The Challenge

Pigeon pea plays a unique role in the agricultural production system of the semi-arid tropics of Kenya because of its high value as a source of protein for both people and animals and is often used to bridge periods of food shortage for the rural poor. Furthermore, pigeon pea is a deep rooted plant (up to 2 metres) that can draw water from deep within the soil profile and is therefore tolerant to water stress. Of particular importance is its ability to improve soil nitrogen content by capturing nitrogen from the atmosphere and converting it into plant available nitrogen for subsequent crops. Close to 90% of Kenyan pigeon pea is produced by small-scale farmers, often intercropped, i.e. grown together, with maize. However, due to the use of unimproved landrace varieties and competition for water and nutrients, yields of both pigeon pea and maize are low. In addition, inappropriate soil management practices and low plant densities lead to poor utilisation of the already scarce rainfall. The key challenge to sustainable food security and improved farmer livelihoods in the semi-arid drylands of Kenya is to implement novel farming practices that will enhance the water use efficiency of the crops and at the same time improve the fertility of the soil and hence the yields.

The Project

Through an IAEA technical cooperation project, the Kenya Agricultural Research Institute (KARI) set out to evaluate the efficiency with which pigeon pea is able to use the available water under dryland conditions in the traditional pigeon pea – maize cropping system, as well as to optimise its role in improving soil fertility. The project, carried out at KARI’s Katumani research station in the Machakos District, assessed the ability of short (3 – 4 months) and long duration (7 – 8 months) pigeon pea varieties to capture atmospheric nitrogen, and investigated higher planting density and crop rotation (rather than intercropping) for soil fertility enhancement.

By using an improved production system with a planting density three times higher than the 6200 plants per hectare normally planted by farmers, high-yielding pigeon pea varieties (yield potential >3.5 t/ha) and the application of 20 kg/ha of nitrogen and 40 kg/ha of phosphorous as starter fertilisers, yields with short duration varieties of 3000-3500 kg/ha and with long-duration varieties of 2500 kg/ha could be achieved when pigeon pea was planted as a sole crop. This compared to traditional yields of 300-500 kg/ha under intercropping with maize. The amount of nitrogen captured by the pigeon pea was 20 kg/ha in the landrace, 40-55 kg/ha in the short duration variety and up to 80 kg/ha in the long duration variety. Hence, the improved production system lead to an increase in soil fertility and water use efficiency that generated 0.8-1.5 kg of biomass/m^3 of water for the short- and long-duration varieties, compared to 0.3 kg/m^3 for the landrace, i.e. almost three times the biomass per unit of water and a three times better utilisation of the existing water resources.
At US $200/ha, the cultivation cost for pigeon pea was somewhat higher under the improved production system, where pigeon pea precedes the maize crop, compared to US $50/ha with traditional pigeon pea-maize intercropping. However, the corresponding net return was also much higher, at US $3000-3500/ha versus US $300-500, providing net cost/benefit ratios of more than 15 versus less than 2.5, respectively.

The Technology

Nitrogen (N) is a major nutrient for plant growth. Adding labelled $^{15}$N isotope as a tracer to the soil plant system enables the determination of the amount of nitrogen derived from the atmosphere through legume crops that can capture this nitrogen and convert it into plant available nitrogen.

The Impact

The ability of the improved production system (pigeon pea in rotation with maize) to generate a 6-10 times higher yield of pigeon pea per hectare is a substantial achievement that will generate significant impact in regions with water scarcity. It is also a strong example of how to capitalise on the inherent ability of deep-rooted crops to tap water resources stored in deeper soil profiles. The additional yield achieved with this production system will contribute substantively to providing a reliable and essential source of protein. At a current market price of US $1/kg of pigeon pea, it will also add an additional income to resource poor farmers of around US $2500-3200/ha, and hence contribute to improving their livelihoods. Projected to the total area of 163,000 ha currently used for pigeon pea production in Kenya this amounts to additional revenue of $400-520 million/yr to Kenyan farmers.

For further information, please visit:
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