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Optimal spacing for groundnuts in smallholder farming systems

Increasing the planting density for groundnut generates multiple benefits by boosting yields of grain and fodder, enhancing soil fertility, improving water infiltration, and preventing weed growth, thereby raising farmers' food security and incomes.

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Description of the technology

Farmers traditionally plant groundnut at a density of around nine plants per square meter. IITA scientists have found that increasing the planting density confers numerous benefits. The new technology specifies an inter-row spacing of 30 cm and intra-row spacing of 15 cm, giving a planting density of 22 plants per square meter. When compared with farmers' traditional practices, the higher density of plants increases the rate of canopy closure over the soil surface by 25% at every 10-day interval from 30 days after planting to harvest. The more profuse plants and earlier closure of the canopy over the soil improves the soil micro-climate, conserves moisture, and enhances plant growth. It also protects the soil from erosion and improves water infiltration.

In on-farm trials, grain yields increased by 85% and fodder yields by 34% compared with the conventional planting density. Feeding groundnut fodder from the 22 plants per square meter density to sheep increased dry matter digestibility by 28% and weight gain by 85%. It also improved the nitrogen concentration of the manure by 12% when compared with that of sheep fed with groundnut fodder from the conventional planting density.

More plants can 'fix' additional nitrogen, thereby increasing soil fertility. The technology was found to increase biological nitrogen fixation by 56% relative to conventional practices. It also reduced weed infestation, with farmers generally needing to weed the crop only once (although they need to take care

Key messages

High productivity:

GRAIN YIELDS increased by 85% and FODDER YIELDS by 34% compared with the conventional planting density;

sheep fed on groundnut forage **almost doubled their rate of weight gain**

Raised incomes:

Farmers can **increase their** INCOMES by up to **120%**

Reduced labor:

WEED BIOMASS is reduced by 76% mostly **eliminating** the need for a **second weeding** operation

Enhanced soil fertility:

NITROGEN FIXATION increased by 56% compared with the conventional planting regime when weeding around the young seedlings). The technology is recommended for all types of groundnut, including erect, semi-erect, and spreading growth types, as well as early- and late-maturing varieties.

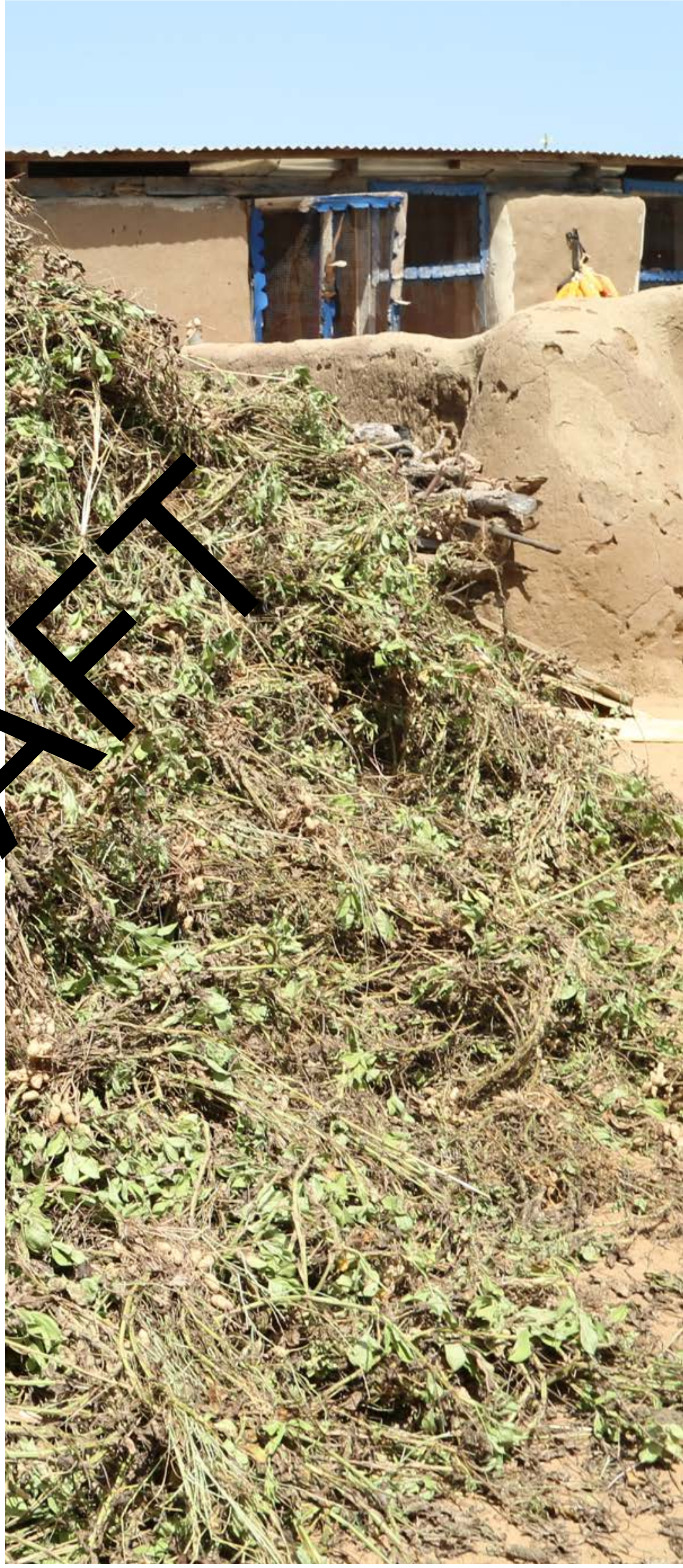
Conditions that favor uptake

Agro-ecological conditions: Groundnut grows best in deep, well-drained, and fertile sandy soils (sandy, sandy-loam, and loamy-sand) with pH 5–7. It has a total crop water need of 500–700 mm per growing period, therefore thrives in areas having an annual rainfall of 700 mm and above. It also requires a temperature range of 25–35°C. Productivity is maximized when farmers adopt good agronomic practices, such as appropriate timing of planting, weeding, thinning, and fertilizer application, as well as an optimal planting density of 22 plants per square meter.

Access to inputs and markets: The technology is most attractive (and will yield the greatest benefits) to farmers who can access effective agro-input dealer networks to obtain improved seeds and fertilizers. Farmers also need access to markets and market information for groundnut grains and livestock fodder to maximize their incomes from the sale of groundnut products.

Alignment with household resource endowments

The technology can be implemented by all groundnut-growing households at any level of resource endowment. It is particularly beneficial for mixed crop–livestock farmers, since the groundnut haulms provide nutritious fodder during the dry season, when little else is available. While farmers need to expend extra labor on harvesting and transporting the groundnut fodder to the livestock compound or area, there are additional benefits to feeding livestock in a confined area, as the manure can be collected more easily and used as fertilizer on subsequent crops. For women to benefit fully from applying these practices, they require access to land resources.



Sun-drying of harvested groundnut at a farmer's homestead in northern Ghana. *Photo credit:* Jonathan Odhong/IITA.

Necessary ingredients for implementation

Appropriate varieties: The technology will provide the greatest benefits to farmers when they plant improved varieties that meet their needs, including groundnut types that are early maturing, high yielding for grain and fodder, and disease resistant.

Planting: The groundnut seeds should be sown in a timely manner at an inter-row spacing of 30 cm and intra-row spacing of 15 cm to achieve the optimal planting density of 22 plants per square meter. The first weeding should be done between 20 and 50 days after planting, depending on local weed growth intensity.

Crop management: Groundnut generally has an effective symbiotic association with a wide range of native rhizobia present in the soil. However, in areas where the association is not effective (resulting in poor root nodule formation), farmers may need to apply an inoculant to the groundnut seeds. Groundnut plants derive most of the nitrogen they need from the air through biological nitrogen fixation and therefore do not require nitrogen fertilizer. Application of a phosphorus fertilizer (triple superphosphate or single superphosphate) at a rate of 30 kg per hectare before planting will help to increase productivity. In areas where soil nitrogen is very low, a starter dose of nitrogen fertilizer at 15 kg per hectare will be required.

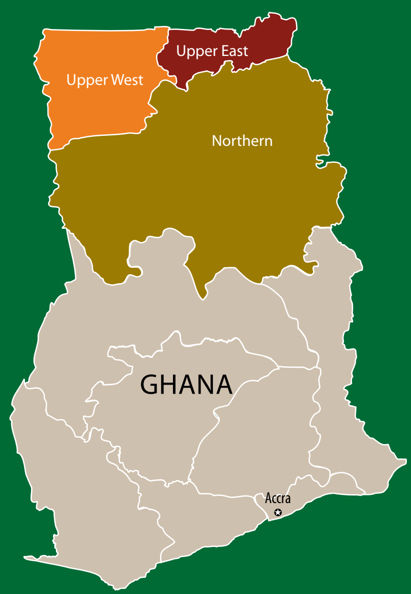
Aflatoxin mitigation: Aflatoxin is a mycotoxin produced by the fungi *Aspergillus flavus* and *A. parasiticus*. Its presence in food is detrimental to health in both humans and monogastric livestock. It especially infects crops like groundnut that are in direct contact with the soil. Farmers will need to receive training on how to minimize aflatoxin infection and prevent losses; this requires an efficient extension system and supervision throughout the value chain. The absence of premium prices for high-quality grain, i.e., not contaminated with aflatoxins, is also a disincentive for investment in groundnut, especially where additional inputs and actions are required.

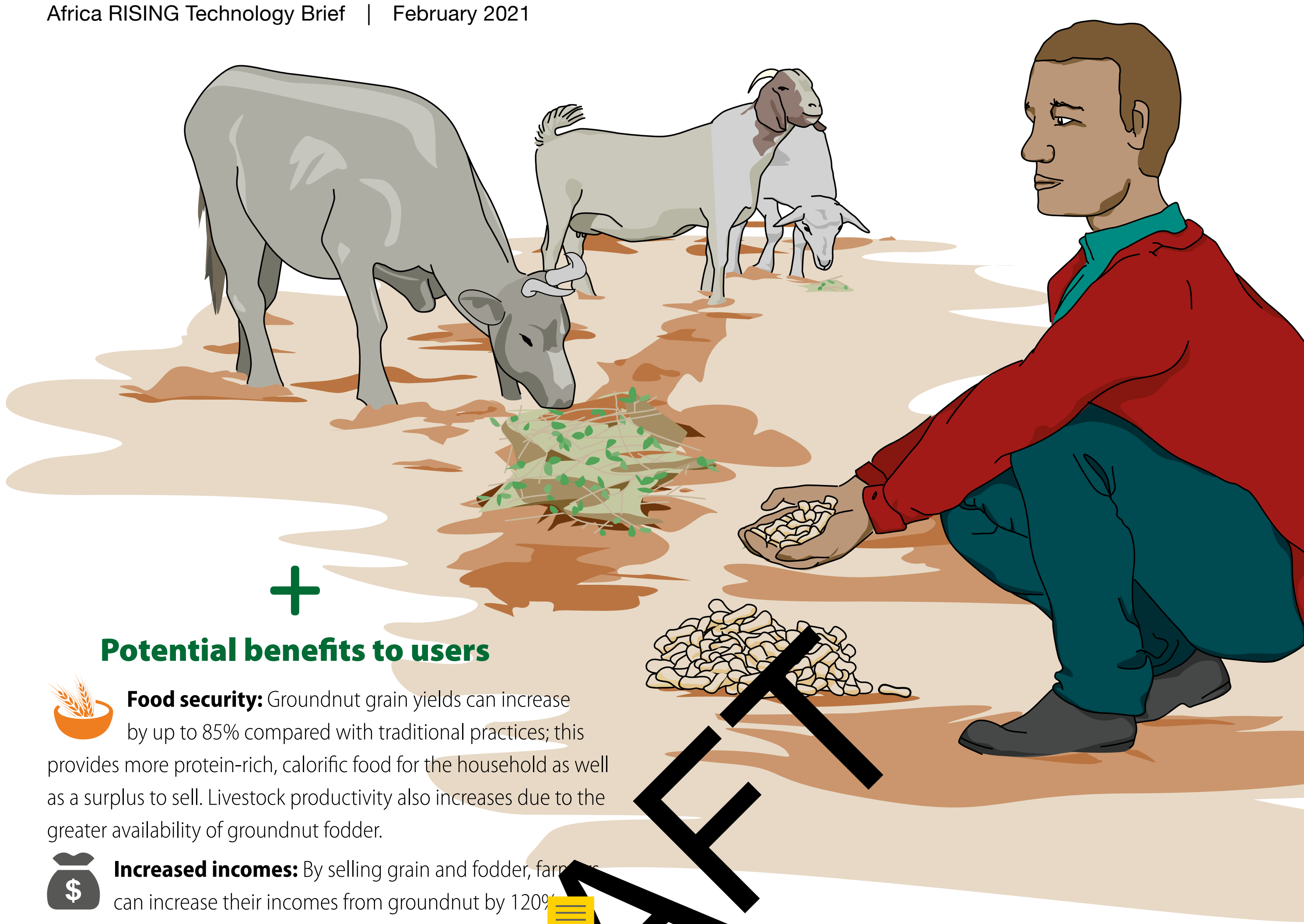
Adaptation possibilities

The required planting density of 22 plants per square meter can also be achieved by planting the groundnut at an inter-row spacing of 45 cm and intra-row spacing of 10 cm. This allows for easier movement between the rows for weeding. Application of fertilizers should be adjusted to the existing soil fertility status; for example, most soils in West Africa are deficient in nitrogen and phosphorus. The recommended planting density of 22 plants per square meter can also be applied to intercrops and crop rotations, where groundnut is grown with cereals (maize, millet, and sorghum).

Where was the technology validated?

The technology was tested through on-farm validation trials. These were led by researchers and farmers in six districts and 12 communities spread across three northern regions of Ghana during the 2016, 2017, and 2018 cropping seasons. Groundnut was planted at densities of 9, 11, and 22 plants per square meter on 580 square meters of land in the researcher-led trials and 4000 square meters in the farmer-led trials. The three northern regions of Ghana have a mono-modal rainfall pattern, with a mean annual rainfall of 700–1200 mm and mean monthly minimum and maximum temperatures of 25 and 38°C.





Potential benefits to users

Food security: Groundnut grain yields can increase by up to 85% compared with traditional practices; this provides more protein-rich, calorific food for the household as well as a surplus to sell. Livestock productivity also increases due to the greater availability of groundnut fodder.

Increased incomes: By selling grain and fodder, farmers can increase their incomes from groundnut by 120%. Around 62% of groundnut farmers in northern Ghana are expected to adopt this technology and this level of adoption has the potential to reduce the incidence of extreme poverty by [illegible]0% when farmers have access to international markets (calculated based on economic surplus, econometric, and Foster-Greer-Thorbeck models).

Soil fertility: The dense plant canopy reduces soil erosion and improves water infiltration, while also increasing soil fertility through enhanced nitrogen fixation. Sheep fed on groundnut haulms produce nitrogen-rich manure.

Less weeding: The close canopy reduces light penetration, thereby suppressing weed growth, with weed biomass reduced by [illegible] compared to conventional groundnut spacing. Depending on how fast the groundnut canopy covers the soil, farmers may be able to weed the crop only once (although care is needed to protect the groundnut seedlings). Conventional spacing requires at least two weeding operations.

Things to worry about

Labor: While less weeding is required, there is an increased labor demand for planting, harvesting, and processing, tasks that are generally carried out by women and children.

Access to inputs: Some farmers may be unable to access inputs, including improved seeds and fertilizers, due to their remote location or lack of cash or credit.

Aflatoxin contamination: Appropriate mitigation measures should to be followed to minimize infection during harvesting, storage, and other handling processes.

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**