Utilising crops to access scarce water enhances crop yields and farmer livelihoods in Mali

The Challenge

Agriculture accounts for 42% of Mali’s GDP and 21% of its exports. Sorghum is one of the major crops produced in Mali in terms of land under cultivation, amount harvested and per capita consumption. Cultivated on approximately 21% of Mali’s 2.6 million ha of arable land, it is grown during the rainy season, primarily by small-scale subsistence farmers, and on soils often deficient in nutrients and low in organic matter. Yields are accordingly low and food shortages and malnutrition are widespread, particularly among the rural population. During the dry season, with less than 40 mm of rainfall over a 6-month period, the soils are unproductive and commonly lie fallow. The challenge is therefore to improve yields in these regions by optimising the use of scarce water resources and improving the fertility of the soil.

An important candidate in meeting this challenge, and one that is often grown in rotation with crops such as sorghum, is cowpea. Cowpea is of particular interest in arid regions because it, in times of drought, grows a taproot as long as 2.5 metres and hence reaches otherwise inaccessible moisture deep in the soil profile. Improved varieties of this crop also effectively capture atmospheric nitrogen and convert it into soil-available nitrogen that can then be utilised by subsequent crops. In addition, the large biomass of cowpea of up to 5 t/ha increases soil organic matter and thereby improves soil fertility; it also provides a good ground cover that effectively reduces the evaporation of already scarce water from the soil surface.

The Project

Through an IAEA technical cooperation project, the Institute d’Economie Rurale in Bamako set out to exploit the intrinsic capacity of cowpea to tap deep-lying water resources in their efforts to improve the fertility of sorghum-growing arid regions in southern Mali, and hence to improve the productivity of sorghum, while at the same time adding an additional crop, cowpea, to the local breadbasket. Improved varieties of both crops were used in this project, as was sorghum/cowpea crop rotation practices. Trials were carried out in farmers’ fields in the village of Zanguéna with the improved sorghum and cowpea varieties, the latter having a high capacity to capture atmospheric nitrogen. The $^{15}$N isotope (see next section) was used to quantify the amount of nitrogen captured from the atmosphere by the cowpea crop.

The project showed that yields of 235 and 248 kg/ha could be obtained with the improved cowpea varieties, the amount of nitrogen captured by these varieties being approximately 40 kg/ha. The subsequent yields of three improved sorghum varieties were 1.5 - 1.9 t/ha compared to the average landrace yield in the area of less than 1 t/ha. At an average price of US $0.31/kg for sorghum and 0.67/kg for cowpea, the improved yields generated additional farmer incomes of US $317 - $441/ha/year.

Through farmers’ field days conducted during the project, villagers in Zanguéna were shown the advantages of diversifying food and income sources. Training was conducted for 150 village women on the hygienic processing of cowpea and the various methods of preparing cowpea meal to improve the nutrition particularly of women and children.
The Technology

Nitrogen (N) is a major nutrient for plant growth. Adding labelled $^{15}\text{N}$ isotope as a tracer to the soil-plant system enables the determination of the amount of atmospheric nitrogen derived by leguminous crops through biological nitrogen fixation, and allows the quantification of the amount of nitrogen fixed for the subsequent crops.

The Impact

Gaining access to deep-lying groundwater and improving soil fertility for crop production are key challenges in the water scarce environments of Mali. In the current project, improved varieties of sorghum and cowpea grown in rotation generated additional yields, beyond those normally achieved by local farmers, of 0.5 - 0.9 t/ha for sorghum and 235 - 248 kg/ha for cowpea. Projected to the 520,000 ha currently used for sorghum production, this would add an additional 260,000 – 470,000 t of sorghum to the annual Malian breadbasket. It would also generate an additional 126,000 t of cowpea, a potentially important diet supplement in Mali’s efforts to improve nutrition, particularly of women and children.

Farmers in the village of Zanguéna, with a population of about 800 people, have quickly adopted both the improved crop varieties and the cereal-cowpea crop rotation system. With a total farmland for the whole village of about 280 ha, the annual increase in grain yield, beyond that traditionally harvested, has been approximately 68 t of cowpea and 200 t of sorghum, well within the projected range. This has contributed considerably to increasing the food security of villagers and livestock, and has substantially improved the fertility of the soil in this arid region of Mali.

For further information, please visit:
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International Atomic Energy Agency, Wagramer Strasse 5, PO Box 100
1400 Vienna, Austria
www-naweb.iaea.org/nafa/swmn

¹ ML15021 on “Sustainable intensification and diversification of sorghum production systems in the southern zone of Mali, Phase 1”, 2007-2010.