Defying the odds, African farmers meet food security goals

In a region that depends on foreign food aid to feed much of its rural population, tens of thousands of subsistence farmers in southern Africa are boosting crop yields, improving the quality of their soils, and moving rapidly towards self-sufficiency and the market economy.

Despite irregular rainfall during the 2004 cropping season – and the near total absence of mineral fertilizers – farmers harvested on average 2–3 t/ha of maize, roughly four times the amount produced by neighbouring farmers.

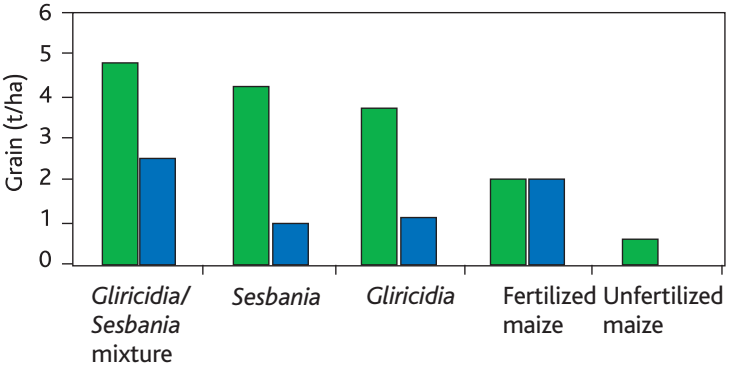
The keys to their success are 'fertilizer trees' – species of trees that transfer nitrogen from the air into the soil. Fertilizer trees are capable of revitalising degraded soils and helping rural communities to survive the 'hunger months' of November through March when food supplies run critically low.

Developed by researchers at the World Agroforestry Centre, the fertilizer tree system is quickly gaining acceptance in Kenya, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe. Since the late 1990s, when just a few hundred farmers first tested the technology, at least 100,000 maize producers have now adopted the concept.

"Our goal is to reach 12 million farmers by 2015," says Freddie Kwesiga, an agroforester and Regional Coordinator – Southern Africa who has spearheaded research in the region since 1986. Kwesiga notes that the total number of farmers currently using fertilizer trees represents about 1.5% of the maize producers in southern Africa.

"That's a huge number for a small research and development team, but it's not nearly enough to help the millions of Africans in need of food." Kwesiga is optimistic, however, that fertilizer trees will be widely used a decade from now.

"The United Nations Millennium Development Goal of cutting the number of hungry people in half by 2015 is helping to drive the use of fertilizer trees and is prompting government policymakers and international donor agencies to take note," he says. In 2002 the Canadian International Development Agency (CIDA) provided ICRAF's Zambezi Basin Agroforestry Project with a Canadian$13 million grant to help it reach 400,000 farmers by 2006. The United States Agency for International Development (USAID) provided an additional US$600,000 in 2003.



aize yields (t/ha) after pure and mixed fallows. Kalunga, Zambia 2002–2003

In the absence of fertilizer

"Its no secret that if you want to increase African food production, you need to do something about the region's depleted soils," says Paramu Mafongoya, a soil scientist and agroforester who serves as ICRAF's Country Representative in Zambia.

Mafongoya notes that applying mineral fertilizers can easily boost the productivity of African soils. "But fertilizers are expensive and basically beyond the reach of the region's farmers." he says. Moreover, the few farmers who can actually afford to buy fertilizers rarely receive supplies on time or in sufficient quantities.

The problems of supplying bulky mineral fertilizers to millions of farmers working in countries with poor road systems, Mafongoya believes, has proved to be an insurmountable problem, especially in land-locked countries such as Malawi and Zambia where nitrogenous fertilizer can cost US$700/t – more than five times the world price.

"The logic of the fertilizer tree concept is that it puts the job of producing fertilizer in the hands of local farmers," Mafongoya says. "Moreover, it's a one-time investment: once the trees are planted, the local community takes up the responsibility of spreading the practices to others.

Mafongoya and Kwesiga are quick to point out that farmers can choose from a variety of fertilizer trees contained in a portfolio made available by ICRAF through national agricultural research and extension systems and

non-governmental agencies. This portfolio also includes numerous varieties of indigenous fruits, trees for timber and medicine, and fodder trees for animal feed.

"ICRAF is committed to providing farmers with an array of useful trees and shrubs that provide rural households with fruits, construction materials, fencing, fuelwood, medicine, and food. We believe – and experience has shown – that trees are pathway out of poverty and we believe that the process starts with improving soil fertility," Kwesiga says.

Such trees help farmers take severely degraded land and transform it into a productive landscape within 24 to 36 months in the rainfall conditions prevalent in southern Africa. While there is no one type of fertilizer tree that fits all situations and ecologies, demand is growing rapidly for a species known as *Gliricidia sepium*.

The 'tree of life'

Imported by ICRAF from Central America in the late 1980s, a new provenance of *Gliricidia* begins enriching the soil within 2 years of planting. By the end of 36 months it provides farmers with the equivalent of 100 kg of nitrogenous fertilizer/ha. This species performs particularly well, researchers say, in sandy soils and under the drier conditions that prevail in southern Africa.

While the amount of fertilizer that *Gliricidia* produces is equal to that provided by other fertilizer tree species, *Gliricidia* has a major advantage over its competitors: it grows back well after cutting. So long as the root system is left intact, the tree will continue to produce nitrogen for many years.

Farmers cooperating with the Project selected the *Gliricidia* used in southern Africa in 1994 and dubbed it the 'tree of life.'

Although *Gliricidia* produces nitrogen nodules below ground, it is the tree's leaves that are most valued by

farmers. The nitrogen content of the foliage ranges from 3 to 4% and provides a high quality fertilizer that is readily utilised by cereal crops. Laboratory analysis conducted at ICRAF's research station in Chipata, Zambia indicates that *Gliricidia* leaves are similar in many respects to ammonium nitrate or urea fertilizers.

Gliricidia also has the advantage of having few natural enemies and it can be grown without agrochemicals. Indeed, the beetles that attack some types of fertilizer trees, most notably *Sesbania sesban*, die when exposed to *Gliricidia*. For that reason, many of the farmers who grow *Sesbania* and other types of fertilizer trees also plant *Gliricidia* as a biological control.

ICRAF scientists anticipate that disease and pest problems will eventually overcome *Gliricidia's* defenses and are keeping close watch. Researchers are also aware that sustained use of the trees may lead to nutrient imbalances in the soil and are therefore conducting studies to determine the need for potassium and phosphate supplementation. For now, however, the move towards large-scale adoption continues without delay.

Breaking the hard pan

According to Joyce Mulilia-Mitti, an ICRAF extension and scaling-up expert, the Centre's fertilizer tree initiative will likely reach its goal of 400,000 users by 2006. "Right now we are at about the 50% mark, but keep in mind that as recently as 3 years ago there were only 3,500 farmers in all of southern Africa using improved agroforestry tree species," she says.

Rapid adoption, Mulilia-Mitti believes, is tied to the Project's clear strategy, an effective technology, and committed donors and partners. A large part of the Project's success, she adds, is also due to the benefits that accrue to women.

"Women are major beneficiaries of fertilizer-tree technology," she notes. For instance, because the trees add organic matter to the soil and the roots break the so-called soil hard pan – the crust that develops on the surface of degraded soils – preparing the soil for maize planting is far easier than it would be in depleted soils that are low in organic matter.

"That's a big incentive for women who are largely responsible for land preparation and crop production," she says.

Women also benefit from the fuelwood that the trees produce. Once fully established, a hectare of *Sesbania* produces on average 10 t of fuelwood each year. The majority of African families need about 3 t of fuelwood each year for cooking. Most of this wood is collected by women who carry their loads long distances from the forest.

"By growing fertilizer trees near the homestead," she says, "the need to cut and carry fuelwood is essentially eliminated and that is an enormously important labour saver for women."

Women in alawi homeward bound after gathering fuelwood


Photo by Anthony Asael

Demand is growing rapidly for Gliricidia sepium

Aiding biodiversity

Planting fertilizer trees may also have a profound impact on the region's forests.

According to the Food and Agriculture Organization of the United Nations, (FAO) Zambia – the country with the most advanced fertilizer tree programme – is losing between 200,000 and 300,000 ha of forest annually. The principal agents are agriculture and charcoal production.

"You can see the damage from just about any location," says John Lazier, a professional associated with the Project through CIDA. "Over the past 20 years, southern Africa's woodlands have been depleted by people searching for fuelwood. Large-scale adoption of fertilizer trees and other agroforestry species could have a major impact on the region's biodiversity and allow native forest species to recover," says Lazier.

"ICRAF's work in southern Africa makes available a large suite of technological options that can overcome constraints that many experts until now had thought were basically insurmountable. These include better ways of producing timber, fuelwood, fruits and medicinal products, but most importantly they provide options for restoring soil fertility. This is a dramatic breakthrough that will have a wide-ranging impact on the region and possibly beyond."

Indeed, according to studies conducted by the European Union-sponsored IMPALA Project (Improved Fallows in Africa), fertilizer trees annually sequester 10–20 t of carbon/ha and increase soil carbon by about 1 t/ha per annum. These amounts compare favourably to virtually any other agricultural system.

Alain Albrecht, leader of the IMPALA Project, notes that fertilizer trees not only store atmospheric carbon, a greenhouse gas responsible for global warming, but also greatly improve agricultural productivity and wood

production in farmers' fields. Albrecht, who holds a joint appointment with ICRAF and France's Institut de recherche pour le développement (IRD) says that the trees not only sequester significant amounts of carbon when used in improved fallow systems, they prevent soil erosion, are financially attractive to poor farmers, and save labour.

"If there is a downside to the technology – and all technologies have a downside – it is that the trees tend to perform better on heavier soils and their extended use may be offset by the fact that they produce nitrous oxide emissions, which may cancel out their carbon sequestration benefits," Albrecht says.

"The principal benefits right now to farmers are improved yields and fuelwood production. However, if this technology is to be of significant benefit to the environment and to farmers who may one day earn carbon credits from their use of the trees, it will require significantly higher levels of adoption.

"That's exactly the objective we have in mind," notes Kwesiga.

"This is a technology that can be taken off the shelf, that addresses some of Africa's most important problems in an effective and sustainable way, and that we anticipate will lead to greater food security, improved health, and provide a much-needed entry point for poor people to a cash economy (see *Pathways out of poverty)*.

Pathways out of poverty

In southern Africa, where agriculture and maize production are almost synonymous, thousands of farmers are diversifying their holdings as they replenish their soils with the help of nitrogen-fixing fertilizer trees. In eastern Zambia, where many farmers have been using the trees for nearly a decade to restore soil fertility, maize producers are supplementing their incomes by growing cash crops that command high prices in urban markets.

One crop that farmers find especially attractive is garlic, that can be easily dried and stored on-farm without special facilities. The retail price of garlic in Zambia is US$5/kg, an attractive amount for farmers who until recently only grew it for home consumption.

Farmers who grow garlic for the market attribute their success to a technique known as 'biomass transfer,' a process which entails cutting and carrying nitrogen-rich leaves produced by fertilizer trees, particularly *Gliricidia*, and depositing them in garden plots at the end of the maize cropping season. Such gardens are usually located near a wetland area or in a shady environment where the soil remains moist enough to produce horticultural crops.

The end of the maize season is usually a down time for the farmers in Zambia, but the availability of the *Gliricidia* leaves allows them grow garlic and other cash crops in quantities that bring high prices during this off-season. Leaves from fertilizer trees provide nitrogen in amounts sufficient to replenish severely depleted soils and produce not only crops for the market, but also nutritious fruits and vegetables that can prevent micronutrient malnutrition and bolster the body's immune system. In a region racked by HIV/AIDS and malaria, that is an important benefit that empowers people who lack access to drugs and food supplements to cope with their most important health problems with little outside assistance.