Sustainable Agriculture, Food Security and Health**

Larry W. Harrington, Ph.D.
Adjunct Professor, Soil and Crop Science Section, College of Agriculture and Life Sciences, Cornell University, Ithaca, New York, U.S.

Summary
Agricultural practices in developing countries affect — and are affected by — health, disease, food security, and poverty. Food-secure families are physically more able to engage in productivity-enhancing agricultural practices. However, productivity growth alone is not enough to ensure food security. Equally important are equity, sustainability, and resilience. Higher productivity helps reduce food prices, making food more affordable for the poor. Opportunities for improving farm systems include climate-smart agriculture, conservation agriculture, harnessing market chains for high-value production, improved water availability and access, improved common property management, and gender-sensitive intensification strategies. Improved agriculture needs to be achieved in the context of unfolding external drivers, among them climate change, population growth, economic growth, and expanding market opportunities. Improving the productivity, profitability, sustainability and resilience of agricultural systems in developing countries depends on a favorable policy and institutional environment.

Current realities
There are relationships among agricultural practices, agricultural productivity, and factors such as health, disease, food security, and poverty. Food-secure and well-nourished farm families have a greater ability to engage in more rigorous agricultural practices that raise productivity. Higher productivity in turn fosters improved food security. Poor families, however, are less likely to be food secure. They often lack the land and water needed for farm intensification, and the cash to purchase food when home stocks run low. Higher productivity helps reduce food prices, making food more affordable for the poor.

Agricultural productivity is a measure of output per unit of input, but productivity growth alone is not enough to ensure food security. Equity (i.e., access by the poor to food and to production resources); sustainability (i.e., agriculture that meets the needs of the present without compromising the needs of future generations), and resilience (i.e., the ability of agricultural systems to recover from a shock or disturbance by reshaping themselves to maintain functions) are equally important. Agricultural productivity has grown rapidly in some developing countries but has lagged in the poorest ones, largely in sub-Saharan Africa. Productivity improvements have come from intensification (i.e., higher yields, more crops per year) and diversification (i.e., greater diversity of crops and livestock). Some past intensification techniques are now considered unsustainable (e.g., aquifer-depleting groundwater irrigation in cereal systems in northern India.) Moreover, these techniques sometimes have led to reduced ecosystem diversity. Intensification is often hindered by lack of access to water, and by common property management practices (e.g., uncontrolled cattle grazing, residue burning) that discourage investment in resource conserving practices.

Developing productive, sustainable, and resilient agriculture needs to be achieved in the context of unfolding external drivers, among them climate change, population growth, economic growth, and expanding market opportunities. Population growth remains high in the poorest countries. These countries also have stagnating cereal yields and declining per capita cropland area. Access to domestic and international markets is improving, however, offering new opportunities. The effects of climate change vary across regions. Farmers in developing countries can expect an increased incidence in extreme weather events (e.g., droughts, flooding) and higher temperatures, leading to higher evapotranspiration and less rainwater available for cropping. Climate change disproportionally impacts vulnerable smallholders.

Scientific opportunities and challenges

It is common to hear of the importance of "doing something" to improve the productivity, sustainability, and resilience of agricultural systems in developing countries. This is easier said than done. Achieving impacts often requires technical change, policy reform, and institutional innovation, where natural resource management is as important as agricultural technology, and where multiple stakeholders need to participate in the innovation process. Agricultural innovations are only attractive to farmers when they provide direct near-term economic benefits.

There are numerous opportunities for improving the productivity, profitability, sustainability, and resilience of farm systems in developing countries. Most of these have to do with sustainable intensification and diversification. One opportunity lies in the development of climate-smart agriculture. This involves breeding crop varieties that better tolerate heat and drought. There are many scientific challenges in achieving this, but scientists in international agricultural research centers such as the International Maize and Wheat Improvement Center (CIMMYT) or the International Rice Research Institute (IRRI) have made considerable progress. Farmer assessment can be used to ensure that stress-tolerant varieties maintain other characteristics that farmers find valuable (e.g., grain quality). Climate-smart agriculture also needs innovation in water management practices (e.g., rainwater harvesting, flexible irrigation, and water control to accommodate "on-demand" dry-season cropping).

Conservation agriculture — crop residue retention, no soil disturbance, and suitable rotations — provides a uniquely powerful approach to raising productivity while improving sustainability and resilience, largely from improved soil-water conservation, better soil health, and reduced land degradation. Successful introduction of conservation agriculture requires private sector involvement in farm equipment development and farmer involvement in local adaptation. It frequently requires modification of common property management practices.

Central to sustainable intensification is production of high-value crops and livestock for local markets, especially during the dry season. Intensification can benefit from innovations in marketing systems such as livestock auctions or the use of information technology for the dissemination of market information. In addition, sustainable intensification usually depends on improved access to water. This can be through rainwater harvesting, tapping groundwater, building small reservoirs, or through improvements in water control in existing canal systems to allow for flexible and reliable "on-demand" irrigation and drainage. A major role for research is to ascertain the profitability and sustainability of water management practices. Equity issues also need to be considered as changes in water management may benefit one social group at the expense of others.

It is surprising how frequently success in sustainable intensification depends on improving common property management. Because conservation agriculture requires permanent soil cover, it cannot be implemented when there is no control of livestock grazing or residue burning. The use of groundwater for dry-season irrigation also means tapping a common resource. Sometimes improved common property management depends on clarification of which institutions have the authority and responsibility for setting management rules.

A major challenge in developing productive, sustainable, and resilient farm systems has to do with the role of women in farm households. Sustainable intensification from high value crops or livestock often depends on women's labor. To be feasible, intensification strategies cannot place excessive demands on their time. Because intensification strategies are most effective in improving family nutrition when women retain a share of the income, strategies should focus on crops or livestock activities where women are able to keep some of the earnings.

Policy issues

Successful strategies for improving the productivity, sustainability, and resilience of agricultural systems in developing countries depend on a favorable policy and institutional environment, including policies that on the surface may seem unrelated to agriculture. There is a range of institutions that are in a position to design and implement appropriate policies.

- Promote climate-smart agriculture, including support for research on stress-tolerant crop varieties and for improvements in formal and informal seed systems. Participants include the international centers of the Consultative Group for International Agricultural Research (CGIAR) system, national agricultural research and extension programs, local NGOs, and public and private seed suppliers.
- Establish policies that favor the development and adoption of conservation agriculture (CA): (a) encourage private sector participation in CA equipment development, (b) foster the creation of private sector service providers for CA, (c) eliminate import tariffs on CA equipment, (d) develop farmer-to-farmer extension programs, (e) reform common property management to control livestock grazing and residue burning, and (f) eliminate subsidies on diesel fuel (these make conventional plowing artificially cheap). Many of these policy changes are in the hands of national and local governments, but there are regional CA networks that can also inform policy change.
- Invest in appropriate water infrastructure for sustainable water availability, including (a) farm- or landscape-level investments in rainwater harvesting, (b) streamlined approval of irrigation wells in "safe" blocks with no risk of groundwater depletion, and (c) adjustments in rural infrastructure to improve precision of farm-level irrigation control. Participants include national, provincial and local governments, and development assistance agencies working in irrigation system rehabilitation (e.g., the Netherlands), and water and sanitation (e.g., Gates Foundation).
- Reform current policies governing groundwater extraction where groundwater is being depleted, making agriculture unsustainable. Opportunities include licensing of tubewells, volumetric pricing, or rationing electricity supplies used in pumping water for agriculture.
- Invest in market and transport infrastructure to improve smallholder access to markets, including livestock auctions (e.g., Zimbabwe) and information technology approaches to the dissemination of market and extension information. Investment is usually in the hands of national governments, supported by donors, NGOs, and private companies.
- Support the role of women in intensification and diversification of agriculture. Specific actions that can be taken include: (a) provide credit for women despite lack of collateral, (b) implement training programs so that family members understand and support women's work in intensification, and (c) prioritize crops or livestock activities in which women retain income (e.g., tomatoes in northern Uganda, goats in Zimbabwe).
- Integrate and coordinate policies relating to agriculture, nutrition, and health

References

Fan, Shenggen; Pandya-Lorch, Rajul; Yosef, Sivan; Fritschel, Heidi and Zseleczky, Laura. 2014. In *Resilience for food and nutrition security*. Eds. Fan, Shenggen; Pandya-Lorch, Rajul and Yosef, Sivan. Chapter 21. Pp. 195-206. Washington, D.C.: International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/128458

Harrington, L., and M. Fisher. 2014. *Water Scarcity, Livelihoods and Food Security: Research and Innovation for Development*: Earthscan.

*** A policy position paper prepared for presentation at the conference on Food Safety, Security, and Defense (FSSD): Food Security and Diet-linked Public Health Challenges, convened by the Institute on Science for Global Policy (ISGP), Sept. 20–23, 2015, at North Dakota State University, Fargo, North Dakota, U.S.*