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Seed Catalogue of Best Perfoming Varieties of Sorghum in Dodoma and Singida Tanzania

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Introduction

Food and nutritional security of resource poor farmers globally is increasingly under a serious threat of climate change. In Kenya, Tanzania and Uganda, agricultural production rates are low, exacerbated by frequent erratic rainfall and droughts due to climate change. The homogenization of agriculture to single crops or varieties in hope of higher yields, coupled with the associated loss of biodiversity, has further decreased the resilience of resource-poor farmers. The loss of genetic diversity in farmers' custody has greatly narrowed the gene pool from which to depend on. In order to help them adapt to climate change, a project called "Promoting Open Source Seed Systems for Beans, Millet and Sorghum for Climate Change Adaptation" funded by the Benefit-sharing Fund (BSF) established under the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) was implemented in Kenya, Uganda and Tanzania. This project increased the availability and diversity of climate-smart varieties of four important crops, namely beans, forage legumes, finger millet and sorghum through testing, breeding and production of high quality seeds and increasing access to a wider range of locally adapted varieties.

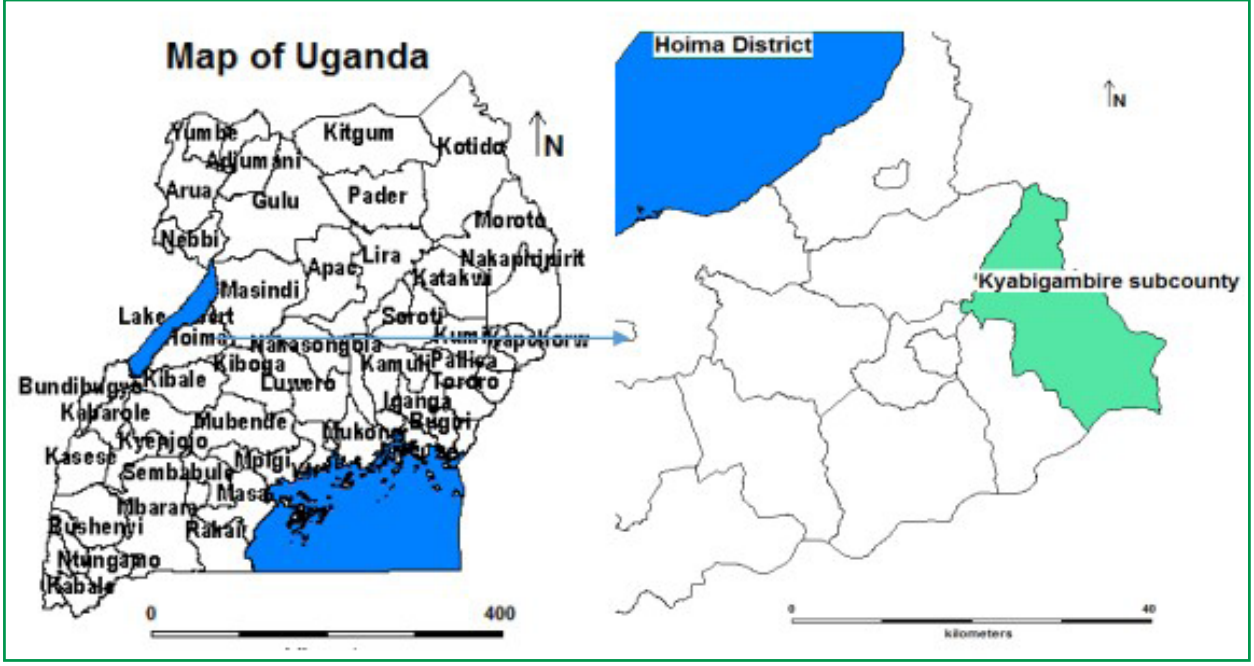
In Tanzania, the National plant genetic resources center received 33 accessions from Uganda National gene bank through Standard Material Transfer Agreement (SMTA). These accessions were multiplied at Miwaleni in Kilimanjaro and Hombolo Agricultural Research Institute in Dodoma and only 24 were able to survive. The 24 accessions were distributed amongst 250 farmers in Dodoma and Singida during the cropping seasons in 2017 and 2018. The farmers were able to test the varieties through crowdsourcing method and participatory varietal selection, and the breeder further evaluated them at the on-station at TARI Hombolo. Farmers selected top 10 accessions that performed outstandingly based on their preferred traits like pest and disease resistance, early maturity, high yields, droughts and flood tolerance and taste. This catalogue presents the best and top selected varieties of sorghum in Dodoma and Singida that can be disseminated in larger areas and also improved further through breeding.

The catalogue provides a summary of soils and climatic conditions in Hombolo and Singida, and agronomic attributes of the selected varieties including their nutritional content. The agronomic attributes were collected during trials and they include grain colour, plant height, lodging, tillering ability, days to maturity, yield potential and pest, disease and drought resistance.

The nutritional content of the selected varieties was done at the Food and Nutritional Evaluation Laboratory (FANEL-BeCa ILRI Hub) in Nairobi Kenya. The nutritional evaluation included determination of moisture content, proteins, ash, fat, iron, zinc, calcium and total phenolics.

Climate information of Hombolo and Singida

Figure 1. Map of Dodoma and Singida project sites in Tanzania



Singida and Hombolo are located in central region of Tanzania. Dodoma is on Latitude 6.1°S and Longitude 35.7°E at an altitude of 1400--2800 m above sea level. The climate is semi-arid, with a total annual rainfall of 395--780 mm. Rainfall distribution is mono-modal. The rainy season starts in late November, peaks in December/January and ends in April. A long, dry spell that sometimes lasts 40 days is often experienced in February/March, during the growing season. The dry season usually lasts 6 months, from May to November. The monthly maximum and minimum temperatures are about 35 and 16°C respectively.

Singida Region is in Central Tanzania, at Latitude 4.8°S, Longitude 34.8°E and altitude 900 to 1500 m. The climate is both semi-arid and sub-humid, with an average annual rainfall of 500--800 mm. Annual rainfall distribution is mono-modal and usually starts in mid-November and ends in April or early May. Temperature ranges between 15 and 32°C depending on season and altitude. The coldest period in the year is July while the hottest is October and November.

Selected sorghum varieties in Hombolo and Singida

Documented importance and nutrition profile of sorghum

Sorghum (Sorghum bicolor, L) is a cereal crop indigenous to Africa and is globally used for food, feed, and biofuel. It is also a leading crop in arid and semi-arid regions and is ranked fifth in importance among the world's grain crops after wheat, maize, rice, and barley (Gedifew and Tsige, 2019). The grains have become an important feed for livestock, especially for pigs and poultry. It is considered one of the best crops for silage, because of the high yields, high sugar content and the juiciness of the stalks (FiBL, 2012). Sorghum is a nutrient-packed grain that you can use in many ways. It's rich in vitamins and minerals like B vitamins, magnesium, potassium, phosphorus, iron, and zinc. It's likewise an excellent source of fiber, antioxidants, and protein and is important as a gluten-free alternative to other types of flour.

Variety Name: UNGBB 2752

Country of origin: Uganda

It has dark red grain colour

Agronomic Characteristics

- Plant has a medium growing height of up to 170 cm.
- The plant is usually erect with few cases of bending.
- It can produce up to seven tillers.
- It takes 111 days to mature and is considered a medium-maturing variety.
- It has intermediate shattering ability and is therefore easy to thresh after harvesting.
- It can yield up to 1533 kg (17 90-kg bags), so it is a medium-yielding variety.
- Easily affected by fall army worm.

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	11.49%	12%
Protein	12.09%	10.44-12.7%
Ash	2.35%	1.57-1.79%
Fat	2.90%	2.66-4.05%
Iron	6.32 mg/100g	4.2 mg/100g
Zinc	3.37 mg/100g	2.5 mg/100g
Calcium	28 mg/100g	15mg per 100g
Total Phenolics (Health promoting compounds)	127.84 mg/100g	109-116.7 mg/100g

Source of reported average: Kaijage et al. (2000): Kulamarva et al. (2010); Aiffy et al. (2012;) Leder (2004).

Further information

- High in protein
- High in ash content implying high mineral content
- High in iron and zinc
- High in health-promoting compounds
- The red variety is not associated with antinutrients (tannins).
- Good for complementary feeding, pregnant. and lactating mothers

Variety Name: UNGB 65

Country of origin: Uganda

It has brown grain colour

Agronomic Characteristics

- Plant height is up to 184 cm.
- The plant is usually erect with low cases of bending.
- It does not produce any tillers.
- It takes 134 days to mature, so it is considered a medium-maturing variety.
- It has intermediate shattering ability, therefore it is easy to thresh after harvesting.
- It can yield up to 1358 kg (15 90-kg bags) and is therefore a medium-yielding variety.
- Easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	10.74%	12%
Protein	9.26%	10.44-12.7%
Ash	2.61%	1.57-1.79%
Fat	2.44%	2.66-4.05%
Iron	7.94 mg/100g	4.2 mg/100g
Zinc	2.50 mg/100g	2.5 mg/100g
Calcium	34.89 mg/100g	15 mg.100g
Total Phenolics (Health promoting compounds)	73.60 mg/100g	109-116.7 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High in iron and calcium
- The red variety is associated with no tannins (antinutrients).
- Good for complementary feeding, pregnant, and lactating mothers

Variety Name: UNGB 2841

Country of origin: Uganda

It has a brown grain colour

Agronomic Characteristics

- Plant height is up to 241 cm; it is therefore very tall.
- The plant is characterised with bending/not always erect.
- It produces up to three tillers.
- It takes 112 days to mature, so it is considered a medium-maturing variety.
- It has intermediate shattering ability and is therefore easy to thresh after harvesting.
- It can yield up to 1667 kg (19 90-kg bags); it is therefore a medium-yielding variety.
- Not easily attacked by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	10.99%	12%
Protein	12.13%	10.44-12.7%
Ash	2.08%	1.57-1.79%
Fat	3.14%	2.66-4.05%
Iron	12.77 mg/100g	4.2 mg/100g
Zinc	3.05 mg/100g	2.5 mg/100g
Calcium	29.50 mg/100g	15 mg/100g
Total Phenolics (Health promoting compounds)	62.62 mg/100g	109-116.7 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al.. (2012); Leder (2004).

Further information

- High in protein
- High in ash, implying that it is high in minerals
- High in iron, zinc, and calcium
- The brown sorghum is also called tannin sorghum, meaning it contains tannins (Antinutrients).
- Processing methods of soaking, fermentation, and germination should be used to increase nutrient availability to the body.
- Good for complementary feeding, pregnant, and lactating mothers

Variety Name: UNGB 2796

Country of origin: Uganda

It has dark red grain colour

Agronomic Characteristics

- Plant height is up to 241 cm therefore very tall
- The plant is usually erect or has lower possibility of bending
- It produces up to 8 tillers
- It takes 116 days to mature, considered medium maturing variety
- It has high shattering ability therefore very easy to thresh after harvesting
- It can yield up to 1317 kg (15 bags of 90kg) therefore a medium yielding variety
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	11.39%	12%
Protein	11.52%	10.44-12.7%
Ash	2.14%	1.57-1.79%
Fat	2.41%	2.66-4.05%
Iron	11.65 mg/100g	4.2mg per 100g
Zinc	2.87 mg/100g	2.5 mg/100g
Calcium	25.47 mg/100g	15 mg/100g
Total Phenolics (Health promoting compounds)	94.86 mg/100g	109-116.9 mg/100g

Source of reported average: Kaijage et al., 2000; Kulamarva et al., 2010; Aiffy et al., 2012; Leder, 2004.

Further information

- High in protein content
- High in ash implying more minerals
- High in iron, zinc and calcium
- The red colour grain is not associated with tannins and has a medium polyphenol content.
- Good for complementary feeding, pregnant, and lactating mothers

Variety Name: UNGB 2777

Country of origin: Uganda

It has a brown grain colour

Agronomic Characteristics

- The plant has a medium growing height of up to 168 cm.
- It is usually erect or has a lower possibility of bending.
- It produces up to six tillers and takes 119 days to mature, so it is considered a medium-maturing variety.
- It has an intermediate shattering ability so it is easy to thresh after harvesting.
- It can yield up to 1833 kg, therefore it is a high-yielding variety.
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	12.27%	12%
Protein	12.00%	10.44-12.7%
Ash	1.71%	1.57-1.79%
Fat	3.14%	2.66-4.05%
Crude Fibre	7.27%	1.74-6.84%
Carbohydrates	63.61%	72.1%
Iron	7.02 mg/100g	4.2 mg/100g
Zinc	2.95 mg/100g	2.5 mg/100g
Calcium	15.59 mg/100g	15 mg/100g
Total Phenolics (Health promoting compounds)	76.94 mg/100g	109-116.7 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High in protein
- High in iron and zinc
- The brown grain colour is associated with the presence of tannins and high total phenolic compounds.
- Processing methods like soaking, fermentation, and germination should be used to increase nutrient availability to the body.

Variety Name: UNGB 2775

Country of origin: Uganda

It has red grain colour

Agronomic Characteristics

- The plant has a medium growing height of up to 236 cm, therefore it is a tall variety.
- It is characterised by intermediate bending attributes.
- It produces up to three tillers.
- It takes 117 days to mature, so It is considered a medium-maturing variety.
- It has intermediate shattering ability, therefore it is easy to thresh after harvesting.
- It can yield up to 1876 kg (21 90-kg bags), so it is a high-yielding variety.
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	11.24%	12%
Protein	12.03%	10.44-12.7%
Ash	2.09%	1.57-1.79%
Fat	1.14%	2.66-4.05%
Iron	6.58 mg/100g	4.2 mg/100g
Zinc	2.96 mg/100g	2.5 mg/100g
Calcium	21.74 mg/100g	15 mg/100g
Total Phenolics (Health promoting compounds)	56.12 mg/100g	109-116.70 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High in protein
- High in ash, implying high mineral content
- High in iron, zinc, and calcium
- The white colour is associated with no tannins (antinutrients), therefore increased mineral and protein available to the body.
- Processing methods like soaking, fermentation, and germination should be used to increase nutrient availability to the body.
- Good for complementary feeding, pregnant, and lactating women

Variety Name: UNGB 2767

Country of origin: Uganda

It has orange-red grain colour

Agronomic Characteristics

- The plant has a medium growing height of up to 230 cm, therefore it is a tall variety.
- It is characterised by intermediate bending attributes.
- It produces up to four tillers.
- It takes 115 days to mature, so it is considered a medium-maturing variety.
- It has a high shattering ability, therefore it is very easy to thresh after harvesting.
- It can yield up to 2167 kg (24 90-kg bags), therefore it is a high-yielding variety.
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	11.71%	12%
Protein	11.92%	10.44-12.7%
Ash	1.89%	1.57-1.79%
Fat	2.83%	2.66-4.05%
Crude fibre	6.12%	1.74-6.84%
Carbohydrate	65.54%	72.1%
Iron	7.77 mg/100g	4.2 mg/100g
Zinc	3.25 mg/100g	2.5 mg/100g
Calcium	19.61 mg/100g	15 mg/100g
Total Phenolics (Health Promoting compounds)	63.67 mg/100g	109-116.7 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High in protein
- High in iron, zinc, and calcium
- The brown variety is associated with high tannin content (antinutrients) and high total phenolics.
- Processing methods like soaking, fermentation, and germination should be used to increase nutrient availability to the body.

Variety Name: UNGB 2742

Country of origin: Uganda

It has dark red grain colour

Agronomic Characteristics

- The plant has a medium growing height of up to 225 cm, therefore it is a tall variety.
- It is characterised by intermediate bending attributes.
- It does not produce any tillers.
- It takes 119 days to mature, so it is considered a medium-maturing variety.
- It has a high shattering ability, therefore it is very easy to thresh after harvesting.
- It can yield up to 2133 kg (24 90-kg bags), therefore it is a high-yielding variety.
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	12.19%	12%
Protein	12.67%	10.44-12.7%
Ash	2.22%	1.57-1.79%
Fat	2.68%	2.66-4.05%
Iron	8.83 mg/100g	4.2 mg/100g
Zinc	10.46 mg/100g	2.5 mg/100g
Calcium	29.80 mg/100g	15 mg/100g
Total Phenolics (Health promoting compounds)	69.07 mg/100g	109-116.70 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High in protein
- High in ash, which implies more minerals
- High in iron, zinc, and calcium
- It is very rich in zinc, four times the reported average.
- The red variety is said to have no tannins and has a medium total phenolic content.
- Processing methods like soaking, fermentation, and germination should be used to increase nutrient availability to the body.
- Good for complementary feeding, pregnant, and lactating mothers

Variety Name: UNGB 2314

Country of origin: Uganda

It has brown grain colour

Agronomic Characteristics

- The plant has a medium growing height of up to 170 cm, therefore it's medium in height
- It is characterised by low bending attributes and is mostly erect'
- It can produce up to two tillers.
- It takes 119 days to mature, so it's considered a medium-maturing variety.
- It has a medium shattering ability, therefore it is easy to thresh after harvesting.
- It can yield up to 1633 kg (18 90-kg bags), so it's a medium-yielding variety.
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	11.53%	12%
Protein	11.63%	10.44-12.7%
Ash	2.25%	1.57-1.79%
Fat	1.82%	2.66-4.05%
Iron	6.34 mg/100g	4.2 mg/100g
Zinc	3.10 mg/100g	2.5mg/100g
Calcium	23.66 mg/100g	15mg/100g
Total Phenolics (Health promoting compounds)	52.80 mg/100g	109-116.70 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High protein content.
- High in ash content, which is associated with more minerals.
- High in iron, zinc and calcium.
- The brown variety is said to contain a high content of tannins (antinutrients).
- Processing methods like soaking, fermentation, and germination should be used to increase nutrient availability to the body.

Variety Name: UNGB 2279

Country of origin: Uganda

It has brown grain colour

Agronomic Characteristics

- The plant has a medium growing height of up to 167 cm, therefore it is medium in height.
- It is characterised by low bending attributes so it is usually erect.
- It produces up to two tillers.
- It takes 117 days to mature, so it is considered a medium-maturing variety.
- It has a low shattering ability so it is rather tedious to thresh after harvesting.
- It can yield up to 1969 kg (22 90-kg bags), so it is a high-yielding variety.
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	10.55%	12%
Protein	11.58%	10.44-12.7%
Ash	2.35%	1.57-1.79%
Fat	2.60%	2.66-4.05%
Iron	15.11 mg/100g	4.2 mg/100g
Zinc	1.97 mg/100g	2.5 mg/100g
Calcium	29.37 mg/100g	15 mg/100g
Total Phenolics (Health promoting compounds)	69.19 mg/100g	109-116.70 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High in protein
- High ash content, which implies more minerals.
- High in iron and calcium.
- Iron is three and a half times higher than the reported average.
- Calcium content is almost double the reported average.
- The brown variety is said to be high in tannins (antinutrients) and total phenolics.
- Processing methods like soaking, fermentation, and germination should be used to increase nutrient availability to the body.

Variety Name: Hakika

Country of Origin: Tanzania

It has a white grain colour.

Agronomic Characteristics

- The plant has a medium growing height of up to 132 cm, therefore it is low in height.
- It is characterised by low bending attributes so it is usually erect.
- It produces up to seven tillers.
- It takes 111 days to mature, so it is considered an early-maturing variety.
- It has an intermediate shattering ability, so it is easy to thresh after harvesting.
- It can yield up to 1300 kg (15 90-kg bags), therefore it is a medium-yielding variety.
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	12.66%	12%
Protein	14.04%	10.44-12.7%
Ash	1.60%	1.57-1.79%
Fat	3.26%	2.66-4.05%
Crude Fibre	6.83%	1.74-6.84%
Carbohydrate	62.08%	72.1%
Iron	12.48 mg/100g	4.2 mg per 100g
Zinc	2.90 mg/100g	2.5 mg per 100g
Calcium	23.19 mg/100g	15 mg per 100g
Total Phenolics (Health benefiting compounds)	7.16 mg/100g	109-116.7 mg per 100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High in protein
- High in iron, zinc, and calcium
- Its iron content is three times higher than the reported average.
- The white variety contains no tannins (antinutrients) and is low in total phenolic compounds.
- Good for complementary feeding, pregnant, and lactating mothers

Variety Name: UNGB 2378

Country of origin: Uganda

It has a brown grain colour

Agronomic Characteristics

- Plant has a medium growing height of up to 241 cm, therefore it is a very tall variety.
- The plant is characterised by high bending attributes, therefore it is usually bent.
- It produces up to two tillers.
- It takes 114 days to mature, so it is considered an early-maturing variety.
- It has an intermediate shattering ability, therefore it is easy to thresh after harvesting.
- It can yield up to 2500 kg (28 90-kg bags), therefore it is a high-yielding variety.
- Not easily affected by fall army worm

Nutritional Value	Dry weight basis	Reported Averages
Moisture content	13.35%	12%
Protein	11.33%	10.44-12.7%
Ash	2.16%	1.57-1.79%
Fat	2.87%	2.66-4.05%
Iron	12.04 mg/100g	4.2 mg/100g
Zinc	2.66 mg/100g	2.5 mg/100g
Calcium	31.61 mg/100g	15 mg/100g
Total Phenolics (Health promoting compounds)	41.17 mg/100g	109-116.7 mg/100g

Source of reported average: Kaijage et al. (2000); Kulamarva et al. (2010); Aiffy et al. (2012); Leder (2004).

Further information

- High in protein
- High in ash, which is associated with higher mineral content
- High in iron, zinc, and calcium
- Iron is almost three times higher than the reported average.
- The calcium content is almost double the reported average.
- The brown variety is associated with a high content of tannins (antinutrients) and total phenolic compounds.
- Processing methods like soaking, fermentation, and germination should be used to increase nutrient availability to the body.
- Good for complementary feeding, pregnant, and lactating mothers.

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