

Green fertilizers can boost food security in Africa



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A continent-wide meta-analysis finds that green fertilizers significantly improve maize yield, either alone or in synergy with small doses of mineral fertilizer

Key elements

1. Maize grown with green fertilizers yields significantly more grain than maize grown without fertilizer or after natural vegetation fallows.
2. Green fertilizers have synergistic effects with mineral fertilizers and produce acceptable yields with relatively modest expenditures on fertilizer imports.
3. Green fertilizers reduce production risk by stabilizing maize yield relative to maize grown without fertilizer or following traditional fallows.
4. Green fertilizers work well where they are needed most, on land with low-to-medium potential, which is typically worked by poor farmers unable to afford mineral fertilizer.

Background

Maize is one of the most widely grown crops in the world, a staple that provides half of the calories consumed in some countries in sub-Saharan Africa. The average grain yield in Africa has stagnated at around 1–2 tonnes per hectare (Figure 1), despite the crop's genetic potential to yield up to 10 tonnes per hectare and the availability of improved cultivars and such inputs as mineral fertilizer. Southern Africa in particular experiences high year-on-year variability in yield. That the maize area harvested has declined or remained the same over the years, at least in the southern parts of the continent, indicates that little or no suitable farmland remains uncultivated. Boosting maize production therefore cannot come from area expansion but will require productivity gains.

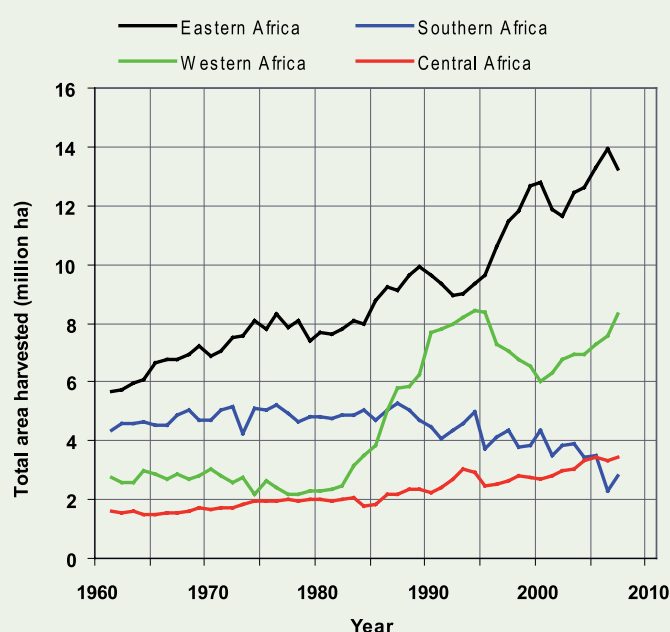
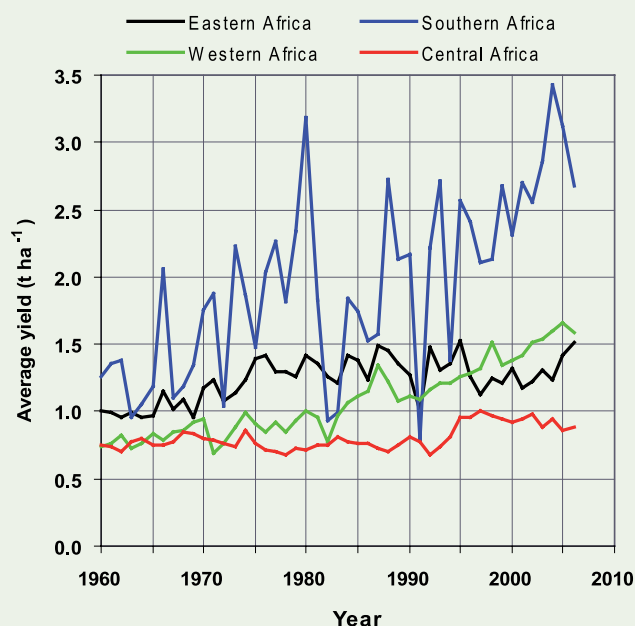


Figure 1. Trends in average grain yield and area of maize harvested in different regions of Africa, with average annual yields for 1961–2007 in each region obtained from FAO (2008).

The prospects for meeting food demand in Africa—which depends mainly on rainfed, smallholder agriculture—will likely remain bleak without major efforts to reverse current unfavourable trends in productivity. Central to this equation is the rapid decline of soil fertility, which affects crop productivity and rural poverty (Conway and Toenniessen 2003). Although mineral fertilizer can restore soil fertility, most smallholder farms in Africa have little access to it because of its high price. The dramatic increases in world fertilizer prices recorded recently are especially damaging to African farmers' hopes of improving their productivity (Hargrove 2008).

The hard reality confronting poor farmers in Africa creates the urgent need to develop a wide range of options for replenishing soil fertility as quickly as possible. Over the decades, scientists have evaluated various woody and herbaceous legumes, or green fertilizers, to improve soil fertility and thereby strengthen household food security in Africa. The approach harnesses biological nitrogen fixation, the process by which legumes, either in a rotational fallow or in an intercropping system, draw nitrogen from the air to produce compounds that enrich the soil when the plants are ploughed under. However, the effects of green fertilizers on maize yield vary widely, generating debate on their usefulness for raising maize productivity and strengthening food security.

Analysis and overview of results

Researchers at the World Agroforestry Centre conducted a meta-analysis with the aim of assessing whether or not there is consistent evidence for maize yield benefits from using green fertilizers in Africa (Sileshi et al. 2008). The analysis selected 94 peer-reviewed studies carried out independently by several researchers in West, East and Southern Africa. The increase in maize yield using green fertilizers was compared with that using mineral fertilizer and maize cropped continuously without fertilizer. The key results from the analysis are as follows.

Increased maize yield. Maize grown with green fertilizers yielded significantly more grain than maize grown without fertilizer, which is the de facto subsistence farmers' practice, or maize grown after a traditional fallow of natural vegetation. Green fertilizers increased the average yield by up to 1.6 tonnes per hectare over these smallholder farmers' practices (Figure 2).

Maize yield doubled when compared with these farmers' practices in two thirds of the case studies with coppicing¹ woody legumes, in half of the cases using non-coppicing² woody species and in one fifth of the cases using herbaceous green manure legumes. At the estimated rate of maize consumption of 1.5 kilograms

1 Coppicing woody legumes are those species that re-sprout by producing side shoots after being cut back.

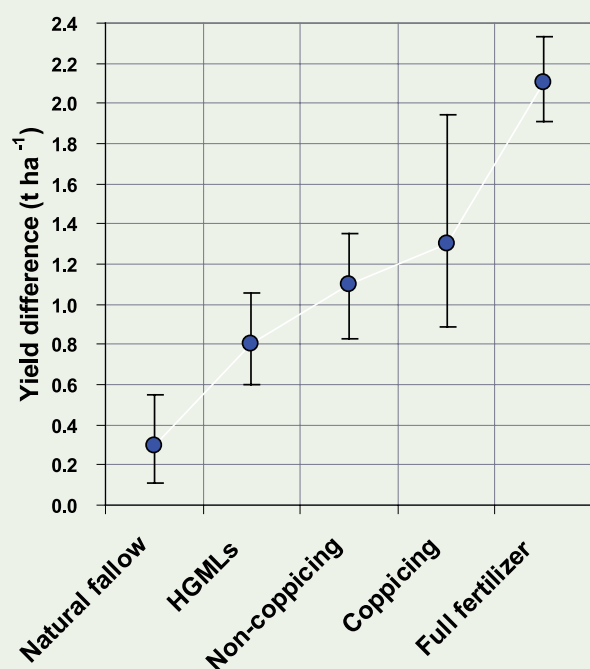


Figure 2. Means and 95% confidence intervals of yield differences between continuously cropped, unfertilized maize (the control) and maize following natural fallows; herbaceous green manure legumes (HGMLs); non-coppicing and coppicing woody legumes; and fully fertilized, continuously cropped maize.

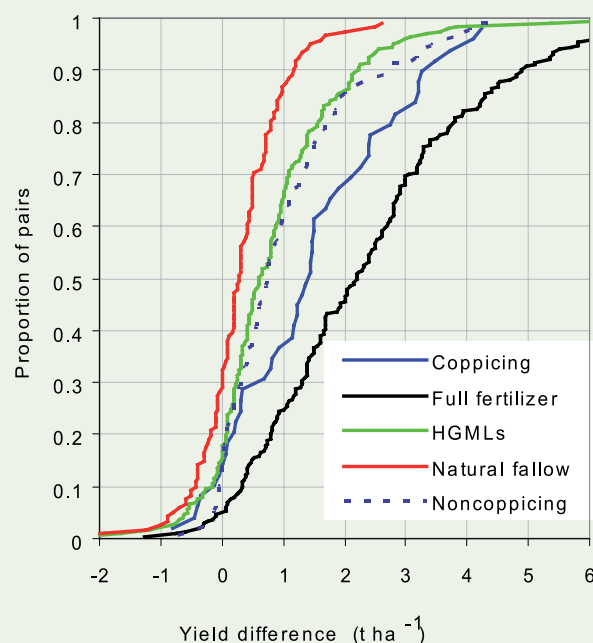


Figure 3. The risk of obtaining less than a 1 tonne increase over the control is higher with natural vegetation fallows than with HGMLs, non-coppicing woody legumes, coppicing woody legumes or full fertilizer amendment.

per person per day, the incremental maize yield provided by green fertilizers contributes the equivalent of 6 months' worth of additional maize for a farm family of six or 7 months' worth for a farm family of five.

Reduced production risk. The maize yield was more stable in fields using green fertilizer than in unfertilized fields or maize following traditional fallows, though not as high as in fields amended with mineral fertilizer. The production risk with respect to maize yield is therefore lower in fields using green fertilizer than in those under farmers' practice.

The probability of increasing maize yield over continuously cropped, unfertilized fields by more than 1 tonne per hectare was 30–63% with green fertilizers. This contrasts sharply with natural fallow plots, for which the probability was less than 15% (Figure 3).

Budget-friendly booster for mineral fertilizer. Green fertilizers are compatible with mineral fertilizers, and their combined use has synergistic effects. Maize yield

was up to 30% higher when green fertilizer plots were amended with half of the recommended dose of mineral fertilizer, compared with similar plots that were not amended. Applying the full recommended dose did not improve yield much beyond that. This result indicates that legume trees and shrubs can play important roles in reducing the cost of meeting fertilizer requirements, with implications for local food security and national budgets.

Effective on sites with low-to-medium potential.

Greater increases in maize yield were recorded using green fertilizers at sites with low-to-medium potential than at sites with high potential. In particular, the type of soil affects the degree of yield response to green fertilizers, with response higher on nutrient-poor soils than nutrient-rich soils. Green fertilizers thus offer greater benefits to farmers with marginal land, who are likely to be poorer than those in areas with high potential.

2 Non-coppicing woody legumes are those species that die after being cut back.

Policy actions: Where do we go from here?

At the 2006 Fertilizer Summit in Abuja, Nigeria, African leaders declared organic fertilizer a strategic commodity for the continent. The findings of the analysis concur that promoting green fertilizers along with mineral fertilizers is vital to a technically sound and financially affordable strategy to improve soil health and agricultural productivity in Africa.

Projects that promote green fertilizers to improve soil fertility and strengthen food security should encourage farmer experimentation with several options rather than rely on the wholesale promotion of a single technology.

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Fertilizer trees such as Sesbania sesban capture nitrogen from the atmosphere and make it available to crops.



The content of this policy brief is based on a paper entitled: Sileshi G, Akinnifesi FK, Ajayi OC, Place F. 2009. Evidence for impact of green fertilizers on maize production in sub-Saharan Africa: a meta-analysis. ICRAF Occasional Paper No. 10. Nairobi: World Agroforestry Centre. <http://www.worldagroforestry.org/downloads/publications/PDFs/OP16027.PDF> To obtain additional copies, contact World Agroforestry Centre (ICRAF), SADC-ICRAF Agroforestry Programme, Chitedze Agricultural Research Station, PO Box 30798, Lilongwe, Malawi, email f.akinnifesi@cgiar.org

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