# Use of Drought-tolerant Crops as a Strategy for Efficient Use of Available Water: Sorghum in Same, Tanzania

Semiarid areas are characterized by low and erratic rainfall, accompanied by high evaporation rates that exceed the amount of rainfall occurring annually. There is general water scarcity, which is partly a result of climate changes and variability and partly a result of increased competition for limited water resources. Climate change and abstractions over the past decades have reduced in-stream flows. A good example is Pangani River Basin where in-stream flow has been reduced from several hundreds to less than 40 $m^3/s$ (IUCN, 2003).

Same District in the Kilimanjaro region of Tanzania experiences semiarid condition in the western lowlands of Makanya, Hedaru, Same, Ruvu and Mwembe wards. Rainfall in these areas shows a high degree of variability and unpredictability, which seems to be increasing over time, with impact on both food and livelihood security. It is therefore apparent that water is essential for crop production and the single most important aspect of crop production that determines yield (Directorate for Agriculture, Irrigation and Cooperatives-SAME, 2013). However, the existing traditional irrigation system appears to be insufficient to serve the needs of the majority of the households and Same District thus faces frequent food shortages. The Same district council therefore decided to promote and encourage farmers to grow sorghum as an intervention to ensure food security (Deutscher Entwicklungsdienst Ded-SAME, 2010).

In Tanzania, sorghum is the third most important cereal after maize and rice. Sorghum is grown as a staple in the semi-arid areas of the Central Zone (Dodoma and Singida). In other areas of Tanzania, such as Mwanza, Shinyanga, Mara, Morogoro, Pwani, Mtwara, Lindi, Mbeya, Tabora, Manyara and Kilimanjaro, sorghum is grown mainly for food security. It is used and processed into traditional foods, fermented and unfermented flat and leavened breads, thin and thick porridges, steamed and boiled cooked products, snack foods, and alcoholic and nonalcoholic beverages. Tanzania annually produces around 600,000 tons of sorghum.

# Sorghum production as a water-smart strategy

Water-smart agriculture includes promotion of, water-use-efficient techniques through selection of crop varieties with ability to survive drought. These drought-tolerant crops include sorghum, lablab, cassava, millet, and sweet potato. The paper focuses on sorghum production in Same District.

Sorghum *(Sorghum bicolor* [L.] Moench*)* is a crop indigenous to Africa; it is a relatively drought-tolerant crop that can be produced over a range of water availability levels (e.g., full irrigation to deficit irrigation or under rainfed conditions). The highly drought-tolerant sorghum usually yields better than maize on soils with poor fertility. It is often the feed grain of choice where irrigation capacity is limited. It requires about 350–600 mm of rainfall to mature and are therefore suitable in semiarid areas where rainfall ranges from 500 to 800 mm/annum, as in Same District. The crop performs much better when land is properly managed and soil and water- conserving and water-harvesting practices are done.

Sorghum tolerates drought better than most other grain crops. This trait can be attributed to:

- Its exceptionally well-developed and finely branched root system, which is very efficient in absorbing water.
- Its small leaf area, which limits transpiration.
- Its leaves folding up more efficiently during warm, dry conditions (compared with maize's).
- Its effective transpiration ratio of 1:310 (the plant uses only 310 parts of water to produce one part of dry matter) compared with maize's 1:400.
- Its leaf epidermis being corky and covered with a waxy layer, which prevents plant desiccation.
- Its stomata closing rapidly to limit water loss.
- Its ability to remain in a virtually dormant stage during dry periods, and then to resume growth as soon as conditions become favorable.
- The ability of side shoots can develop and form seed (even if the main stem dies), when water supply improves.

Farmers in many parts of Same (especially in the western lowlands) grow mainly maize under rainfed conditions. Maize yield has drastically declined in the last 15 years (DAICO–Same District, 2010)—from 0 to 1.5 tons per hectare, depending on variety, soil fertility, and management practice. This is in contrast to yields in other places such as Meru District in Arusha where they get as high as 7.5 tons per hectare (DAICO–Meru District, 2013). On the other hand, the yield of sorghum in Same ranges from 1.25 to 2.5 tons per hectare. Sorghum is more water-smart compared with maize and other cereals due to higher production from little available rainfall (Fig. 1).

This paper aims to discuss improvement of water use efficiency by planting sorghum, which has the ability to survive drought, in order to improve production and productivity and thus enhance food security and standard of living of people in semiarid areas.

# Methodology

The methodology involved documenting field experience, observations, interviews, and literature review. From these, the Same district council, in collaboration with development partners, decided to start a sorghum development program. Implementation started by sensitizing village leaders on the importance of planting sorghum. This was followed by establishing demonstration plots and farmer field schools and training of champion farmers on improved methods of sorghum production. Improved seeds were supplied to these champion farmers for use in their demonstration plots.

***Fig. 1.*** *Maize is not a good option in semiarid conditions.*

Participatory approaches and tools were used in the preparation of plans to implement a demand-driven program so as to promote self-employment and ensure sustainable projects. Through participatory approaches, village communities were enabled to prepare village agricultural development plans (VADPs). These VADPs later on became the basis of district agricultural development plans. The most frequently identified problem was poor crop performance due to erratic rainfall. This has led to shortages of food, progressively low income for farmers, poor contribution to development activities, and low standard of living.

The sorghum development program in Same District is being implemented in 10 villages, including Mwembe. The program started in 2012 in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Selian Agriculture Research Institute (SARI) through the Sorghum for Multiple Use Project (SMU).

# Results and discussion

## Key achievements

- The perceptions of smallholder farmers, especially women, toward the initiatives are positive. Morale is very high as they realize that, by planting sorghum, they can get more yield, more income, and more food.
- Farmer's knowledge of appropriate sorghum farming techniques has increased. About 1400 farmers grew sorghum in 600 acres in the 2013/2014 season.
- There was increasing demand for sorghum at Same, which has resulted in increased prices of up to Tsh 1500–2000 per kg.
- Increased food security among farmers—from 0 maize/acre to 8 bags of sorghum.

## Key challenges

- The main challenge encountered is the inadequate knowledge among farmers about sorghum as a water-smart crop and its appropriate farming method. There is very little understanding of the drought tolerance ability of sorghum. Majority of the farmers do not know the proper agronomic practices for sorghum. This has caused reluctance among farmers to grow the crop.
- Sorghum is attacked by birds at the milking stage.

# Solutions

- Capacity building of farmers. Several activities may be done to achieve this: establishment of farmer field schools (FFS), establishment

**The champion farmer**

Mrs. Walter Mjema lives in Mwembe village in Tanzania's Kilimanjaro region. This dry area receives less than 400 mm of rain each year. Climate change is affecting rainfall patterns. The traditionally rainy months of October and November have not brought steady rains for the last 2 years.

Mrs. Mjema is a champion farmer who participated in the implementation of the Care GWI II program. She has also been involved in the Small-scale Innovation Project as a researcher farmer. She practices and demonstrates soil and water conservation and water-harvesting techniques in her farm.

"I have been growing sorghum since 2011. Every year, I harvest not less than 10 bags (100 kg each) of sorghum from my small piece of land of 1.25 acres. Before sorghum, I used to grow maize on that land. Because of drought, production was very poor. I hardly get five bags of maize," says Mrs. Mjema.

Her family sold nine bags of sorghum last season and got Tsh 900,000. They used that money to buy 5 bags of maize (Tsh 250,000) and the rest was used to meet family needs like tuition. "I get food and money, so I am happy being food-secured".

Mrs. Mjema further explains, "I have experienced that, without any supplementary irrigation, sorghum performs well and yields are reasonable, meaning that growing sorghum is an efficient way of utilizing available little rainwater in the village. I therefore agree with agriculture extension officers who say that sorghum is a drought-tolerant crop. And as a champion farmer, I advise and encourage other farmers in the village to grow it. So far, more than 50 farmers at Mwembe Village followed my footsteps."

of demonstration plots, training of farmers on sorghum production and processing through seminars, workshops, and study visits.

- Encouraging farmers to use rainwater harvest technology and small-scale irrigation. Farmers are also motivated to cultivate drought-tolerant crops such as lablab, cassava, millet, and sweet potato.

# Conclusions

In line with the 2013 national agricultural policy, adoption of water-smart sorghum is critical to achieve food security. The policy intends to promote rainwater use efficiency in order to enhance water productivity. This can be achieved through selection of crop varieties that are able to survive drought and applying small quantities of water at critical times. The crops chosen for dry farming should either be drought-evasive or drought-tolerant. Production of drought-tolerant crops such as sorghum can help farmers improve yield in semiarid areas, improve food security, and improve income. The use of sorghum can mitigate the effects of climate change on global food production.


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