Farm-scale Management Practices to Improve Productivity and Resilience

Meeting the dual challenges of achieving food security and responding to climate variability and change will require significant changes in agricultural practice in coming years. Climate-smart agriculture takes an ecosystem approach, working at the landscape level to increase productivity, enhance resilience to changing temperatures and rainfall patterns, and reduce the greenhouse gas emissions that contribute to climate change.

A number of factors threaten agricultural productivity of African farmers. Many of Africa's soils are highly weathered and low in nutrients and soil carbon. As a result, they have limited capacity to retain the nutrients and soil moisture necessary for high yields. Climate variability and change pose additional challenges for producers. Some farmers are experiencing more frequent and intense storms that cause erosion, rainwater runoff, and crop damage, while others experience more frequent droughts. At the same time, rainfall patterns are becoming more variable with delayed onset and length of the rainy season and, in some cases, drought. These unpredictable patterns make it difficult for farmers to plan and manage their crops. Fortunately, there is a range of management practices and technologies that can be applied on-farm to increase agricultural resilience to climate stress.

Key issues

In sub-Saharan Africa, 250 million people went hungry in 2010. Hunger is particularly prevalent in arid and semiarid lands, where soil quality has been decreasing for years. Poor crop performance and high risk of crop failure in these systems, combined with low levels of rural development, have discouraged farmers from investing in soil fertility improvements. From 1945 to 1990, soil nutrient removal (without replenishment with fertilizer or manure) and other forms of soil degradation reduced agricultural productivity in Africa by an estimated 25% (UNEP, 1990).

Some of the causes of soil fertility depletion in Africa include limited adoption of fertilizer replenishment strategies and soil and water conservation measures; decline in the use and length of fallow periods; expansion of agricultural production into marginal and fragile areas; and the removal of vegetation through overgrazing, logging, development, and domestic use. An overall decline in farm input investment, including fertilizers, seeds, and technology adoption exacerbates soil degradation. Trade policies that increase fertilizer prices relative to commodity prices and inefficient input markets that fail to provide timely delivery of high–quality fertilizer prove to be disincentives for fertilizer use. There is growing evidence that, where soil carbon content is low, the yield response from fertilizer application is not profitable for the farmer (Marenya and Barrett, 2009).

Water management is another key constraint to agricultural productivity. Ninety-five percent of the food in sub-Saharan Africa is grown under rainfed agriculture (Rockstrom and Falkenmark, 2000), which is highly vulnerable to adverse weather conditions. The largest threat to rainfed agriculture is not overall water scarcity but extreme rainfall variability. This leads to more intensive rainfall events provoking runoff and erosion, while reducing infiltration rates. Variability can also cause longer intervals between rains, drying the root zone at critical points in the growing season, as well as more frequent and severe droughts resulting in crop failure. In the dry areas, water, not land, is the limiting factor in improving agricultural production. Maximizing water productivity, and not yield per unit of land, is therefore a better strategy for on-farm water management under such conditions. When water is scarce, higher farm income may be obtained by maximizing water productivity than by maximizing land productivity.

Other challenges to achieving food security include rapid population growth, limited access to agriculture-related technical assistance, and lack of knowledge about profitable soil fertility management practices leading to expansion into less favorable land.

Sustainable practices

A range of well-established restoration and management options can improve human livelihoods, repair ecosystems, and increase the resilience of both people and landscapes to climate change. The FAO (2010) highlights key components of climate-smart production systems that are relevant to farm-scale management, including

- *Soil and nutrient management.* Enhancing the availability of soil nutrients can be achieved by increasing soil organic matter (conservation agriculture, reduced tillage, continuous soil cover, composting); improved application of fertilizers (micro-dosing, controlled–release or deep–placement fertilizer technologies); and increasing fertility by integrating legumes into farming systems (grain-legume crop rotation, cover crops, relay crops, integration of leguminous trees on-farm). Improved land preparation practices that minimize soil disturbance and ensure that fields are ready to plant at the start of the rains can also significantly increase productivity. On-time planting allows crops to benefit from a nitrogen flush with the first rains. In Zambia, total maize production is reduced by 1.5% for each day planting is delayed (Garrity, 2009).

- *Water harvesting and use*. Capturing rainwater where it falls (ridge tillage, planting pits/zai holes and catchment ponds), retention of soil moisture (mulching, permanent soil cover) and increasing water productivity through irrigation and counter-season production can enhance overall yield. High runoff and low infiltration rates mean that only 15-30% of rainfall is available for crop production. However, water–harvesting technologies can reverse this trend. In Mali, adoption of improved ridge tillage increased water infiltration rates, allowing the soil profile to hold 17% more water while increasing soil carbon by an average of 8% per year. The result was a 30–50% increase in yield (Kablan *et al.*, 2008).

- *Integrated pest and disease management.* National-level monitoring and tracking the shifting distribution and strains of diseases and pests due to changing climate regimes should be linked to on-farm practices such as integrated pest management and adopting resistant varieties to limit crop damage.

- *Resilient ecosystems*. Improving ecosystem management and sustaining biodiversity support pest management, micro-climate regulation, pollination, and nutrient cycling. While achieving ecosystem resilience requires action at the landscape scale, farm management practices that reduce erosion and rainwater runoff; increase on-farm habitat for beneficial insects, pollinators and wildlife; sequester carbon; and reduce conversion of natural habitat to agriculture support ecosystem resilience across the landscape.
- *Genetic resources*. Developing improved varieties and preserving genetic resources of crops and their wild relatives are critical at the national level to ensure that appropriate climate–resilient varieties are developed and accessible to producers.
- *Harvesting, processing, and supply chains*. Efficient harvesting and early transformation of agricultural produce can reduce postharvest losses and preserve quantity, quality, and nutritional value of food products. Farm-scale interventions, including enhancing the ability to meet market grades and standards and improving harvesting, storage, and primary processing, can ensure profitability while reducing postharvest loss.
- *Diversification can increase the efficiency of farming systems and build their resilience to climate change*. It can spread risk, increasing economic resilience at the farm and at the local levels. Diversified rotations, including crop varieties and species with different thermal/ temperature requirements, better water use efficiency, resistance to pest/disease, and lower yield variability are effective ways to reduce risks and increase efficiency.

Farming systems consistent with climate-smart agriculture

A number of farming systems/approaches compatible with climate-smart agriculture are being adopted at a significant scale in Africa. These include the following:

Conservation agriculture (CA)

This is defined as having three key components: (1) minimal soil disturbance (no-till/low-till), permanent soil cover (mulch or cover crops), and crop rotation (Hobbs, 2007). According to the FAO, CA aims to conserve, improve, and make more efficient use of natural resources through integrated management of available soil, water, and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production.

Evergreen agriculture (EA)

This is the integration of particular tree species into annual food crop systems (Garrity *et al.*, 2010). The World Agroforestry Center introduced the concept of EA by highlighting experiences with farmer-managed natural regeneration of trees in the Sahelian Parklands and integrating agroforestry species into CA in Zambia and Malawi. Research indicates that the potential for significant productivity increases when trees are integrated into cropland.

Sustainable agricultural intensification

The process entails increasing agricultural production from the same area of land while reducing negative environmental impacts and increasing contributions to natural capital and the flow of environmental services.

Ecoagriculture

This is a landscape approach that supports rural communities to achieve three core goals: enhance rural livelihood, conserve or enhance biodiversity and ecosystem services, and develop more sustainable and productive agricultural systems. It recognizes farmers and communities as key stewards of ecosystems and biodiversity and the need for collective management of the landscape by a range of stakeholders (EcoAgriculture Partners, 2011).

Considerations for program design

The design of climate-smart agriculture programs should pay close attention to the obstacles identified by FAO and other organizations and scientists working on climate–resilient agriculture programs.

Key design issues include:

- Adopting an ecosystem approach with cross-sectoral coordination and collaboration at the landscape scale is essential to adapt to climate stresses.
- A range of effective climate-smart practices already exists and could be introduced and scaled in developing country contexts.
- Institutional, technical, and financial support may be required to support smallholder transition to climate-smart agriculture.
- Data, knowledge, and technology gaps exist and should be addressed to support improved technologies, methodologies, and climate resilient varieties.
- Harmonization of climate change, agricultural, and food security policies is required at the national, regional, and international levels.

Source

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