFORE MEALS.

TO MAKE THE TASTY FRITTERS, THIS RECIPE USES SORGHUM, BUT ORDINARY FLOUR WORKS FINE AS WELL AND IS COMMONLY USED.



POTATO FRITTERS WITH SORGHUM

INGREDIENTS (4 SERVINGS):

1–2 eggs
1–3 tbsp sorghum flour
2–4 potatoes, peeled and grated
2–3 garlic cloves, crushed
cooking oil
chives, chopped
salt

ALTERNATIVE INGREDIENTS TO SUBSTITUTE SORGHUM FLOUR:

You can consider using other cereals that provide a similar texture and nutritional profile.
· whole wheat, buckwheat or rice flour
· chickpea flour
· maize meal

PREPARATION:

- In a bowl, beat the eggs and add salt.
- Gradually pour in the sorghum flour until the dough is thick.
- Add the crushed garlic and chopped chives to the dough and mix well. Then add in the grated potatoes.
- Heat oil in a pan. Using a large spoon, create small flat portions of the potato-batter mix.
- Immerse the patties in hot oil and fry them on both sides for 6 minutes or until crispy and golden.
- Remove them from the pan and serve warm.

tsp = teaspoon

tbsp = tablespoon *(≈ 3 tsp)*


KAKUK

CULTIVATION PRACTICES

In this chapter we present you with agroecological practices which have found abundant mention above. They visualise how the selected crops can be introduced into already existing fields thus improving soil fertility and yields as well as national and nutritional value of a diversified production.

As a little add-on we went a step further and selected an absolute quick-win:
a practice that has great potential and can make a big difference as

a) it can be carried out without a lot of equipment, input or supplies,
b) does not need a lot of space,
c) has what it takes to promote employment,
d) holds great potential for the inclusion of women and
is multipurpose regarding the use of compost as well as vermi uice.

So lastly, we want to present to you the concept of a vermicompost, tell you what it is,
why one should use it and how to build one yourself!
You will not come out of reading this chapter an absolute expert on agroecological practices,
but we hope it gives you some insight into the manifold methods that exist in this realm
and their countess benefits.

Find here all agroecological cultivation practices implemented under the ProSoil programme:

AGROFORESTRY

WHAT IS AGROFORESTRY?

In a nutshell, agroforestry could be defined as "agriculture with trees".[48] More specifically, tree species and their arrangement across the field, that are deemed beneficial to the agroecosystem, are selected. For example, apart from making the agroecosystem more biodiverse and resistant to diseases, trees shade and shelter soil, crops or cattle. Furthermore, they might access different resource pools in the soil and, as in case of the commonly used legume species, even add nitrogen to the soil. Hedgerows, shelterbelts, and riparian buffer strips can also be counted to agroforestry. Thus, under the right arrangement, the agroecological benefits are manifold, ranging from input reduction over improved soil and animal health to enhanced biodiversity and economic diversification.[49]

Agroforestry systems can be classified as follows:

- Silvopastoral systems: combination of trees and livestock
- Silvoarable systems: combination of trees and crops
- Agrosilvopastoral systems: combination of trees, livestock, and crops.

WHY USE AGROFORESTRY?

Agroforestry is a nature-based solution for climate change mitigation and adaptation. More specifically, agroforestry aims to produce timber and nutritious food while protecting the environment. Agroforestry systems are highly adaptive to current climate changes and provide multiple other benefits for the environment, economy and transformation of agricultural and food systems. Those benefits include:

1. Enhanced soil fertility and nutrient cycling[50]
Agroforestry systems contribute to improved soil fertility through nutrient cycling. Trees with deep roots extract nutrients from lower soil layers and deposit them through leaf litter, enhancing organic matter content and nutrient availability. Additionally, nitrogen-fixing tree species enrich the soil with nitrogen, promoting soil health, enhancing crop productivity and reducing the need for synthetic fertilisers.

2. Biodiversity conservation and ecosystem services[51]
Agroforestry systems foster biodiversity by providing habitats for diverse plant and animal species. The presence of trees in agricultural landscapes enhances ecological connectivity, supports pollinators and promotes natural pest control. Agroforestry contributes to the conservation of native flora and fauna, enhances landscape aesthetics and provides valuable ecosystem services such as water regulation and soil erosion control.

3. Climate change mitigation and adaptation
Agroforestry plays a crucial role in mitigating climate change by sequestering carbon dioxide through tree biomass and soil organic matter. In agroforestry systems, trees act as carbon sinks, offsetting greenhouse gas emissions. Additionally, the shade provided by trees mitigates heat stress on crops and livestock, reducing the vulnerability of agricultural systems to climate extremes.

4. Sustainable livelihoods and economic benefits[52]
Agroforestry provides multiple economic benefits, contributing to sustainable livelihoods. Farmers can diversify their income by incorporating tree products, such as fruits and timber into their agricultural activities. Agroforestry systems also offer opportunities for value-added processing, marketing, and agritourism, enhancing rural economies and reducing dependency on single crops.

Agroforestry systems require time to develop fully. Therefore, it is important to consider an agroforestry system as early as possible to be able to profit from its benefits.
For all of you excited by the idea of an agroforestry system this guidebook will help you to implement it.

HOW TO IMPLEMENT AND MANAGE AGROFORESTRY[53]

Agroforestry needs to be individually adapted to people, place and purpose. And it needs to be feasible in implementation and set goals. Only if the farmers are motivated and engaged in the long term, greater benefits rather than direct effects can be considered. Especially benefits such as climate mitigation and water conservation scale with extension and are most effective when implemented on a catchment area or landscape level. Thus, planning an agroforest requires more time and planning effort in comparison to only crop production.

Before the implementation, consider the following aspects:

1. What are the causes of low productivity?

2. How do trees help improve productivity on the farm?

Consider the possible disadvantages of trees
- Loss of physical space for crops
- Reduction in crop yield due to shading
- In semi-arid regions, potential water competition

3. Should livestock be included livestock?

4. Tree choice
- Depends on the farmer's needs
- Depends on the placing of the tree
- After determining these factors the appropriate type of tree can be chosen according to its growth rate, crown type and root system

ALLEY CROPPING

I) WHAT IS ALLEY CROPPING?

Alley cropping, also referred to as hedgerow intercropping or avenue cropping, is an agroforestry approach where food crops are cultivated within alleys created by rows of trees and shrubs, preferably leguminous species. It is a modified version of the bush-fallow system, as it retains its fundamental characteristics while enhancing productivity. By cultivating diverse crops in proximity, producers can benefit from improved crop yield, microclimate advantages and risk management. The hedgerows are pruned when planted and intermittently during crop growth to prevent complete shading and competition with the associated food crops.

However, during fallow periods, the hedgerows are allowed to grow freely, providing ground cover. By simultaneously integrating crop and fallow patches on the same land, alley cropping enables farmers to extend cropping and harvest periods over a longer time, offering different agricultural possibilities. Over time, alley cropping systems[54] undergo changes as trees and shrubs mature, exerting influence on light, water and nutrient dynamics within the field.

Alley farming is largely similar to alley cropping, with the minor difference that a certain proportion of the crops cultivated is being used as fodder for animals or for mulching. It essentially integrates animals into the alley cropping system.

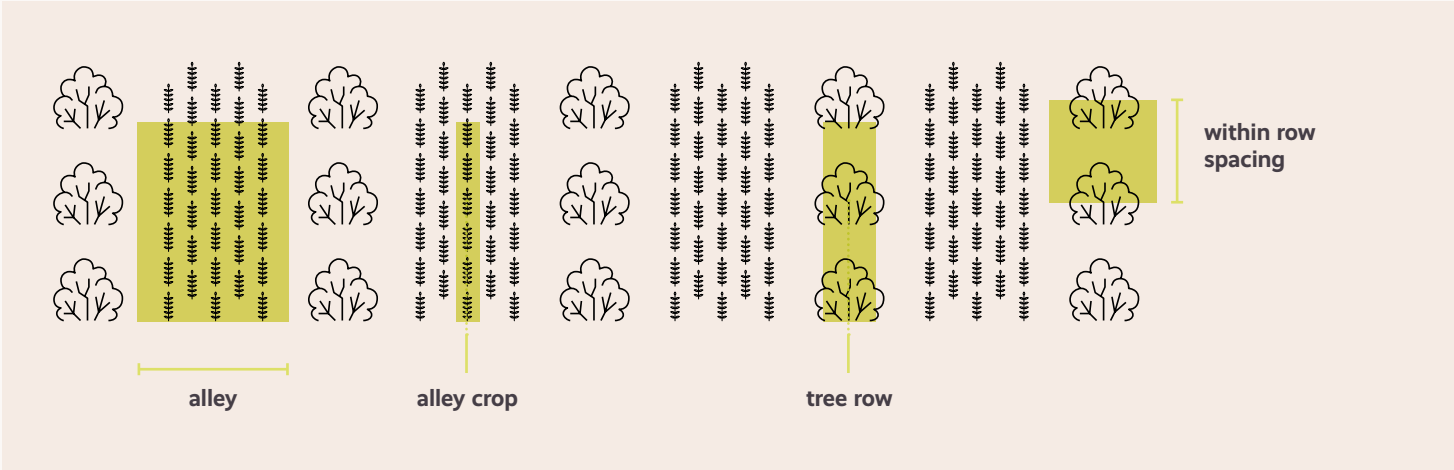


Figure 2 : Common terminology used when discussing alley cropping systems are alley, alley crop, tree row, and within row spacing.[55]

II) WHY USE ALLEY CROPPING?

Alley cropping offers several documented benefits, including:

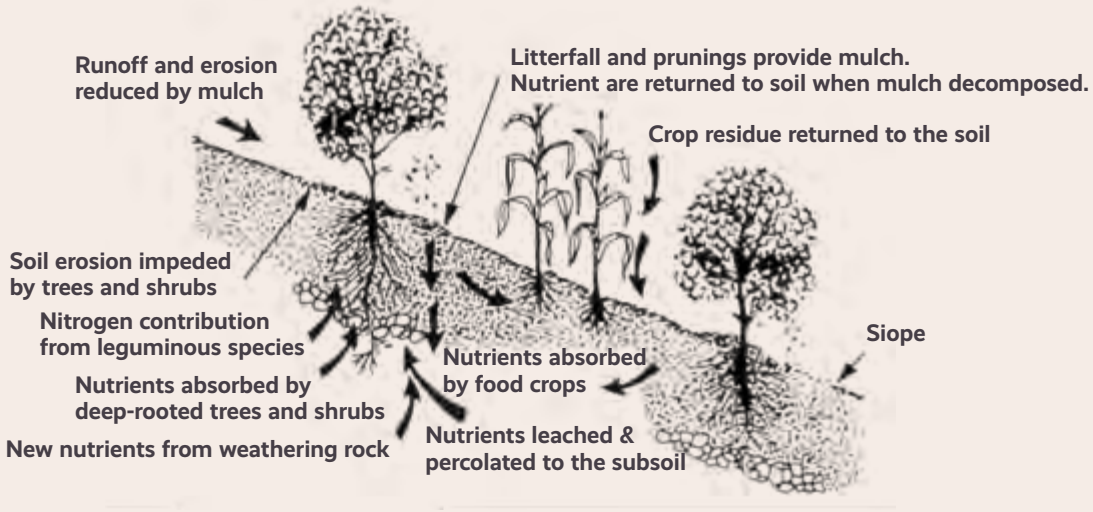


Figure 3: Schematic representation to show the benefits of nutrient cycling and erosion control in an alley-cropping system.[56]

1. Soil improvement and conservation:
Alley trees, with their deep roots, extract nutrients from lower soil layers and recycle them to the surface through leaf litter. Legume species also enhance soil fertility through nitrogen fixation.[57] Studies have demonstrated that hedgerow mulch positively influences soil properties, such as moisture infiltration, organic matter content, nutrient status and earthworm activity.[58/59] Additionally, using hedgerow prunings as surface soil cover reduces runoff and erosion, while planting woody hedgerow species on sloping land aids in soil and water conservation.[60]

2. Increased crop yield:
Comparisons between alley farming and traditional cultivation systems often show higher crop yields in alley crops. However, improper management of hedgerow pruning in relation to the crop growth cycle can diminish this advantage.[61]

3. Weed control:
Alley farming provides effective weed control and suppression through mulch cover and shading. Research has reported up to 90 per cent reduction in weed growth in alley plots of crops like maize and Leucaena.

4. Improved animal productivity:
Proper hedgerow plant management ensures availability of browse for animal feeding during periods of scarcity. This fodder can supplement low-quality grasses, crop residues, and by-products. Some evidence suggests that it can even serve as the sole feed for goats, particularly with species like Gliricidia or Gliricidia-Leucaena combinations.

III) HOW TO IMPLEMENT AND MANAGE ALLEY CROPPING:

a) Selection of suitable tree and shrub species

When implementing alley cropping, the careful selection of tree and shrub species is crucial. Consideration should be given to factors such as climate suitability, growth rate, adaptability to the local environment and compatibility with the associated crops. Leguminous species are often preferred due to their nitrogen-fixing abilities, which contribute to improved soil fertility. Examples of commonly applied species are *Gliricidia sepium*, *Leucaena leucocephala*, and *Calliandra calothyrsus*, with increasing water demand. Soil acidity is a further important criteria for the success of the cultivated woody species, as shown in the following list.

b) Pruning and maintenance practices

Proper pruning and maintenance are essential for the success of alley cropping systems. Regular pruning helps manage shade, ensuring adequate light penetration for crop growth. It also stimulates the production of biomass for mulching and promotes the recycling of nutrients. Careful attention should be given to timing, frequency, and techniques of pruning to avoid negative impacts on crop growth and overall system productivity. Pruning residues can be used as mulch to improve soil moisture retention, suppress weed growth and enhance nutrient cycling.[62]

Non-acid soil	Acid soil
Acacia auriculiformis	*Acioa baterii*
*Cajanus cajan**	*Caliandra calothyrsus*
Gliricidia sepium	*Flemincia macrophylia*
Leucaena leucocephala	*Paraserianthes falcataria*

** Needs frequent replenting*

Table: Potential woody species for alley farming in lowland (<750 m above sea level) humid and subhumid tropics, Source: (FAO)[63]

IV. CHALLENGES AND POTENTIAL SOLUTIONS:[64]

a) Land and resource constraints:

Implementing alley cropping may face challenges related to limited land availability, especially in densely populated areas. Fragmented land holdings and competition for resources, such as water and nutrients, can also pose obstacles. Potential solutions include promoting land-sharing initiatives, encouraging collaboration among farmers, and adopting efficient resource management practices like water conservation techniques and organic fertiliser application.

b) Knowledge and technical support:

Lack of knowledge and technical expertise can hinder the adoption of alley cropping. Farmers may require guidance on selecting appropriate species, implementing proper management practices and optimizing crop-tree interactions. Providing training programs, extension services and knowledge-sharing platforms can bridge these knowledge gaps. Collaboration between researchers, extension agents and farmers can facilitate the transfer of practical knowledge and promote the successful implementation of alley cropping systems.

INTERCROPPING

A) WHAT IS INTERCROPPING?

The most commonly used definition of „intercropping" is the practice of growing two or more crops simultaneously on the same piece of land, with spatial arrangements and management techniques that optimise resource use and complementarity between the crops. The crops may differ in their growth habits, nutrient requirements or rooting depths, allowing for efficient resource utilisation. Intercropping can enhance crop productivity through improved soil fertility, effective weed suppression, pest and disease management, and utilisation of vertical space. This practice promotes biodiversity, reduces soil erosion, and provides economic benefits by maximizing land use and diversifying agricultural production.[65]

B) WHY USE INTERCROPPING?

1. Efficient use of resources
Intercropping maximises the use of available resources such as sunlight, water, and nutrients. Different crops with varying growth habits and root structures utilise resources at different levels and depths, reducing competition and increasing overall resource efficiency.

2. Pest and disease management
Intercropping disrupts the build-up of pests and diseases by creating a diverse cropping system. The presence of multiple crops confuses pests and reduces their ability to spread and cause extensive damage. Additionally, some plant combinations exhibit natural repellent or allelopathic effects, reducing pest and disease pressure.[66]

3. Yield stability and risk reduction
Intercropping provides resilience against crop failure and market fluctuations. If one crop fails or suffers from adverse conditions, other companion crops can compensate and ensure a stable yield. The diversified income from multiple crops reduces the risk associated with relying on a single crop.[67]

4. Increased farm productivity and income
Intercropping increases the overall productivity of the farm by utilising the available land more efficiently. The combination of complementary crops can result in higher total yields compared to monoculture systems. Additionally, the market demand for diverse agricultural products allows farmers to generate additional income by selling multiple crops.

VERMICOMPOST

WHAT IS VERMICOMPOST?

Vermicomposting uses earthworms to convert organic material into high quality compost (high humus) as fast and efficient as possible. The extract of the earthworms is high in nutrients and on average better than conventional compost. Vermicompost also produces worms which can be used as a protein source for cattle or to extend the compost side.[68]

In fact, the promotion of vermicompost production is one of ProSoil's primary agroecological measures.[69] This practice is intensively applied in the highlands of Ethiopia, Kenya and in India, but as well in other countries. So far, 150,000 smallholder households have been reached in Kenya alone. Around 4,000 smallholder farmers are already using vermicompost and 2,000 trainers have been trained as vermicompost experts, 50 of whom have specialised in the production of vermicompost starter kits.

WHY USE VERMICOMPOST?

Vermicompost is a comparatively simple method with enormous potential. It brings ecological and economic benefits in equal measure, and it can be applied with relatively few, locally available inputs. This is particularly important when the demand for mineral fertilisers is greater than the supply or when mineral fertilizers are no more effective as soils are depleted of organic matters. Or when mineral fertilisers are simply becoming too expensive that smallholder farmers can no longer afford them – with consequences for agricultural production, such as in the context of crises and conflicts like the COVID-19 pandemic or the war in Ukraine.
Experiences from ProSoil's work in Ethiopia, Kenya and India show that a growing number of smallholder farmers are interested in this ecologically sound and promising method that can be produced on site with locally available resources. For many, this becomes a successful business model that opens up new income opportunities.
Because once one has invested properly in worm cultures in the form of a starter set, smallholders can reduce or completely dispense with the purchase of fertiliser in future.
Compared to conventional compost, the production of vermicompost also offers commercially lucrative benefits, particularly in including women: Worms are suitable as fish feed or can be used as fodder for poultry, which is particularly attractive for smallholder farms that keep poultry or have established aquacultures. The liquid extracted from vermicompost, the "vermitea" is also the starting material for the production of biopesticides for use on the farm and in the community.

There is a strong ecological benefit in the use of vermicompost linked with improved soil health. Tests have also shown that plants such as tomatoes or strawberries are less susceptible to certain plant diseases when the soil has been fertilised with worm compost.Vermicompost leads to a supportive biome for beneficial microorganisms, which in turn leads to better nutrient availability in the soil and soil structure as well as better plant growth and health. Soil health is also connected to a secondary benefit of vermicompost which is enhanced adaptation to climate change. Vermicompost improves the water-holding capacity of the soil and needs less resources due to higher microbial activity. Therefore, fields become more efficient and climate resilient. Last but not least, vermicompost supports climate mitigation, due to reduced application of mineral fertiliser and raw manure greenhouse gas emission are reduced.[70]

The downside to vermicompost is the initial financial and timely investment. However, the time lost in the beginning is outweighed by the reduction in effort during the cultivation. Vermicompost is easier applied than manure and less or no plowing is needed on the field due to a better soil structure. Another drawback is that vermicomposting does not produce high enough temperatures to kill weed seeds and pathogens. To cope with this drawback, the organic material can be pre-composted and heated up in a simple pile compost for 15 days, before introducing the worms once the temperature has fallen below 35°C. However, evidence shows that plant pathogens are removed or at least reduced during the process of vermicomposting and the various beneficial effects of vermicompost cause a suppression of plant diseases and pest.[71]

HOW TO IMPLEMENT AND MANAGE VERMICOMPOST?

LIVING CONDITIONS

The essential points for a productive vermicompost can be broken down to five different factors.

- ***First*** is the bedding of the worms. The bottom layer should have a high carbon-nitrogen ratio to slow down the breakdown of materials. Carbon-based materials are residuals from the field, dry leaves and hay. The bottom layer is also important for temperature regulation and holding the moisture. Mixing carbon-based materials with manure improves the material's water-holding capacity. The material added should create an airy mass, so the worms access enough oxygen. Lastly, the environment must be moist for the worms, with an adequate range of 60 to70 per cent water moisture.
- ***Secondly***, the fodder source for the worms which includes almost anything organic. This includes manure, fresh fodder scraps and in general any kind of plant residuals. Meat and high-fat waste can cause anaerobic conditions and smell and should be pre-composted before added.
- ***Thirdly***, as mentioned before the moisture level needs to be at least higher than 50 per cent with ideal conditions between 70 to 90 per cent.
- ***Fourthly***, the compost needs to be well aeriated to avoid anaerobic conditions and providing enough oxygen for the worms.
- ***Lastly***, the temperature needs to be controlled. Worms are productive in the range between 15°C to 35°C. Lower temperatures lead to a reduce in efficiency, whereas temperatures above 35°C can cause the worms to leave the area or die due to the environmental stress. In order to keep the pile cool enough, it can be watered or placed in the shadow.

If using an open pile, consider the following factors in positioning the vermicompost:

- Potential weather events (e.g. sun, heavy rainfall).
- Away from natural predators.
- Closeness to the field.

STEPS TO BUILDING A VERMICOMPOST:

1. Building a worm bin
- Either a bucket or box with at least the following dimensions: 50 x 50 x 20 cm and with 0.5 cm holes at the bottom is needed.
- If neither are available an open pile can be constructed which should not exceed a height of 1 m as the worms prefer to live in the upper area of the pile.

2. Worm bedding
- The bottom layer (10 cm thick) should be constructed with carbon-based material.
- And then be covered with manure and fertile soil.
- The bedding needs to display a moisture level of 70–80 per cent.

3. Adding worms
- The worms should be distributed on the entire surface of the pile.
- If working with a box the lid should then be closed.
- If working with an open pile, the pile can be covered with a plastic sheet.

4. Adding fodder
- After giving the worms a day to work their way into the bedding, plant materials can be added as fodder.
- Add plant materials and other fodder.

5. Controlling living conditions
- Moisture levels, density and fodder availability should be checked regularly.

GLOSSARY

OUR CROPS AND HOW TO GROW THEM

→ **TREES** p. 94

→ **PULSES** p. 96

→ **CEREALS** p. 99

More about the crops → RECIPES, p. 15

TREES → MAHUA

SCIENTIFIC NAME	***Madhuca longifolia (Sapotaceae)***
ENGLISH	**Mahua, butter tree, Illupai**
FRENCH	**Mahua, arbre à beurre**
HINDI	**महुआ (Mahua)**

GROWTH CONDITION

- SOIL TYPE: **Growth on poor dryland. Prefers deep, loamy or sandy soil with good drainage**
- LIGHT REQUIREMENTS: **Sunny position**
- ROOT DEPTH: **Spreading and wide root system**
- TEMPERATURE: **2–46°C (frost tolerant)**
- RAINFALL: **500 mm–1,500 mm annually (humidity: 40–90 per cent)**

MANAGEMENT

PREPARATION

Seeds cannot be stored long before planting (max. 1 week). Therefore, the seeds should be planted directly after they were harvested. Best success rate for germination is achieved when the seeds are greenish black.

For faster germination, soak the seeds for 1 day in water prior to seeding.

PROPAGATION

Direct seeding or cuttings can be used for growing. If sown in pots large, long pots should be used to provide space for the long taproots. Transplanting can be done after 2-4 months. Seeds will sprout in 3 weeks and after 3 months the plants form the nursery can be transplanted. Alternatively, cut branches of 100-150 cm in length and up to 4 cm in diameter from the tree.

- DIRECT SEEDING: **1–2 seeds**
- SEED DEPTH: **4–5 cm**
- IN ROW DISTANCE: **8 m**
- BETWEEN ROW: **8 m**

CULTIVATION PRACTICES

The cultivation practices are based on the management of the canopy. Stakes are used to let the tree grow straight. For the ground structure 3-5 branches should grow. Regular pruning is not required, but dry, weak and diseased branches should be removed. Trees can be cut down after 25–30 years.

HARVESTING

The best time to harvest is in the morning. To simplify harvesting use a net to catch the falling flowers. A fire underneath will keep the net free from most insects.

SEED PRODUCTION

Seeds are produced plentifully every second or third year. As mentioned above seeds need to be sowed directly to achieve the best possible result.

STORAGE

Leaves and flowers can be stored if dried or grounded. They can also be used in production of alcohol and vinegar.

More about/Recipes → MAHUA, p. 18

TREES → MORINGA

SCIENTIFIC NAME	***Moringa oleifera (Moringaceae)***
ENGLISH	**Drumstick or horseradish tree**
FRENCH	**Arbre de Moringa, arbre du paradis**
HINDI	सहजन **(Sahjan)**

GROWTH CONDITION

- SOIL TYPE: **Tolerates a wide range of well-drainage soil types, pH 5–9**
- LIGHT REQUIREMENTS: **Full sun**
- ROOT DEPTH: **Deep taproot**
- TEMPERATURE: **25–35°C (range 7–48°C; also frost tolerant)**
- RAINFALL: **250–1500 mm, depending further site conditions**

MANAGEMENT

PREPARATION

For faster germination, soak the seeds for 1 day in water prior to seeding.

PROPAGATION

For a successful propagation in the field, dig a 30-cm-deep hole and backfill it with a mix of compost and soil before seeding. The seeds will sprout after 3 weeks. Pre-grown plants can be transplanted from the nurseries after 3 months. Alternatively, propagation with cuttings is possible, using branches of 100–150 cm length and up to 4 cm diameter.
For alley cropping extend the distance between the rows to 10 metres.

- DIRECT SEEDING: **3–5 seeds**
- SEED DEPTH: **4–5 cm**
- IN ROW DISTANCE: **3 m**
- BETWEEN ROW: **3 m**

CULTIVATION PRACTICES

Moringa can be intercropped with various crops such as vegetables, legumes or other trees. Its fast growth and dense foliage provide shade and improve soil fertility, benefiting companion crops. Alley cropping, which involves planting *Moringa* trees in rows with space for other crops in between, can be an effective cultivation practice.

HARVESTING

Pruning helps shape the tree and stimulates branching, leading to higher leaf production. Young *Moringa* trees should be pruned to around 1 m in height to encourage lateral branching. Leaves, pods and seeds can be harvested after the tree has reached 1–1.5 metres in height.[72]

SEED PRODUCTION

Moringa can be propagated from seeds or cuttings.

The seeds should be collected from the trees, dried and stored in a cool, dark and dry place. The germination rate declines by 50 per cent after one year.

STORAGE

Preserving the leaves by drying or grounding the leaves to flour. Producing oil from the seeds for cooking.

More about/Recipes → *MORINGA, p. 24*

PULSES → COWPEAS

SCIENTIFIC NAME	***Vigna unguiculata (Fabaceae)***
ENGLISH	**Cowpea, black-eyed pea**
FRENCH	**Niébé, pois yeux noirs**
MOSSI / YORUBA	**Nyambala** (BURKINA FASO) **/ Ewa** (BENIN)

GROWTH CONDITION

- SOIL TYPE: **Variable soil types in semi-arid region, from sands to well drained clays, little tolerance to salinity**
- LIGHT REQUIREMENTS: **Full sun, also tolerates moderate shade**
- ROOT DEPTH: **Depends highly on soil conditions and cultivar, comparatively deep taproot system, 1–2 metres**
- TEMPERATURE: **20–35°C**
- RAINFALL: **400mm–1100mm**

MANAGEMENT

PREPARATION

Normal sustainable cultivation practices. Soaking the seeds in water for faster germination.

PROPAGATION

Best technique is to grow them directly from the seed.

- DIRECT SEEDING: **10–30 seeds per m**
- SEED DEPTH: **3 to 5 cm**
- IN ROW DISTANCE: **3–10 cm**
- BETWEEN ROW: **75 cm**

CULTIVATION PRACTICES

It is commonly intercropped in rows with wide, irregular spacing between young stands of companion cereals or other crops, allowing for efficient resource utilisation and weed suppression. Alternatively, cowpea can be cultivated as a pure stand at higher density using improved varieties and organic agricultural inputs, leading to increased yields while addressing insect and pest challenges. Additionally, implementing light grazing can promote plant regrowth and integrate livestock. However, careful monitoring and management of pests and diseases, such as Phaseolus and stem rot, remain crucial for successful cowpea cultivation.

HARVESTING

Cowpea is typically harvested after 100 to 120 plus days (depending on the variety). The harvesting process can involve either a mechanical harvester or manual hand-picking, with upright varieties often suited for machine harvesting. It is recommended to harvest cowpea when the pods have reached an appropriate length, and the leaves have become drier without significant leaf drop. Optimal seed moisture content for harvesting is around 14 to 18 per cent. The pods can remain in the field for about one week without spoilage before harvesting. In the case of consumption purposes, the leaves can be picked around four weeks after planting.[73]

SEED PRODUCTION

Hand-pick or cut the pods and let them dry.

STORAGE

To ensure proper storage, precautions should be taken to mitigate insect pests. It is advisable to store cowpea in a protected place to minimise the risk of infestation. The storage life of cowpea largely depends on the moisture content of the seeds. For long-term storage, it is recommended to reduce the moisture content to around 8 or 9 percent. Additionally, cowpea leaves can be dried under the sun to preserve them for up to a year, extending their usability for culinary or medicinal purposes.[74]

More about/Recipes → COWPEAS, p. 36

PULSES → MUNG BEANS

SCIENTIFIC NAME	***Vigna radiata (Fabaceae)***
ENGLISH	**Mung bean, green gram**
FRENCH	**Haricot mungo**
HINDI	**मूंग (Moong)**

GROWTH CONDITION

Cultivation types are typically green or golden. Golden mung beans are mostly used for fodder and green mung beans are used for human consumption.

- SOIL TYPE: **Soil types with good drainage**
- LIGHT REQUIREMENTS: **Sunny position but tolerates light shade**
- ROOT DEPTH: **Deeply penetrating vigorous roots**
- TEMPERATURE: **Best range 21–26 °C (Tolerates 8–40 °C)**
- RAINFALL: **Best 500–1,250 mm annually**

MANAGEMENT

PREPARATION

Preparing ridges and furrows in the field and preparing the field with drainage and ample aeration. Rhizobium inoculation is recommended for the first use on the field.

Soak the seed for 12 hours in warm water before sowing.

PROPAGATION

Germination takes place between 12–25°C. It sprouts in 3–7 days as well in dry soil.

Direct seeding, 1–2 seeds per hole and cover lightly with soil.

- DIRECT SEEDING: **1–2 seeds per hole**
- SEED DEPTH: **3–5 cm**
- IN ROW DISTANCE: **10–25 cm**
- BETWEEN ROW: **30–45 cm**

CULTIVATION PRACTICES

Weed control during the growing process.

HARVESTING

Harvest when pods are darkening and hand-pick at weekly intervals. If varieties are maturing uniformly, then the whole plant can be harvested. The plants and pods should be dried for 3–5 days before being threshed.

Leave the root in the soil to decay to release the saved nitrogen in the soil.

SEED PRODUCTION

Hand-pick or cut the pods and let them dry.

STORAGE

Store the pods in dry and insect-free containers. If possible, store them below 15°C.

More about/Recipes → MUNG BEANS, p. 42

PULSES → VELVET BEANS

SCIENTIFIC NAME	***Mucuna pruriens (Fabaceae)***
ENGLISH	**Velvet bean, Mucuna**
FRENCH	**Pois mascate**
HINDI	**केवाँच (Kewanch), कौंच (Kaunch)**

GROWTH CONDITION

- SOIL TYPE: **Any soil with good drainage. Mucuna also tolerates infertile soil and high acidity.**
- LIGHT REQUIREMENTS: **Sunny**
- TEMPERATURE: **19–27°C**
- RAINFALL: **1,000–2,500mm annually but growths in rainfall low as 400mm**
- MATURITY: **100–280 days after flowering / Rapid growth / Flowering after 2–3 months**

MANAGEMENT

PREPARATION

Minimal soil disturbance is preferred and no specific seed planting preparation is required. Soak the seeds in water overnight for fast emergence.

PROPAGATION

The beans are planted 3–4 weeks later than the other crop for intercropping. Longer delays in sowing will reduce the yield due to shading.

- DIRECT SEEDING: **1 seed per hole**
- SEED DEPTH: **3–7 cm**
- IN ROW DISTANCE: **30–40 cm**
- BETWEEN ROW: **90–100 cm**

Weed, pest and further management practices

Weed control during the growing process is especially important at the beginning for optimal growth. Mucuna is used in Brazil for limiting Fusarium oxysporum infestation in cotton.

CULTIVATION PRACTICES

It is mainly used as a cover crop or in combination with other plants for intercropping. Adequate watering during the initial growth stages is crucial. Mucuna pruriens is a climbing vine that requires support or trellising structures for proper growth and to facilitate harvesting. Bamboo poles or stakes can be used to provide support to the vines. Once established, it is relatively drought-tolerant and can withstand dry conditions. However, supplementary irrigation during prolonged dry spells can improve productivity. Weed competition can significantly affect its growth. Regular weeding or mulching around the plants is essential to suppress weed growth and ensure better nutrient availability.[75] As an invasive legume, it can invade ecosystems instead of benefitting them if not managed well.

HARVESTING

Velvet bean can be harvetsed when the pods turn green to dark brown or black.

Cutting for forage should be done when the pods are still young, between 90–120 days after sowing.

SEED PRODUCTION

Hand-picking or cutting the pods and letting them dry.

STORAGE

Store the pods in dry and insect-free containers. If possible, store them below 15°C.

More about/Recipes → VELVET BEANS, p. 46

CEREALS → DURUM WHEAT

SCIENTIFIC NAME	***Triticum turgidum ssp. durum (Poaceae)***
ENGLISH	**Durum/hard/macaroni wheat**
FRENCH	**Blé dur, Blé macaroni**
AMHARIC	ዱሩሚ **(Durumi)** (ETHIOPIA)

GROWTH CONDITION[76]

- SOIL TYPE: **Wide range of arable soils, medium textured soil best suited, tolerates dry conditions, Mediterranean crop**
- LIGHT REQUIREMENTS: **Full sun**
- ROOT DEPTH: **75–200 cm[77]**
- TEMPERATURE: **Mediterranean temperatures, between 20–30 °C**
- RAINFALL: **Needs less than 500 mm per year**

"Durum wheat originated from the domesticated form of a wild species named emmer wheat (Triticum dicoccum) between 12,000 and 10,000 years ago, in the West Levantine. Phoenicians have traded it along the Mediterranean shores since historical times and throughout the rise of civilisations this crop has encountered several waves of expansion until its global importance today. However, durum wheat did not originate solely in West Asia. Archeological evidence suggests that emmer reached Ethiopia approximately 5,000 years ago, probably arriving from the Levantine, through Egypt, along the Silk Road."

MANAGEMENT

PREPARATION

The soil must be well drained and seeds can be coated to improve germination.

PROPAGATION

Seeds start germinating at a temperature above 18°C.

- DIRECT SEEDING: **3–5 seeds**
- SEED DEPTH: **4–5cm**
- IN ROW DISTANCE: **3 m**
- BETWEEN ROW: **3 m**

CULTIVATION PRACTICES[78]

If seeds are not germinating, resowing should be done at the latest 3 weeks after the sowing. Thin out the holes to two plants per hole. The thinned-out plants can be replanted in holes without plants.

For water management in dry areas apply tied ridging to improve the soil moisture. Another option is to mulch the field to prevent evaporation. Also, the combination with pigeon pea is an option to provide nitrogen and suppress weeds in the field.

HARVESTING

Late harvest season to avoid early waterlogging.

SEED PRODUCTION

Seed multiplication is done in the same way as with Sorghum: there are three to four stages (dependent on the demand of the farmer), which the breeder goes through to get from the nucleus seed to obtaining the certified. Please check out the more detailed description of the process in the Sorghum chapter (p. 101).

STORAGE

A storage facility which protects the seeds from sunlight (preferably a dark room) is optimal to store the seeds at temperatures ranging from 10°C to 20°C. Moisture content, temperature and length of storage affect the germination of durum wheat significantly. Storage temperatures of above 30°C, lead seeds to germinate after 4 weeks. Relative air moisture between 1 and 15 per cent are optimal to store the seeds safely for around 12 weeks.[79]

More about/Recipes → DURUM WHEAT, p. 60

CEREALS → PEARL MILLET

SCIENTIFIC NAME	***Cenchrus glaucus (Poaceae)***
ENGLISH	**Pearl/Black millet**
FRENCH	**Millet perlé/perleux/noir**
HINDI	**Bajra** (also used in ENGLISH, FRENCH and SPANISH)
YORUBA	**Ayanka** (NIGERIA)

GROWTH CONDITION

- SOIL TYPE: **Tolerates a wide range of well-drainage soil types**
- LIGHT REQUIREMENTS: **Full sun**
- ROOT DEPTH: **Deep taproot, until 2 m in pursuit of water and soil nutrients**
- TEMPERATURE: **25–30°C (range 7–48°C; also frost tolerant)**
- RAINFALL: **700–2,200 mm (tolerates: 400–2,600 mm)**

MANAGEMENT

SEED PRODUCTION

Pearl millet[80] falls under the category of open-pollinated varieties, which means that it gets pollinated by wind, like Sorghum. Seed multiplication is done accordingly to the principle of Sorghum: there are three to four stages (dependent on the demand of the farmer), which the breeder goes through to obtain the certified seed from the nucleus seed if intended. Please check out the more detailed description of the process in the Sorghum chapter (p. 101).

PREPARATION

Normal sustainable cultivation practices. Soaking the seeds in water for faster germination. Normally in moisty soil and under appropriate temperatures, germination takes place after 2–3 days.

CULTIVATION PRACTICES

PREPARATION: Starting with the preparation of the field, the crust and hardpans are broken to bury plant residues and to incorporate organic manure (like lime and other soil amendments). One can use contour ploughing, stone bunds or Zaï pits. Then, the specific seed variety best adapted to the local context is chosen, e.g. short duration varieties if soil moisture is limited. For the highest germination rate, soak seeds overnight in water.

PROPAGATION: During the start of the rainy season, holes are dug 2–5 cm into the topsoil to fill each hole with a maximum of 5 seeds. In sandy or clay soil, the holes can be dug deeper. The holes are dug in rows, with row spacing ranging from 20–100 cm. In poorer soils, the rows must lay further apart for the crop to get enough nutrients to grow accordingly.
First weeding must be done after 2 weeks, thereafter every 5 to 6 weeks.

PROPAGATION

- DIRECT SEEDING: **3–5 seeds**
- SEED DEPTH: **4–5cm**
- IN ROW DISTANCE: **3 m**
- BETWEEN ROW: **3 m**

HARVESTING

25–30 days after fertilisation of the plant, the phase of maturity should be reached identifiable by a black layer at the bottom of the grain. It is advisable to harvest as early as possible to avoid losses due to birds or extreme weather happenings. Then, the seed heads should be cut first for the stalk to dry out for one week and to be cut later. At this stage, the grains are still subject to substantial moisture (on average 20 per cent, should not be below for good quality), which is why proper drying of the grains is needed for further processing.

STORAGE

After harvesting, mechanical thresher or other tools are used to separate the grain from the seed heads. In case of absence of such machines, cattle are used to trample on these seed heads to achieve the separation of the grain. The drying process should start immediately after and should last until the moisture content falls below 14 per cent. If the grain is intended to be stored for longer than 6 months, the moisture level should be below 12 percent.

More about/Recipes → PEARL MILLET, P. 66

CEREALS → SORGHUM

SCIENTIFIC NAME	***Sorghum bicolor (Poaceae)***
ENGLISH	**Sorghum**
FRENCH	**Sorgho**
AMHARIC	ማሽላ **(Mashəla)** (ETHIOPIA)

GROWTH CONDITION[81]

- SOIL TYPE: **Tolerates a wide range of soil (even poor soil) and waterlogging**
- LIGHT REQUIREMENTS: **Full sun**
- ROOT DEPTH: **2 m**
- TEMPERATURE: **20–25°C**
- RAINFALL: **700–2,200 mm**

MANAGEMENT

PREPARATION

Standard sustainable cultivation practices and well-drained soil are required.

PROPAGATION

Seeds start germinating at a temperature above 18°C.

- DIRECT SEEDING: **5–8 seeds per hole (for 2–3 plants)**
- SEED DEPTH: **4–5 cm (dry) / 2.5–4 cm (wet)**
- IN ROW DISTANCE: **30–40 cm / 12–20 cm***
- BETWEEN ROW: **75 cm / 45–60 cm***

** Under favourable growing*

CULTIVATION PRACTICES

If seeds are not germinating, resowing should be done at the latest 3 weeks after the sowing. Thin out the holes to two plants per hole. The thinned-out plants can be replanted in holes without plants.

For water management in dry areas apply tied ridging to improve the soil moisture. Another option is to mulch the field to prevent evaporation. Also, the combination with pigeon pea is an option to provide nitrogen and suppress weeds in the field.

HARVESTING

The time for harvesting Sorghum is when it starts to blacken or dry on top of the fruit. Sorghum is harvested with a threshing machine and afterwards dried in the sun.

SEED PRODUCTION[82]

In most countries there are three to four classes of seeds: the nucleus, breeding, foundation and finally the certified seed. It takes a three to four stages in processing to achieve the quality required for the farmer to obtain the best possible harvest results. It starts with the nucleus seed, which should be planted in off-season on a separated plot at least 400 m from the next Sorghum field. Careful inspection and weeding are necessary to ensure the best output. Harvesting the first batch should be done at the flowering stage. The seed obtained is called the "breeding seed" (1st generation). The same process is repeated to obtain the foundation seed. The last step should then produce the seed quality according to national standards set by the national governmental authorities. It is advised to produce 30–50 kg of nucleus seeds every 4 years.

STORAGE

Store the grains in a clean, dry and well-ventilated place.

More about/Recipes → SORGHUM, p. 70

ENDNOTES / SOURCES

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