Nutrient-rich beans for improved nutrition, incomes, and soil fertility

This new, bio-fortified 'magic' bean provides valuable food and nutrition security for small-scale farmers in southern Africa. It is rich in protein, iron, and zinc, improves soil fertility, and produces higher yields than local bean varieties.

Photo credit: CIAT/Neil Palmer.

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Description of the technology

Maize is the predominant staple crop in southern Africa, being planted on up to 80% of the available agricultural land. Most people rely heavily on maize for their food, but this can result in a diet that is deficient in protein and micronutrients. Lack of iron and zinc is a public health concern since it causes anemia and stunting in children. Grain legumes provide a source of essential nutriens, improve nitrogen cycling, and can be grown alongside maize without taking land away from cereal production.

The early-maturing, bio-fortified common bean variety NUA45 (also known as the 'magic' bean) was introduced by the Africa RISING project in the Linthipe area of central Malawi in 2018/19. NUA45 is a large-seeded bean (40 g per 100 seeds) with a red mottled grain color. It is high in protein and bio-fortified with iron and zinc, providing 22 mg/kg more iron and 6 mg/kg more zinc than the locally popular variety CAL143. This new bean variety can produce up to 2000 kg of grain per hectare, considerably more than most local varieties, which yield around 1000 kg per hectare. It also supplies sufficient nitrogen (25–30 kg per hectare) for its own growth through biological nitrogen fixation. Many farmers in Southern Africa intercrop common bean with maize for complementary benefit of biological nitrogen fixation of beans to maize. Soil health and fertility are augmented further when NUA45 crop residues are incorporated into the soil after harvest.

Key messages

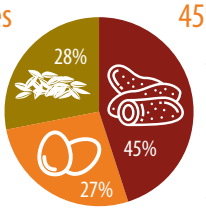
Food security:

YIELDS up to **2000 kg per hectare** –

2x the yield of local varieties

Beneficial nutrition:

Comprises



45% CARBOHYDRATE,
27% PROTEIN,
28% FIBER,
80 mg/kg IRON and
32 mg/kg ZINC

Healthy soils:

Fixes approx.
25–30 kg NITROGEN per hectare,
sufficient for its own growth

Source of income:

YIELDS up to **400 kg from 0.2 hectares**,
providing a NET INCOME of US$ 210 when sold

Conditions that favor uptake

Agro-ecological conditions: The ideal growing conditions for NUA45 are moderate rainfall of around 800 mm, with temperatures ranging from 15 to 27°C. The bean plants thrive in well-drained soils with a pH ranging from 5.0 to 6.0. The variety can be grown on ridges spaced at 75 cm apart, either as a monocrop or intercropped with maize. Intercropping allows the farmer to harvest two crops from the same plot of land in the same cropping season. When intercropped with maize, NUA45 should be planted at the correct spacing for maximum yield. Farmers should plant one maize seed every 25 cm in a row, planting the bean seed in the same hole with the maize. With maize planting stations spaced at 25 cm, additional beans can be planted 12.5 cm between the maize plants.

Access to markets and inputs: In general, maize planted together with common beans is the dominant intercropping system in southern Africa. Common bean has a relatively stable and high market price. Uptake of the technology requires reputable agro-dealers selling certified NUA45 seed, although Africa RISING has successfully promoted community seed multiplication. To benefit from maximum yields, farmers need to apply a starter quantity of nitrogen, phosphorus, and potassium fertilizer; they also need to control common pests and diseases.

Alignment with household resource endowments

Farmers growing NUA45 as a monocrop in rotation with maize need to apply less initial fertilizer to the beans since the crop will benefit from residual fertilizer applied to the maize. The maize crop following the beans will also benefit from the nitrogen 'fixed' by the beans, with soil fertility boosted by organic matter when crop residues are retained in the field. Under a maize–bean intercrop, a symbiotic relationship is evident. The bean plants benefit from the phosphorous fertilizer applied to the maize crop, while the maize plants benefit from the additional nitrogen generated through biological nitrogen fixation by the beans.

Photo credit: Rowland Chirwa/CIAT.

Necessary ingredients for implementation

Technology requirements: Farmers need access to NUA45 seeds and other inputs such as fertilizers and pesticides. They also require extension information on crop management, nutrition, processing, and cooking to enable them to reap maximum benefits from including this bean variety in their diets.

Land preparation: The field should be prepared before the planting season. The farmer should make ridges at 75 cm intervals on which to plant the maize and beans (this is common practice for maize growers). NUA45 can also be planted on the flat with a row spacing of 60 cm for a monocrop of beans.

Soil amendments: Maximum yields require an application of fertilizer to support early plant growth. Compound fertilizers containing nitrogen and phosphorus are recommended (examples available in Malawi include Super D and Compound D). Nitrogen is essential for early shoot development, and phosphorus for root development and formation of nitrogen-fixing nodules. If inorganic fertilizer is not available, farmers are encouraged to apply manure. Grain yield gains of up to 100% can be realized by applying 40 kg per hectare of nitrogen and phosphate (compared with no fertilizer application).

In a common pure bean stand, a 10 cm deep groove should be made at the centre of the ridge. Small quantities of fertiliser should be spread in the groove (6 g covers a distance of 1 m). In a Maize-bean intercrop, 9 g of basal fertilizer is applied per maize station. After 21 days, top dressing fertilizer can be applied between maize stations at 9 g/station.

Weed management: The plot should be kept weed-free for the first six to eight weeks after planting. Farmers should not weed after the beans have flowered to avoid flower shedding, except through careful hand pulling.

Pest and disease management: Like most bean varieties, NUA45 can be attacked by common bean mosaic virus, which is transmitted by aphids. Additional pests of economic importance in bean production include bean stem maggots and bean beetles. Aphids and bean stem maggots can be controlled by spraying Dimethoate 20WP at the early stages of crop development (two to four weeks after crop emergence). Bean beetles can be controlled by spraying Lambda cyhalothrin (Carbaryl or Karate). To avoid bean stem maggot infestation, it is essential to plant early, apply fertilizer, and practice crop rotation or intercrop with cereals such as maize.

A researcher examines 'magic' bean plants at a farmer's field in central Malawi.
Photo credit: Neil Palmer/CIAT.

Adaptation possibilities

During the rainy season, a crop of common bean can be grown in high-altitude areas (>1500 m above sea level), as well as in the medium-altitude regions (1000 to 1400 m). In the low-altitude areas (< 600 m), the crop can be grown during the cool months of the year, under irrigation or residual moisture. The crop requires approximately 800 mm of moisture. NUA45, as a drought-tolerant and short-season variety (maturing in 65–70 days), can be grown in areas prone to drought due to low mean rainfall or a short rainy season. The soil should have a pH range of 5.0 to 6.0.

Other grain crops: In addition to maize, NUA45 can be grown as an intercrop or a rotation crop with pearl millet and sorghum in the cool upland areas, where common bean is adopted.

Where was the technology validated?

The information presented is derived from large-scale testing in 2018/19 in the Linthipe area of Dedza district in central Malawi, located at 1400 m, with an average annual rainfall of around 1100 mm. Trials were conducted on 36 plots of 5 x 5 m replicated four times. The fields were planted with NUA45 as a pure stand and intercropped with maize. The Government of Malawi has released NUA45 under the name Chitedze 09 as a technology for improving food security, nutrition, and incomes, with the added benefit of augmenting soil fertility.

Potential benefits to users

Food security: The improved bean NUA45 can produce twice the yield of local bean varieties. The beans can be grown by intercropping on the same land area used for a traditional maize monocrop.

Nutrition: NUA45 supplies more iron and zinc than many commonly grown bean varieties. It is suitable for processing and may be combined with maize to make a nutritious flour. This can be cooked and eaten as a healthy porridge by young children. Mashed beans can also be made into a popular fried snack known as 'bean bites'.

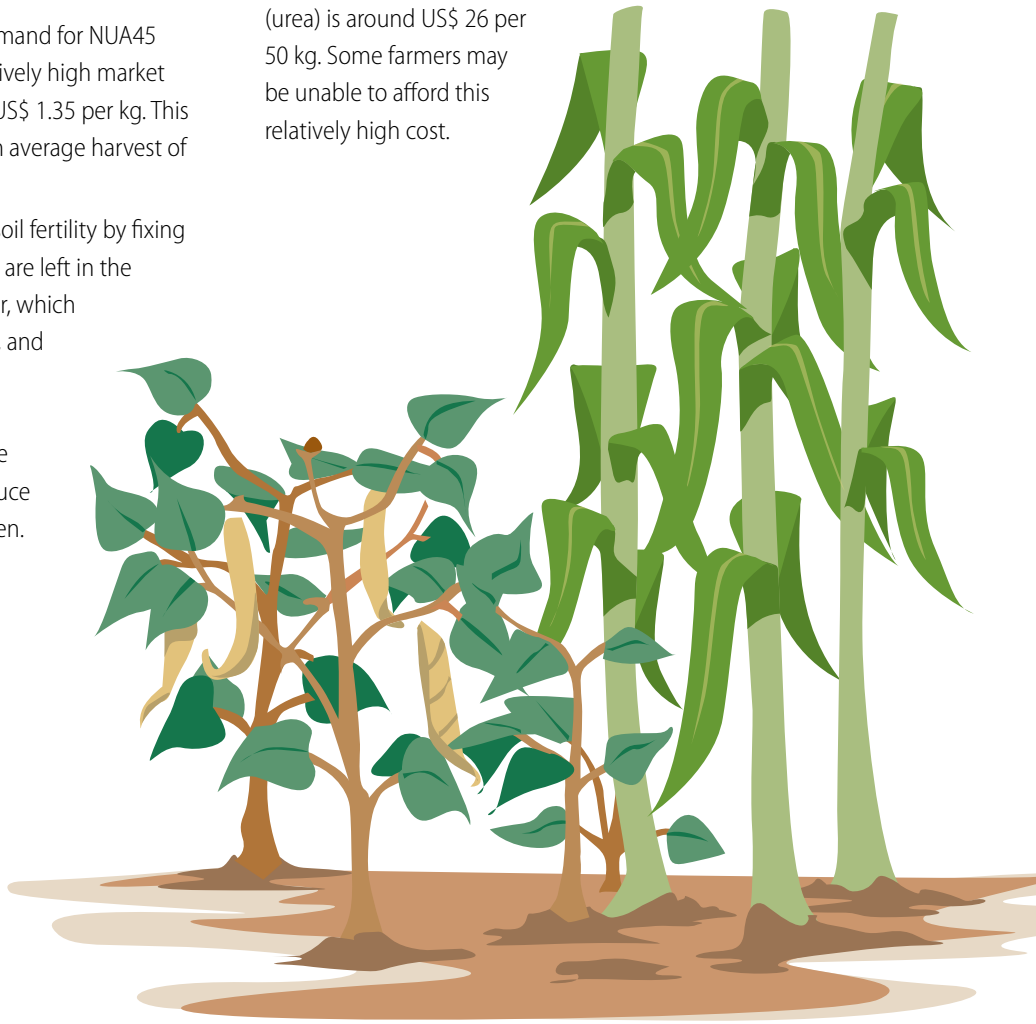
Increased incomes: The high demand for NUA45 'magic' beans translates into a relatively high market price, with farmers in Linthipe obtaining US$ 1.35 per kg. This equates to a net income of US$ 210 for an average harvest of 400 kg from a 0.2-hectare plot.

Soil fertility: NUA45 enhances soil fertility by fixing nitrogen. When the crop residues are left in the field, they provide valuable organic matter, which boosts soil health, improves soil structure, and supports moisture retention. When maize is grown in rotation after NUA45 (and the bean crop residues are incorporated in the soil), the maize will grow better and produce higher yields due to the additional nitrogen.

Things to worry about

Seed availability: Not surprisingly, there is a high demand for NUA45 beans from farmers and nutrition-oriented institutions, but few seed companies currently supply seeds for this variety. In Malawi, the Africa RISING team has introduced an innovative community seed multiplication initiative, which has provided sufficient seed for more than 2000 households.

Costs of fertilizer: The current price of basal dressing compound fertilizer (NPK) is around US$ 30 for 50 kg, and top-dressing fertilizer (urea) is around US$ 26 per 50 kg. Some farmers may be unable to afford this relatively high cost.



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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**