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Photo credit: Wills Munthali/ICRISAT.

Resilient and highly productive Pearl Millet (IP 8774) for semi-arid ecologies

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About the Technology

IP 8774 is a highly productive drought-tolerant, early-maturing pearl millet (*Pennisetum glaucum* L) variety developed under the Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) Project. The variety was proposed for release through the Tanzania Agriculture Research Institution (TARI-Ilonga). IP 8774 revealed a wide range of adaptation and is best suited in low potential semi-arid ecologies.

The new variety has a high-tillering level (Plate 1) and is extra-early maturing (65–70 days). Under optimum growing conditions, it can yield up to 3000 kg/ha. Average yields of 1700 kg/ha were recorded under water-stress environments of Central Tanzania compared to 650 kg/ha for the local variety. The exemplary performance by IP 8774 demonstrated its potential in mitigating food shortages in dry ecologies. The variety is short (133 cm) compared to the local check with a plant height of up 200 cm, a trait that women farmers indicated reduces drudgery during harvesting. The variety thrives very well when intercropped with medium-duration pigeon pea.

Conditions that favor uptake

Agroecological conditions: The improved pearl millet line IP 8774 can grow in a wide range of ecological conditions and yield reasonably well even under unfavorable drought-stress conditions and high temperatures. Pearl millet is mostly

Key Messages

Early harvest: Matures early, **70 days**

High productivity: produces up to **3000 kg/ha,** **95%** higher than local varieties. It's also high Tillering.

Resilience: It is drought tolerant and resistant to **Downy mildew**

Food: Provides **food** even in environments unsuitable for **maize production**

Drudgery: It is short, a **trait most women pick** out as important during **harvesting**

Plate 1. The high tillering ability of the pearl millet line IP 8774 in Laikala-Kongwa District. Up to 4.3 effective tillers per plant were achieved. *Photo credit: Wills Munthali/ICRISAT.*

grown in countries with hot and dry weather; characteristic of the arid and semi-arid environments of the tropics, it grows best at 30–34 °C. It is therefore, well adapted for semi-arid environments serving as a major source of basal energy, proteins, and micronutrients. This variety is more tolerant to higher temperatures than any other major cultivated cereal. The best temperature for the germination of pearl millet seed is 23 to 32 °C. Poor emergence and seedling growth may result if planted before soil temperatures reach 23 °C. The optimum rainfall requirement of the variety ranges between 600 and 800 mm but can grow in areas that receive even less than 350 mm of seasonal rainfall.

Alignment with household resource endowments

Food and feed security: In semi-arid ecologies such as central Tanzania, IP 8774 is a major food crop, especially where other grain crops like maize cannot survive. Crop residues and green plants provide sources of animal feed critical in the crop-livestock farming system in the Region.

Fuelwood: Stocks are used as fuel for cooking. This is key in the low potential sub-ecologies of Laikala and Moleti. IP 8774 produced 3148 kg/ha of biomass compared to 2870 kg/ha for the local variety.

Economics: While pearl millet is largely grown as a food crop, the new variety (IP 8774) has the potential to improve income security for the farming community in the semi-arid regions of Central Tanzania. From evaluation data, IP 8774 produced a gross margin of US$293.67 compared to US$134.64 for the local variety. When intercropped with a medium duration pigeon pea (Ilonga-14-M2), the combined gross margin is US$569.09 compared to US$116.8 when local pearl millet is combined with the local long-duration pigeon pea.

Necessary ingredients for implementation

Land preparation: IP 8774 requires a fine seedbed to facilitate germination. Plowing is done either by hoeing, tractor, or oxen. It is advisable to harrow in case the field has big soil clods. The planting field should be prepared very early. The land should be plowed 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 kg/ha is recommended. Where ridges are formed 45 cm apart, the plants should be 12 to 15 cm apart within a row, advisable where the land has a gradient that may encourage erosion. In the broad bed and furrow method, the rows should be 60 cm apart on the bed, and the distance between plants should be 10 cm, advisable where that is flat enough with a minimum chance for erosion.

IP 8774 can be grown as a sole crop or intercrop. It was tested and deployed under an intercrop system with pigeon pea in two planting patterns (within a row and alternate planting) and showed high land equivalent ratios (LERs) of up to 1.38 in the alternate planting (2:1; 2 rows of IP 8774 to one row of medium duration pigeon pea (ICEAP 00557)).

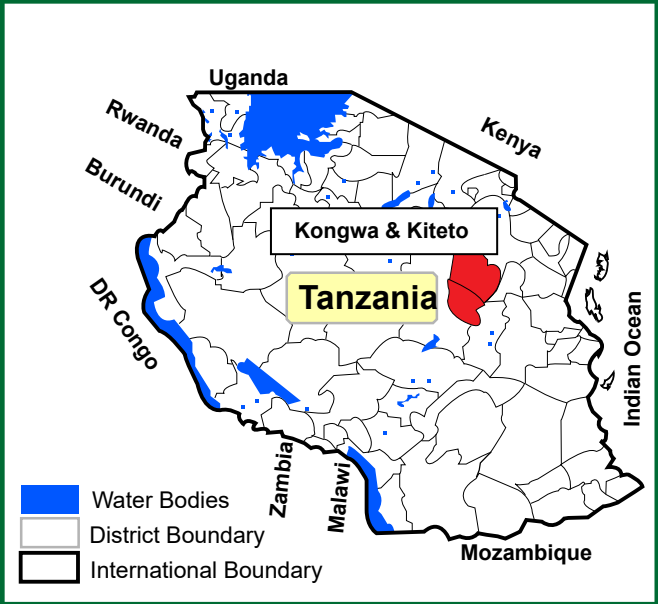
Crop management: IP 8774 should be grown on deep, well-drained permeable soils to allow the development of extensive root systems. Mature plant roots may penetrate to 4 to 6 feet in ideal soil. Root development can be severely restricted in soils having excessively high or low soil moisture levels and hardpan and compacted layers. Under dryland conditions with low rainfall, apply 30 to 40 kg/ha of nitrogen. Fertilizer should be applied one week after germination using the dollop method in which two holes are drilled on either side of the planting station in case of dry planting. If planted with sufficient moisture at field capacity, fertilizer should be applied at planting by opening a furrow of 5 cm deep. Weeding is another key element in crop management. Since the crop is often in a moisture stress environment, weeds compete severely with the crop for moisture and should be cleared as soon as they appear.

Maturity: IP 8774 is an early maturing variety with about 60 days to 50% flowering and maturing around 85 days after sowing. Even though the seed may not likely shatter, pearl millet should be harvested soon after grain matures to avoid losses due to birds and stem lodging

Post-harvest handling: Before storage, pearl millet should be properly dried to avoid mold and germination (sprout). Pearl millet should be stored at a 12–13% moisture content.

Locations where the technology was validated

Studies were conducted on-station at Tanzania Agricultural Research Institute TARI-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 masl. The average annual precipitation in the Region is 556 mm. Kongwa District is typical semi-arid agroecology with an average temperature of 28 ˚C and annual rainfall between 250 and 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 in farmers' fields fluctuated, ranging between 200 to 600 m per year.



Potential benefits to users

Nutritional value: Pearl millet is a principal source of energy, protein, vitamins, and minerals for people in the regions where it is cultivated. It generally has 9 to 13% protein. Pearl millet contains more calories than wheat. It is rich in calcium, potassium, magnesium, iron, zinc, manganese, riboflavin, thiamine, niacin, lysine, and tryptophan. Pearl millet grain is gluten-free and is the only grain that retains its alkaline properties after being cooked, making it ideal for people with gluten allergies.

Things to worry about and remedies

Pests and diseases: Downy mildew of pearl millet, caused by Sclerospora graminicola, sometimes referred to as "green ear", is the most destructive disease of pearl millet and may significantly reduce grain yield. Currently, Fall armyworm has become an important pest of pearl millet, causing > 70% yield loss. Chemical control measures that are the most effective may be out of reach to most small-scale farmers, rendering it a threat to food security.

Crop loss due to poor management: Our studies showed that crop losses due to late planting and flatbeds varied across ecologies; i.e., 21.7% in moderate potential (Njoro and Kiperesa) and up to 53.22% in low potential sub-ecologies (Laikala and Moleti). Using ridges would reduce crop loss and thus 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 which ensures high water retention, high nutrient through leaf fall, and nitrogen fixation. The cereal-legume technology label gives details.

Sketch illustration of farmers checking the progress of their pearl millet crops on the farm.

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**

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