Building on Successes in African Agriculture

Strategies for Sustainable Natural Resource Management

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Sub-Saharan Africa, with the highest fertility rate in the world, faces increasing demographic pressure on its natural resource base. As a result of rapid population growth and growing land constraints, cultivated land per capita has fallen by 40 percent since 1965, from 0.5 to about 0.3 hectare per person. At the same time, land quality has fallen. Data on nutrient balances over the past 30 years suggest that African soils have sustained annual net losses of nitrogen, phosphorus, and potassium on the order of 22, 2.5, and 15 kilograms (kg) per hectare respectively. This soil mining may contribute from one-third to as much as 80 percent of farm output in some locations. Failure to replenish soil fertility—from organic or inorganic sources—leads to unsustainable output and incomes in agriculture.

Old strategies for coping with these new pressures on the natural resource base are becoming increasingly infeasible. Classic methods of replenishing soil fertility via shifting cultivation and long-term fallows break down as population pressure reduces the interval between fallows as well as their duration. The withdrawal of fertilizer subsidies across much of Africa during the structural adjustment liberalizations of the 1990s and the collapse of rural credit systems have rendered reliance on chemical fertilizers increasingly less profitable and infeasible for farmers.

Consequently, Africa's farmers require new solutions to address the increasing pressure on the continent's soil and water resources. Among hundreds of innovative efforts across the continent, two promising sets of responses have emerged in different locations.

First is the use of planting basins, an approach that has emerged in recent decades in both the Sahel and Zambia. Known as zaï in the Sahel and as "conservation farming" in Zambia, the systems involve a series of common practices: dry-season land preparation to avoid peak-season labor bottlenecks and ensure timely planting with the first rains; minimum tillage of only 15 percent of surface area using grids of 10,000 to 15,000 small planting basins per hectare, which harvest water and focus nutrients in a small area nearest the plants; breaking of hard crusts and plow pans in soils to enable water and root penetration; and application of organic material and sometimes also small doses of chemical nutrients in the basins immediately adjacent to the plants.

The second strategy involves the use of improved fallows, introduced over the past decade in eastern Zambia and western Kenya. In this strategy farmers introduce rotations of leguminous trees planted for one to three seasons on a given plot, then cut them down and plant crops on the same plots for two to three seasons. These managed, or "improved," fallows build up soil fertility through crop rotations with nitrogen-fixing trees and retention of organic material from plant leaves and branches. The use of trees rather than smaller leguminous plants helps to penetrate the soil with root channels, which serve as biological plows, facilitating water and root infiltration by subsequent crops.

Both technologies are of recent vintage. Although zaï have become popular in the Sahel since early 1980s, use of these two approaches elsewhere only emerged a decade or more later. They have attracted widespread interest because of their environmental sustainability, reduced use of purchased inputs, and ability to increase farmer yields and to recapitalize soil fertility.

IMPACT

• ***Production.*** Under these technologies cereal yields increase substantially—in Burkina Faso and Niger yields of 400–1,200 kg per hectare are obtained on soils that were so degraded that nothing could be produced—though outcomes vary considerably from year to year and location to location. Returns to labor and land typically rise compared with conventional tillage without fertilizer. The basins have attracted between 20,000 and 80,000 adopters in each location, while the more recently introduced improved fallows have attracted 5,000 to 20,000 adopters in each country. As these ranges indicate, adoption estimates remain subject to a wide margin of error, though most indicators suggest a steady increase in numbers over time.

• ***Equity.*** Both small and larger farmers adopt these technologies. Most adopters are small hand-hoe farmers. The well-off smallholders appear more likely to adopt improved fallows in Zambia, though the poor are using them as much as the wealthy in Kenya. In Burkina Faso, as well, middle-income and rich farmers are most likely zaï adopters because they have sufficient family labor as well as the ability to hire more for this labor-demanding technology, but poor farmers also adopt the technology. Improved fallows appear to be well suited to female-headed households. In Kenya the proportion of female-headed households using improved fallows is higher than that of male-headed households. In Zambia males use them slightly more than females.

• ***Sustainability.*** Ecologically, these technologies aim for sustainable intensification of smallholder production. Financially, they appear attractive because of low cash input costs and generally higher returns to land and labor.

DRIVERS OF CHANGE

• ***Changing incentives.*** Both technologies emerged in response to rapidly changing farmer incentives. Recurrent droughts, during the 1970s in the Sahel and during the 1990s in Southern Africa, have driven interest in water harvesting in both places. Declining fertilizer subsidies and reduced fertilizer availability, which accompanied structural adjustment during the 1990s, substantially diminished farmers' access to fertilizer in Burkina Faso and Zambia and triggered a serious search for alternative methods of soil fertility management.

• ***New technologies for soil fertility management.*** Farmer innovation resulted in the development of the planting basin technologies. A handful of smallholders in Burkina Faso is credited with developing and expanding use of zaï in the Sahel. Similarly, commercial farmers from the Zambia National Farmers Union (ZNFU) launched research and extension of conservation farming technologies for all sizes of farmers. With improved fallows, formal researchers launched the initial innovation but worked closely with farmers who later made significant modifications to the technologies.

• ***Extension.*** In Burkina Faso individual farmer-innovators launched private extension services themselves by creating farmer groups or organizing an annual fair to exchange experiences. At the same time, soil and water conservation projects organized many study visits for farmers to the Yatenga region in Burkina Faso, where the zaï are most widely applied. A project-supported study visit in 1989 by farmers from Niger to Burkina Faso led to widespread adoption of the technology in parts of Niger's Tahoua Department. A slightly different sequence emerged in Zambia when the ZNFU launched its Conservation Farming Unit. The unit received early extension support from a private sector cotton company, from selected NGOs, and beginning in 1998, from government extension officers. With the improved fallows, initial extension support came from a variety of NGOs and subsequently from government extension staff.

KEY LESSONS FOR BUILDING FUTURE SUCCESSES

• ***New technologies are available for managing soil fertility in Africa.*** A wide variety of experimentation is currently underway to develop and extend technologies appropriate for Africa's changing economic and ecological environment. Widely scattered, many of these efforts are small in scale. The four case studies summarized here are among the few that have attempted to carefully measure the increased inputs—of organic matter and labor—required to achieve increases in yield. Given peak season labor constraints in many smallholder agricultural systems in Africa, additional assessments are required to identify the most promising of these often labor-demanding technologies.

• ***Strong extension support, formal and informal, is necessary.*** These technologies all involve substantial departures from conventional land management. They demand changes in the timing of key activities and in the flow of inputs and output. The practices do not diffuse from area to area on their own, as new crop varieties often do. Careful extension is therefore necessary to promote widespread adoption. Clustering seems to work well in some cases, as it did with cotton farmers in Zambia and with improved fallows in both study locations. Where extension support has been weak, as with the animal draft variant of conservation farming, adoption and on-farm effectiveness have been low. Farmer study and exchange visits have also played a key role in the rapid spread of these labor-intensive technologies.

• ***Farmer involvement is necessary in technology development.*** Many of the innovations underway have been developed by farmers themselves. Those developed by the formal research system repeatedly emphasize the importance of close researcher interaction with farmers in the design and testing of new land and water management practices. Because of variable soils and farmer conditions and preferences, a range of technologies and alternatives remains necessary in most locations. The widespread experimentation currently underway suggests active interest in developing such alternatives. ■

For further reading see S. Haggblade and G. Tembo, "Conservation Farming in Zambia," Environment and Production Technology Division Working Paper No. 108 (Washington, DC: International Food Policy Research Institute, 2003); D. Kaboré and C. Reij, "The Emergence and Spreading of an Improved Soil and Water Conservation Practice in Burkina Faso," Environment and Production Technology Division Working Paper No. 116 (Washington, DC: International Food Policy Research Institute, 2003); F. Kwesiga, S. Franzel, P. Mafongoya, O. Ajayi, D. Phiri, R. Katanga, E. Kuntashula, F. Place, and T. Chirwa, "Improved Fallows in Eastern Zambia: History, Farmer Practice, and Impacts," Background Paper No. 12 for the conference on "Successes in African Agriculture: Building for the Future," Pretoria, South Africa, December 1–3, 2003; F. Place, S. Franzel, Q. Noordin, and B. Jama, "Improved Fallows in Kenya: History, Farmer Practice, and Impacts," Environment and Production Technology Division Working Paper No. 115 (Washington, DC: International Food Policy Research Institute, 2003).

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