Varieties for Better Nutrition and Stress Resistance

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Summary

The yield of millet and sorghum in Africa remain far below attainable levels, and communities growing the crops are some of the most food insecure and malnourished on the continent. One of the primary causes of this problem is limited access to new varieties that are high yielding, bio-fortified, and withstand drought, heat, and pests. Recent surveys demonstrate that new lines of sorghum are planted on just 3% of farmland in Burkina Faso, 15% in Niger, 20% in Nigeria, and 21% in Mali, leaving great scope for improvement. Delivering quality seed from improved millet and sorghum to farmers is critical to sustainably enhance production and to strengthen the climate resilience of the value chain. Newly developed varieties also have better taste and cooking characteristics that provide greater potential for value addition and marketing, they have multiple uses, from food, feed, and fodder, to brewing and biofuels.

Technical Description

A number of improved millet and sorghum varieties were developed by ICRISAT in collaboration with the national agricultural research institutes, farmer organizations, seed companies and non-governmental organizations. They are highly nutritious and fulfil many pressing health needs. These are the last crop growing in times of drought and high temperatures, making them a viable risk management strategy for farmers. New cultivars include open pollinated varieties (OPV) and hybrid lines that offer a grain yield advantage of more than 30% compared to traditional landraces and less improved types. Most of the new millet and sorghum lines are bio-fortified with naturally high levels of iron (45-79 ppm) and zinc (32-64 ppm) and were also selected for early maturation to avoid yield loss where rainfall ends prematurely. Certain varieties possess adaptations that make them tolerant against moderate to extreme drought and heat, and resistant against common diseases and pests. Among the improved cultivars, some have a “stay green” character, making them of good use as animal feed. The success of breeding programs is best exemplified by the sorghum hybrids Pablo and Fadda, naturally rich in iron and proteins and offering a yield advantage of 30% to 40% over local varieties.

Uses

Specific sets of millet and sorghum varieties are available for different climatic conditions, soil types and food habits in African drylands. Iron and zinc bio-fortified lines with short growth cycle, drought tolerance and disease resistance are popular in the Sahel regions and the drylands of eastern and southern Africa. Improved sorghum cultivars are suitable for regions with an annual rainfall of 400 mm to 1000 mm. Millets are particularly recommended where annual cumulative rainfall is less than 600 mm and unevenly distributed over the season, as well as on sandy soils that retain too little water and on degraded lands with low nutrient availability.

Composition

Breeding programs for millet so far have released two hybrids and 11 OPVs, which include GB 8735 (Gajera Mota), Chakti and ICRI-Tabi. For sorghum, OPVs are dispatched such as Jakunbe, Jiguikala, Soumba, Fambe B and Lata 3. All released varieties and hybrids were registered in the ECOWAS/WAEMU/CILSS regional seed catalogue (2016-2018), and most have been taken up in national seed catalogues. ICRISAT and its partners continue to develop lines of millet and sorghum with higher yield potential, stronger tolerance to drought and heat, greater nutritional value, and better market characteristics.

Means of application

High-yielding, nutritious and resilient lines are developed through selection of parents with desired traits, conventional crossing and hybridization, and finally extensive field testing. Improved varieties of millet and sorghum (OPVs and hybrids) are multiplied and made accessible to farmers via “Formal Seed Systems” that involve stringent inspection and certification standards. Recommendations of good land preparation, fertilizer and crop management practices are formulated for specific soil types and climate conditions that must be followed to realize high yields and efficient use of nutrients and water. For sorghum, the seed rate is 8 to 12 kg per hectare with a spacing of 75 - 90 cm between rows and 30 - 50 cm between plants. For pearl millet, the seed rate is 5 to 8 kg ha-1 with a spacing of 80 - 100 cm between rows and 40 - 100 cm between plants depending on the zones. Generally, it is advised to apply DAP at 62 kg ha-1 during planting and CAN at 198 kg ha-1 when the crop is knee-high. Weed encroachment needs to be curtailed through physical removal or spraying of pre- and post-emergence herbicides. Farmers should follow integrated Striga and soil fertility management, and water conservation techniques to maximize grain yields and resource use efficiency.

Agroecologies	Dryland area, Moist savanna.
Regions	Africa South of Sahara.
Developed in Countries	Ethiopia, Zimbabwe, Senegal, Niger, Burkina Faso, Mali, Chad, Tanzania, Sudan, Nigeria, Kenya.

Available in	Ethiopia, Zimbabwe, Senegal, Niger, Burkina Faso, Mali, Chad, Tanzania, Sudan, Nigeria, Kenya.
Solution Forms	Genetics.
Solution Applications	Improved variety.
Agricultural Commodities	Sorghum/Millet.
Target Beneficiaries	Women, Youth, Small-scale farmers, Commercial farmers.

Commercialization

Commercialization Category

Commercially available

Startup Requirements

The following are followed to establish a formal seed system for these new varieties: 1) Identify lines that match climatic conditions, soil types, agronomic practices, and market demands, 2) Establish quality assurance standards and frameworks to ensure multiplication of certified seed with high germination rate, 3) Formulate roadmaps for investment and marketing by public agencies and private companies, 4) Train seed producers on bulking methods and agrodealers on stock management to ensure sufficient availability, and 5) Link farmers with credit providers and food processors to finance the purchase of improved varieties.

Production Costs

Developing a high-yield, nutritious and resilient variety attracts substantial costs to pay for facilities, expert knowledge, and skilled labor. The size of investment is however not different to that for other improved lines, allowing the new lines to be sold at standard market prices. Depending on the planting rate, seed for one hectare of land costs between US $14 and $18 for sorghum, and US $8 to $12 for pearl millet. The inorganic fertilizer needed to apply the prescribed rates costs between US $120 to $150 per hectare. A ton of animal manure, which is the minimum recommended for one hectare, is delivered at a price of US $35 to $45. The total cost of labor for land preparation, planting, thinning, weeding, and harvesting commonly ranges between US $230 and $260 per hectare.

Customer Segmentation

The multiplication and delivery system for seed of the two small-grain crops involves diverse actors including public and private sectors who multiply breeder seed into foundation seed and use the latter to bulk certified and commercial seed. End-users of improved millet and sorghum varieties are suppliers of agricultural inputs, small-scale and commercial farmers, food processors, retail markets, and nutritionists.

Potential Profitability

Multiplying certified seed or producing grain for food from nutritious and resilient cultivars can generate stable incomes and avoids food shortages during unfavorable seasons. The newly developed millet and sorghum varieties provide higher yields compared to local landraces, allowing sales of surplus grain for cash. Better nutritional quality of food is achieved through bio-fortification, which helps reduce chronic forms of malnutrition. Health studies demonstrate that introducing millet with high iron and zinc increases the hemoglobin level in blood, which is often low for women and children. Replacing a substantial part of maize-based foods with millet and sorghum products decreases the risk of developing diabetes and helps to manage blood sugar levels.

Licensing Requirements

Millet and sorghum varieties developed by ICRISAT, and national systems are offered royalty-free for multiplication and sales by seed growers and private companies. Production and marketing of certified seed requires compliance with national standards and licenses.

Innovation as Public Good

Improved varieties of millet and sorghum are classified as a Regional Public Good.

Solution Images



Africa's first bio-fortified pearl millet "Chakti"



Hybrid sorghum « Pablo »



Hybrid sorghum "Pablo"

Institutions

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Accompanying Solutions

Fertilizer Micro-Dosing to Enhance Yield and Use Efficiency

Flour Milling and Blending Systems

Warrantage Inventory and Credit System

Proactive Management of Striga Infestation

Contour Bunds for Water Harvesting