BEST PRACTICE

Cassava: improving sustainability of farming systems

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Throughout Africa populations are growing fast and pressure on land is steadily increasing. To maintain productivity, farmers are constantly adapting their management of natural resources. Farming systems are thus changing from ”slash and burn systems” to ”natural fallow” systems into ”continuous cropping” systems without external inputs and ultimately into more ”intensive” systems using agricultural inputs.

Cassava-maize systems in East Africa

A principal crop in Africa’s farming systems is cassava, with a total production that has quadrupled in the last five decades to about 118 million t/year. Cassava is a major crop in East Africa, where it is often produced together with maize by smallholder farmers. Such cassava–maize-based systems are found around Lake Victoria and in Burundi, Rwanda, and eastern DR Congo. Apart from being dominated by cassava and maize (on average one-third of cropped land is planted with cassava and one-quarter with maize) these systems have a high self-sufficiency in food. Sixty percent of all households sell cassava and maize; each crop generates an average of US$90 per year.

Due to its widely varying levels of land pressure, this region allows an interesting study of natural resource management and opportunities to improve both the productivity and the sustainability of cassava-based farming systems.

Pauline Auma of Busia district (western Kenya) proudly shows her cassava harvest. Photo by Anneke Fermont, IITA.

Cassava is widely grown in East Africa today, but this is a recent development. Only three decades ago cassava production was limited to the odd corner in farms as enforcement of its production during colonial times had given the crop a very bad image. The remarkable change in the importance of cassava has been driven by sharply increasing land pressure. No longer having the land available to restore soil fertility through natural fallows, farmers replaced fallows with cassava.

Does cassava improve soil fertility?
Jacinta Ouma, a farmer in Teso district, western Kenya, explains: "Cassava drops its leaves on the soil while it grows. This improves the soil, so if I plant maize after cassava it grows better." Jacinta is not alone in this belief. A similar practice, known as *jachère manioc* or 'cassava fallow', exists in West Africa.

Almost 90% of farmers interviewed in Uganda and Kenya had the same opinion. Farm surveys in Uganda and Kenya showed that farmers plant cassava on all soil types to maintain soil fertility. If land pressure increases and soils consequently become more acidic (pH <5.8) and deficient in phosphorus (P) (available P <4-5 mg/kg), farmers increasingly plant cassava in the poorest fields in their farm. In Siaya district, western Kenya, with nearly 400 people/km^2, farmers planted nearly twice as much cassava on infertile soils than on fertile soils.

Women in Teso district (western Kenya) peel cassava for eating. Photo by Anneke Fermont, IITA.

Modeling to substantiate farmers' claims
To understand farmers' observations, we used a modeling approach. Our results suggest that planting maize on an infertile soil will result in slowly declining levels of soil organic matter, while planting cassava will slowly increase soil organic matter over time. The difference is explained by the fact that cassava grows much better than maize on infertile soils. The large amounts of easily available nitrogen (N) in its crop residues likely give cassava its reputation as a soil improver.

The model estimated that cassava returns about four times more N to the soil than maize. Through its deep rooting system and its association with mycorrhizae, cassava can pump up nutrients from the subsoil and absorb nutrients from less easily accessible pools. Nutrients from its N-rich litterfall are then redistributed to more labile pools in the topsoil.

But all is not sunshine and roses. Continuous cropping systems without external nutrient inputs deplete the soil's nutrient pool. On the highly weathered soils found in large parts of Africa, this will unavoidably result in nutrient limitation and declining crop yields. In East Africa, N and P limitations for cereal crops are widely documented. A series of field trials with over 100 farmers demonstrated that cassava production is often limited by N and P, and commonly by potassium (K).

Cassava grows better on good soils
Cassava is known for its ability to produce fair yields where other crops fail. This has led many to believe that soil fertility is not important in cassava production. Our field trials show that this is a misconception. On the contrary, using improved varieties but no fertilizer, low soil fertility was the principal constraint to production and caused farmers an average loss of 6.7 t/ha with respect to an attainable yield

The field of Nikirima Arajabu in Iganga district (Uganda) shows a very strong response to NPK fertilizer. Photo by Anneke Fermont, IITA.

of 27 t/ha. Drought caused a loss of 5.4 t/ha and poor weed control 5.0 t/ha, whereas pests and diseases caused an average loss of 3.8 t/ha.

The farm surveys showed that Kenyan and Ugandan farmers harvested on average between 7 and 10 t/ha using farmer practices. This is far below the maximum yield of 35 t/ha that was observed during the two-year on-farm fertilizer trials and clearly shows the potential for improving yields.

Using an integrated management package that consisted of an improved genotype, recommended planting practices and NPK fertilizer, average yields in farmers' fields more than doubled from 8.6 to 20.8 t/ha. About 30% of the yield increase was due to the use of improved genotypes, while a whopping 60% was the result of fertilizer use. These findings reinforce the idea that soil fertility/nutrient availability is a principal production constraint for cassava.

Options to improve system sustainability

Though fertilizer use may be the easiest way to improve cassava productivity and improve system sustainability, high prices limit the adoption of fertilizers, unless strong markets develop. Farmers have, however, other options to improve cassava productivity, increase nutrient availability, and reduce nutrient losses within their farming system. These include: (1) better weed control and drought avoidance strategies; (2) improving cassava's efficiency as a soil fertility improver; (3) returning cassava stems to the field after harvest to reduce nutrient losses; and (4) planting cassava in rotation/intercrop with (cash) crops that receive manure/ fertilizer.

Dealing with the challenges from increasing land pressure and related sustainability issues while substantially improving crop yields requires R4D teams with a strong interdisciplinary character. African farmers have shown great resourcefulness in maintaining system productivity by introducing cassava as a soil fertility improver. Now, IITA and its partners have the challenge to come up with innovative strategies to maintain or further improve system sustainability and crop productivity in increasingly stressed farming systems.