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Resilient and high yielding sorghum (IESV 23010-DL) for semi-arid ecologies

Photo credit: Wills Munthali/ICRISAT.

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About the Technology

The early-maturing, resilient, and highly productive improved sorghum line IESV 23010-DL sorghum (Sorghum bicolor) variety was evaluated under the Africa RISING Project and proposed for release through the Tanzania Agricultural Research Institute (TARI)-Ilonga. The new variety matures in 120 days, and under optimum growing conditions, grain yield goes up to 4200 kg/ha. Average yields of 2400 kg/ha were recorded underwater stress environments of Central Tanzania compared to 850 kg/ha for Kari Mtama (released check) and 570 kg/ha for Lugugu, a local check.

The new variety is tolerant to Grey leaf spot Cercospora zea-maydis), rust Puccinia spp), anthracnose, downy mildew, powdery mildew, and head smut. The variety was released in Malawi as Pilira 4 (Pilira meaning tolerant). It has red grains, flowering within 68.8 days, a seed weight of 3g/100 seeds, and a shelling percentage >65.

Conditions that favor uptake

Agro-ecological conditions: Sorghum is well adapted to tropical and subtropical climates, but the, more significant part of the area of the crop falls in drought-prone, semi-arid tropical regions of the world. In these harsh environmental conditions, sorghum is predominantly grown for human consumption, followed by animal feed and fodder. Red sorghum like IESV

Key Messages

Early harvest: Matures within

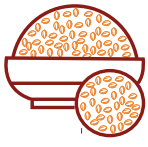
120 days

High productivity: produces up to

4200 kg/ha,

80% higher than local varieties.

Drought tolerant: Provides **food** in environments that are not suitable for **maize production**



Income: Being **early maturing**, it provides **income** before the major sources of income are ready for harvest.

23010 could also play an important role in the brewing industry, especially for opaque beer, starch, and syrup making. IESV 23010 variety showed to be very stable in the semi-arid agro-ecologies of Central Tanzania, characterized by annual rainfall between 200-700 mm. The crop can be grown successfully on a wide range of soils, from alfisols (red) to vertisols (black). It tolerates a pH range from 5.5 to 8.5. Deep ploughing to attain a good seedbed and maintenance of weed-free conditions are key to unlocking productivity.

Access to inputs and markets: Adoption of the new varieties by farmers is largely a function of access to adequate seed and allied inputs like fertilizers, howeverIESV 23010-DL suits the semi-arid agro-ecologies of Central Tanzania, where sorghum is generally grown with limited inputs like fertilizer due to inadequate rainfall. While the variety is high yielding, unlike Lugugu, a landrace, it does not produce much biomass, and as such, it has less water and nutrients requirements for its growth.

Alignment with household resource endowments: In semi-arid ecologies, IESV 23010-DL has more uses than a major food crop, the crop residues and green plants act as sources of animal feed. Stocks are also used as building material and fuel for cooking.

Economics: Sorghum is primarily grown as a food crop, but gross margins from evaluation data show its potential as a source of income. IESV 23010 produced a Gross Margin of US$285.99 compared to US$78.67 for the local variety. When intercropped with a medium duration pigeon pea (Ilonga-14-M2), IESV 23010 gave a Gross margin of US$239.78 compared to US$51.06 when the local variety is combined with the local long duration pigeon pea.

Necessary ingredients for implementation

Land preparation: IESV 23010-DL requires a fine seedbed. Ploughing can be done either by hoeing, tractor, or oxen. It is advisable to harrow in case the field has big soil clods. It is recommended that land be ploughed immediately after harvesting the previous crop.

Planting and intercropping: Drill in furrows or plant in hills. Plant 4-5 seeds per hill and thin to one seedling per hill three weeks after emergence or when plants are about 6 cm high. A seed rate of 7-10kg/ha is recommended. When IESV 23010-DL is dry planted, the planting depth should be 5.0cm, but in moist soils, a depth of 2.5cm to 4.0cm is ideal. It can be grown both as a sole crop or intercrop.

Crop management:

Fertilizer application: IESV 23010-DL needs two bags (100kg) per hectare of NPK (20:20:0) during planting and top-dressing with a similar amount of CAN. In this region, livestock keeping is a significant economic activity, and many farmers apply manure, thus minimal or negligible use of inorganic fertilizer.

Weeding: First weeding should be done within two to three weeks after emergence, followed by the second wedding two weeks later.

Pest and diseases: Common insect pests include the shootfly and stem borer. The significant conditions include smut, charcoal rot, anthracnose, stem, and leaf rust. Marshall or Dipterex should be used to control stem borers and shootfly at 3kg/ha. Seed should be dressed with a combination of fungicide and insecticide to control most the diseases. Use scaring devices to control birds. It is advisable to have several farmers in a locality growing the crop to share out the bird damage.

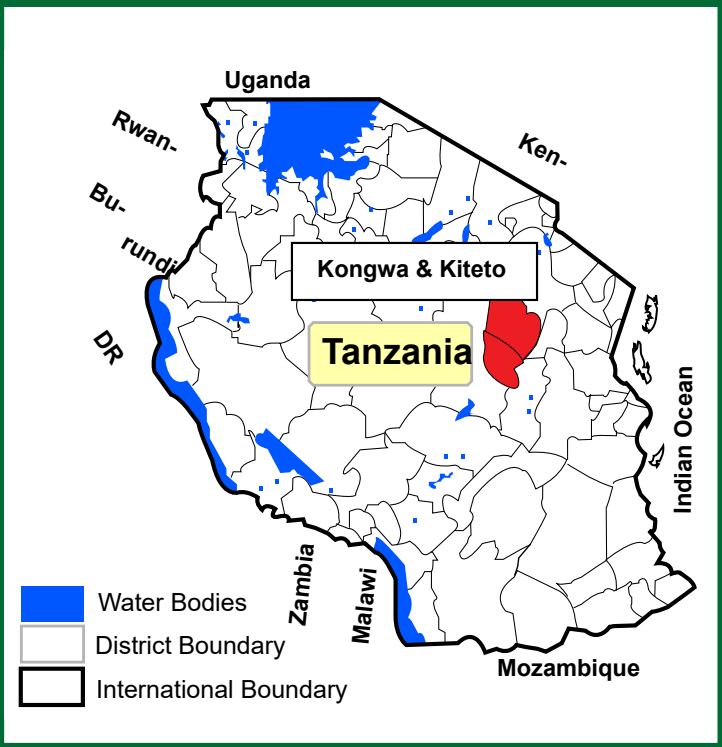
Harvesting and post-harvest handling: Harvest the crop when the grain is hard and does not produce milk when crushed between the fingers. The heads are harvested, threshed, and stored in cool, dry conditions., the grain should be dusted with actellic super at 50g per bag or any other effective storage chemical to control storage pests

Adaptation possibilities via Crop integration: IESV 23010-DL was tested for adaptability in an intercrop system. It was intercropped with pigeon pea (plate 1), another popularly grown crop in the region, and excellent adaptation was observed with Land Equivalent Ratios (LERs) >1. Two planting patterns were used; within the row (full population of IESV 23010 + pigeon pea at 180 cm on the same row) and alternate (one row of pigeon pea + two rows of IESV 23010-DL. IESV 23010-DL performed better in an alternate planting pattern with LER up to 1.4.

Plate 1: Sorghum–pigeon pea intercrop at Mlali, *Photo credit: Wills Munthali/ICRISAT.*

Where was the technology validated?

Studies were conducted on-station at ARI-Hombolo and on-farm in Kongwa (Mlali, Moleti, Laikala, and Chitego), Dodoma and Kiteto (Njoro village) district, Manyara in Tanzania. Dodoma Region lies at 6˚10'S, 35˚45"E, and 1120 m above sea level. The average annual precipitation in the region is 556 mm. Kongwa District is a typical semi-arid agroecology with an average temperature of 28 ˚C and annual rainfall between 250–600 mm. Kiteto district in Manyara Region has weather conditions varying from semi-arid to sub-humid. The annual precipitation ranges between 350 and 700 mm, with a temperature range of 18 ˚C–25 ˚C. The altitude ranges from 800 to 2000 masl. During the evaluation period, the rainfall in Kongwa and Kiteto between 2013 and 2016 at farmers' fields fluctuated, ranging between 200 and 600 m a year.



Sketch illustration of a flourishing IESV 23010-DL crop.

+ Potential benefits to users

Food security: IESV 23010-DL, is an early maturing variety that can provide food when other crops like maize are not yet mature. The variety has a higher yield (> 60%) than the long-duration local variety (Lugugu).

Labour reduction: The variety is short in stature (176 cm on average) compared to over 283 cm for Lugugu, a landrace. Short stature is a crucial trait during harvesting, as indicated by women farmers during participatory variety selection.

Nutritional value: Sorghum is an important source of dietary nutrients to the farming community of Central Tanzania. It contains 78.1% carbohydrates, 3.5% fats, 11.6% protein and 6.6% fiber.

— Things to worry about

Pests and diseases: Even though IESV 23010 is tolerant to Gray leaf spot (Cercospora zeae-maydis), rust (Puccinia spp), anthracnose, downy mildew, powdery mildew, and head smut, severe infection may attract high costs from fungicides, and limited resource farmers may suffer yield losses.

Crop loss due to poor management: Our studies showed crop losses for IESV 23010 due to late planting and use of flatbeds varying with sub-ecologies; 15.53 % in high potential (Mlali and Manyusi), 32.1% in moderate potential (Njoro and Kiperesa), and up to 100% in low potential sub-ecologies (Laikala and Moleti). Using ridges would reduce crop loss and offset the associated labor cost.

Erosion and runoff with the type of field preparation recommended: To overcome this problem, most farmers practice "fanya juu fanya chini" (physical structures) in their fields.

Nutrient mining/soil degradation due to stover is used as feed or fuel instead of recycling: The integration of the high-yielding resilient varieties under the existing cropping systems (intercrop-for pearl millet, with pigeon pea) would add value hence ensuring high water retention, high nutrient through leaf fall, and nitrogen fixation. The cereal-legume technology label gives details.

The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-for-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative. Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base. The three projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads an associated project on monitoring, evaluation, and impact assessment.

Africa RISING website: **https://africa-rising.net**