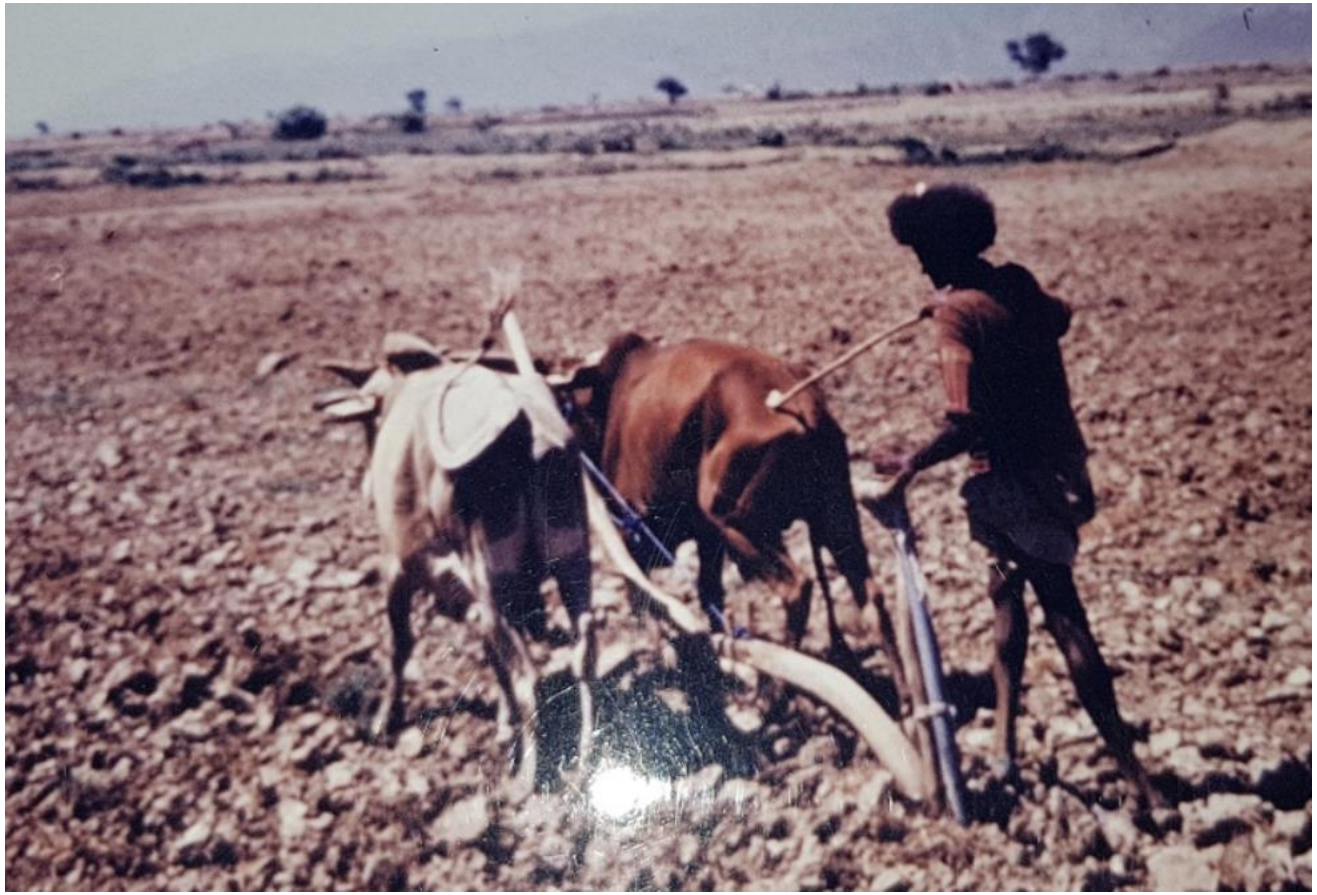
# Experiences from Sudan: Sorghum Superpower

5th largest food crop
suitable for arid and dry conditions
highly varying yields depending on variety  and water management
important for fodder



Flood-Based Livelihoods Network Foundation

# Sorghum

## Species Description and Information

### physiological marvel

- can grow in both temperate and tropical zones
- is among the most photosynthetically efficient plants.
- has one of the highest dry matter accumulation rates
- is one of the quickest maturing food plants

### Versatility

**(world's most versatile crop)**

18 subspecies were once recognized by botanists

### Botanical Name

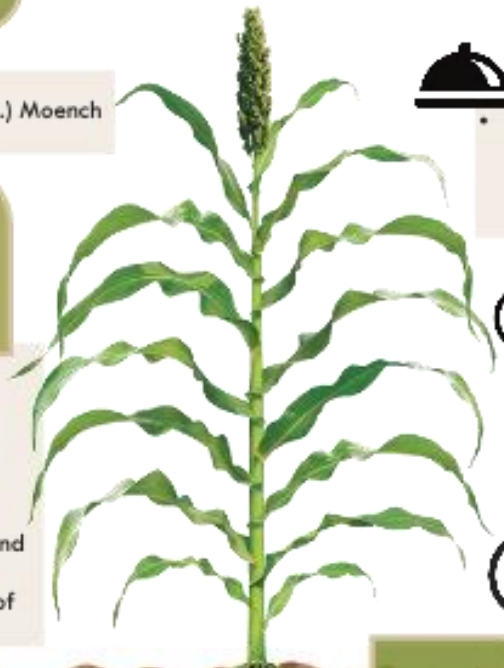
Sorghum bicolor (L.) Moench

### Synonyms

Sorghum vulgare Pers., S. drummondii, S. guineense, S. roxburghii, S. nervosum, S. dochna, S. caffrorum, S. nigricans, S. caudatum, S. durra, S. cernuum, S. subglabrescens

### Description

- many types
- canelike grasses 50 cm - 6 m tall
- Most are annuals, a few are perennials
- stems are usually erect, single, and may be dry or juicy (insipid or sweet)
- some varieties tiller profusely with more than a dozen stems (produced early or late in the season)
- plants that tiller after the harvest can be cut back, allowed to resprout, and grown without replanting (like sugarcane)
- soil permitting, the plant produces a deep tap root with a large number of multibranched lateral roots



- boiled like rice, cracked like oats **for** porridge, "malted" like barley for beer, baked like wheat into flatbreads, popped like popcorn for snacks, sugary grains and are boiled in the green stage like sweet corn

- boiled like rice, cracked like oats for whole plant is often **used as** forage, hay, or silage; stems: (building, fencing, weaving, broom-making, firewood, sugar, syrup, and even liquid fuels for powering vehicles or cooking meals); living plants are used for windbreaks, cover crops, and for staking yams and other heavy climbers; seeds are fed to poultry, cattle, and swine

- Sorghum, the "living factory": some **products**
- Industrial alcohol, vegetable oil, adhesives, waxes, dyes, sizing for paper and cloth, and starches for lubricating oil-well drills

### Drought-defying mechanisms

1. Massive and deep-penetrating roots responsible for drought tolerance
2. Conserves moisture by reducing its transpiration when stressed (by rolling its leaves and possibly by closing the stomata to reduce evaporation)
3. For a plant with such a modest leaf area, sorghum's roots are huge. This underground "survival tool" seeks out moisture deep in the soil, equipping the crop for good growth in semiarid climates. The resulting ability to yield grain under dry conditions makes sorghum a crucial tool in the fight against world hunger
4. Can turn down its metabolic processes and retreat into near dormancy until the return of the rains

### Planting and irrigation

- sorghum grows under rain-fed, flood-based or irrigated conditions
- in flood based spate irrigation sorghum yields depend on stored soil moisture
- by pre-planting irrigation, deep ploughing and soil mulching moisture is conserved
- it is often preferable to irrigate the field 2-3 times to ensure moisture beyond stress levels
- if so, grain yield may reach up to 3.5 ton/ha
- uniquely suited varieties have found their place in the spate irrigated areas

Source 1: Lost Crops of Africa, Volume I: Grains Board on Science and Technology for International Development, Office of International Affairs, National Research Council, 1996
Source 2: Sorghum Production under Spate Irrigation Systems, Practical Note 7, Flood-Based Livelihoods Network (FBLN), 2014

Flood-Based Livelihoods Network Foundation

# Sorghum

## Challenges and drawbacks

- Unknown production statistics as they are lumped together with millet's
- Lack of attention, is called a "Lost" crop

- It warrants and produces merely a fraction of what it could
- Under-supported for the world's fifth major crop, and its vast and untapped potential
- Undeveloped with a remarkable array of untapped variability in grain type, plant type, adaptability, and productive capacity (more undeveloped and underutilized genetic potential than any other major food crop)

- Selection and management will be needed to get good yields under saline conditions
- Needs more proper processing and management to overcome its protein nutrient deficiency and low digestibility

**Drawbacks** from fulfilling its international potential

Lack of status

Low food value

Overall nutrient composition:
12% protein
3% fat
70% carbohydrate

Difficulty in processing

Food quality problems:
1- tannins, occur in the seed coats of brown sorghum grains and reduce the nutritional effectiveness
2- protein quality, alcohol-soluble protein that has low digestibility in humans.

## Assets

- Elite handful of plants that collectively provide 85+% of all human energy
- Highest production of food energy per unit of human or mechanical energy expended

- Only surpassed by rice, wheat, maize, and potatoes in feeding the human race.
- Could contribute a great deal more to food supplies than it does at present
- Would contribute most to those regions and peoples in greatest need

- One of the toughest of all cereals. It withstands high rainfall—even some waterlogging
- Some tolerance to salt
- Can endure hot and dry conditions
- Can produce on sites so burning and arid that no other major grain can be consistently grown, except pearl millet

- Requires less water than maize or wheat requires between two and four irrigations per year, compared to wheat's six or seven.
- Now grown in some areas where irrigation has salinized the soil.

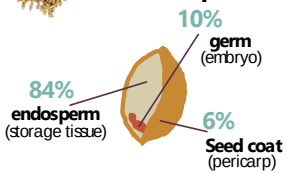
- Average yields per hectare are not as great as those of wheat, they are substantially higher than those of maize.
- Supplies 74% of the raw material used in animal feed in Mexico

Source: Lost Crops of Africa, Volume I: Grains Board on Science and Technology for International Development, Office of International Affairs, National Research Council, 1996

# Sorghum Nutrition and Concerns

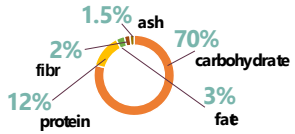
Flood-Based Livelihoods Network Foundation

## Kernel's main parts




## Chemical composition

Kernel's whole-grain form hardly differs from whole-grain maize or wheat




When the seed coat and germ are separated to leave a stable flor: 83% carbohydrate, 12% protein, 0.6% fat,e1% fibr , and 0.4% ash

## Similarities with maize

- starch is the major component followed by protein, fat, andefibr
- its complex carbohydrates have properties similar to those from maize

## Differences

- generally contains 1% less fat and more waxes
- protein content is quite variable

## Nutrition components

**Carbohydrates** — 32% to 79% of its weight

- major component, and largely sugars
- straches occur in both polygonal and spherical granules
- strach is 70-80% branched amylopectin and 20-30% amylose, some contain 100% amylopectin; others, 62% amylose
- strach can be used interchangeably with maize strach in many industrial and feed applications
- when boiled, starch forms an opaque paste of medium viscosity and a rigid nonreversible gel on cooling.
- strach diameter: 5µ to 25µ, and gelatinization temperature 68°- 75°

**Protein** — 7% to 15% of its weight

- more variable than that in maize, and contains no gluten
- mostly, the kernel contains about 12%, which is 1-2 percentage points higher than maize
- Lysine, which provides about 45% of the recommended requirement
- A large proportion is prolamine, a cross-linked form that humans cannot easily digest, making up about 59% of the total protein in normal sorghum. This is higher than in other major cereals, and it lowers the food value considerably
- sorghum grain needs to be processed to realize its full protein value

**Fat** — 1% less fat than maize

- Free lipids (2-4% of the grain), and bound lipids (0.1-0.5%)
- Similar oil properties to those of maize oil (fatty acids are highly unsaturated. Oleic and linoleic acids account for 76% of the total)

**Vitamins**

- higher levels of the B vitamins pantothenic acid, niacin, folate, and biotin than in maize, while most B vitamins are located in the germ
- similarvlevels of riboflai n and pyridoxine
- lower levels of vitamin A (carotene)
- pellagra—a disease caused by too little niacin in the diet

**Minerals** — 1% to 2% ash content

- potassium and phosphorus are the major minerals
- low calcium and zinc levels
- a good source of more than 20 micronutrients

## Future as a global food

It is unfit for human consumption; samples of milled flor (comprising only the grain's endosperm) were merely boiled into porridge and fed directly
In Africa, the whole grain is ground up (protein and vitamin-rich germ is also included) and often some form of fermentation is also employed

## Nutritive effectiveness

60% of the protein is in the highly cross-linked form called prolamine. Human digestive enzymes are unable to break up this indigestible protein. Even bodies desperately in need of more muscle, enzymes, blood, and brain continue passing prolamine that might otherwise provide the necessary amino acids

## Food quality concerns

Tannins, which occur in the seed coats of dark-colored sorghum grains, block the human body's ability to absorb and use proteins and other nutritional ingredients. Unless the grain is a low-tannin (yellow or white) type or unless brown seed coats are carefully removed, some tannins remain, and this reduces sorghum's nutritional effectiveness

## Nutrition concerns

**Germinated sorghum grain**

A cyanogenic glucoside is formed. In the shoots, enzymes act on this to produce cyanide. This is a potential hazard only with germinated sorghum, and not with the grain itself

## "Incomplete" protein for human nutrition

It is deficient in critical amino acids, most importantly lysine; provides about 45% of the recommended lysine requirement. It is low in protein digestibility, thus must be properly processed

Source: Lost Crops of Africa, Volume I: Grains Board on Science and Technology for International Development, Offic of International Affairs, National Research Council, 1996

Flood-Based Livelihoods Network Foundation

# To the World from Africa: Sorghum The Green Revolution

## History

**Ancient food** over the millennia

- was domesticated several times
- sorghums have fed countless generations
- At least four major types arose in different places

**4000** years ago — one of the oldest type , the durra (crook-necked) variety was eaten in **Egypt**

### Ethiopia

is durra's center of diversity
durra sorghum is still the staple food for most of the populace of the Horn of Africa

### Eastern Nigeria through Chad and western Sudan

a center of diversity for the caudatum race

### Region from western Nigeria to Senegal

gave rise to the guinea race

### Area from Tanzania to South Africa

is the center for the kafirr ace

## Common Names

India: jola, jowar, jawa, cholam, durra, shallu, bisinga
Burma: shallu
East Africa: mtama, shallu, feterita
China: kaoliang
Middle East: milo
West Africa: great millet, guinea corn, feterita
Egypt: durra
United States: sorghum, milo, sorgo, sudangrass
English: chicken corn, guinea corn, Sudan durra, feterita
South Africa: Kafircorn

## Global production

**100+ million** tons of annual world production of sorghum and millet together

**60 million** tons are certainly sorghum

**70 million** metric tons of grain

**50 million** hectares of land

Dietary staple of **500+ million**

**30+** countries

### Number of hectares under sorghum (FAO figures for 1985)

- **3 million** South America
- **9 million** North and Central America
- **18 million** Africa
- **19 million** Asia

## Main grain production (in millions of tons)

| | |
|---|---|
| 28.70 | The United States |
| 10.30 | India |
| 6.80 | China |
| 6.60 | Mexico |
| 6.20 | Argentina |
| 4.25 | The Sudan |
| 3.50 | Nigeria |

## Green revolution – Mexico from Africa

- second Green Revolution, after wheat
- the third largest in terms of area (after maize and beans) as well as in terms of value (after maize and cotton)

**1300%** expansion in the number of hectares

**1.5+ million** hectares of sorghum (more than double the wheat land)

**2772%** increase in sorghum production

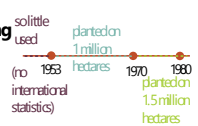
**6th** largest sorghum-producing country in the world

1958 to 1980 — 1980

## International support and breakout

- its yield improvements have outstripped those of all other major cereals in the US
- is increasingly employed in India
- the most rapid and unexpected growth of all is occurring in Mexico, Central America, and the Caribbean

**Mexico embracing sorghum**




**Pragmatic reasons**

- cheaper to produce than maize
- yields about twice as much grain as maize
- more dependable where rainfall is unreliable

Source: Lost Crops of Africa, Volume I: Grains Board on Science and Technology for International Development, Office of International Affairs, National Research Council, 1996

- Introduce untapped varieties and promote its adaptabilities and productive capacities
- Inter-cropping with millet, tetak, guar and mung beans for additional harvest and improvement of the nutrient retention capacity of the soil
- Share and exchange outstanding local sorghum varieties proven to be successful in different areas
- Improve infrastructure for seed production; breed better sorghum to achieve stable yields, raise pest and disease resistance, boost its tolerance to drought and improve its grain quality for storage and processing
- Apply water conservation techniques to make productive use of water within the command area
- Introduce improved farming tools (like scythes) in spate areas to address labour shortage
- Improve local grain storage to protect the grains from high temperatures, temperature changes, insects and rodents, domestic animals and control of moisture levels.


*A selection of sorghum products*

# General cropping pattern

Early floods (high temperature)

- Sorghum, guar, pulses

Later floods (lower temperature)

- Oilseeds, chickpeas, wheat
- Vegetables

Combination with groundwater: many options

Specific tree crops