Currently, one billion people are undernourished, another billion are overweight or obese, and the global food system is the largest emitter of greenhouse gases and the largest user of water and land resources. In developing countries where the bulk of undernutrition occurs, these challenges are especially difficult as forests and woodlands are being cleared for agriculture, and food is produced on degraded soils and landscapes. The stakes for future production, improved livelihoods, and conservation of ecosystems and the services they provide are too high to ignore.

Meeting the Challenge: The Agriculture and Food Security Center

In response to these challenges, in 2013, Columbia University transformed the Tropical Agriculture and Rural Environment Program into a university-wide Agriculture and Food Security Center (AgCenter). Over the past decade, we have been at the forefront of applied research and advocacy for sustainable smallholder farming, with a focus on Africa. One notable accomplishment, working with many African governments, was to enable smallholder farmers to double or triple yields of their basic food crops, contributing toward improved nutrition for children and increased incomes for households.

Our mission is to mobilize science and technology to advance sustainable agricultural intensification on the ground, with a particular emphasis on tropical areas but including developed countries as appropriate to our comparative advantage. While continuing our commitment to Africa, we are making plans and partnerships to work in Asia and Latin America.

The Global Challenge: To feed 9–10 billion people by 2050 in ways congruent with positive social, environmental and economic outcomes
A Unique Approach

Our approach emphasizes field-based systems research that identifies biophysical limitations and constraints to production and focuses on the agronomic tools and practices to overcome them, as well as their effects on livelihoods and the environment. Having a research base of 10 sites in 10 African countries where poverty and hunger are endemic, and which cover a range of agroecological zones and farming systems—from agroforests in tropical forest margins to degraded rangelands in the semi-arid zone—provides us with relevant and representative field conditions for research.

We are also set apart by our interdisciplinary team and partnerships. As part of Columbia University’s Earth Institute, our colleagues in health, nutrition, ecology, engineering, and policy, including post doctoral fellows and students, help us provide innovative multidisciplinary solutions to current problems. Our longstanding close ties with land grant universities and research institutes in the U.S., as well as universities across the world and the international agricultural research centers of the CGIAR, provide continuity and a network for long-term collaboration.

Our collaborative efforts with other units of the Earth Institute and Columbia University and our national and international partners have provided direct and effective links for transforming our results into policy action. We are uniquely poised to lead a larger, more concerted effort to achieve sustainable agricultural intensification to feed the growing world population.

The Three Interlinked Pillars of the Agriculture and Food Security Center

The AgCenter analyzes the tradeoffs and synergies between sustainable agricultural intensification, livelihoods and ecosystem services—searching for alternatives that minimize negative environmental effects while increasing yields and improving livelihoods. Our approach integrates research, education, outreach and global partnerships.

We focus on three pillars, with education and public awareness activities supporting all of our work. While each of the three pillars is important, it is the linkages among them that are essential for finding solutions to feeding our world sustainably.

PILLAR 1: AGRICULTURE

Ensure long-term food production to meet needs for food security in environmentally, economically and socially sustainable ways.

Crop yields have doubled and tripled in parts of Africa through increased applications of fertilizers and improvements in seed germplasm. However, these gains have often been achieved through inefficient and costly fertilizer applications. Increasing crop yields with efficient use of resources requires site-specific recommendations. Yet current recommendations are often based on a regional or national scale, with little relevance to local biophysical or socioeconomic characteristics. Moreover, knowledge and information about African soils is highly fragmented and often out of date, making improvements to the current recommendations difficult. Several on-going projects allow us to advance quickly in refining local and regional agricultural extension recommendations.
PILLAR 2: ENVIRONMENT
Minimize negative impacts of the agricultural intensification on the environment while increasing positive impacts, without compromising food security

Increasing food production can have multiple environmental impacts. It is essential to learn from past experiences and promote farming strategies that minimize adverse environmental impacts but do not compromise food production. Rural livelihoods in the tropics depend on agricultural landscapes and the products and other ecosystem services they deliver. The AgCenter is focused on identifying strategies to manage landscapes for multiple objectives and encouraging the long-term adoption of practices that will not compromise the environment.

PILLAR 3: LIVELIHOODS
Assess and improve food and nutrition security in low-income settings

In the area of food and nutrition security, we focus on understanding and leveraging the potential of agriculture for nutrition security across various agroecological zones. We also conduct research to understand dynamics around income and poverty, such as investigating the relationship between changes in agricultural development and household well-being.

Developing and Applying Innovative Tools

We are also developing tools to both complete our work as well as allow other stakeholders, including scientists, policymakers and practitioners, to address the global challenge of sustainable agricultural intensification. These assessment tools and information services allow context-specific recommendations, adaptive management, and monitoring and evaluation. For example, tools for assessing the nutritional composition and gaps of local crops and consumption patterns will lead to recommendations for additional crops and varieties in promoting food-based approaches for meeting nutritional requirements.

Important agronomic tools include the Africa Soil Information Service, a digital soil map of Africa, which focuses on soil properties relevant to agriculture, climate change and water resources. We are also developing SoilDoc, an innovative lab-in-a-box, and Vital Signs, a project with Conservation International and CSIR South Africa, which is an integrated monitoring system for ecosystem services in agricultural landscapes. AgCenter staff have published two major books and several articles in leading publications such as Science, Nature, The Lancet and Proceedings of the National Academy of Sciences. We are also assembling the results of the last 30 years of tropical soils research in a new book.

VITAL SIGNS

There is an urgent need for better data, analytical methods and risk management approaches to guide sustainable agricultural development and ensure healthy and resilient livelihoods and ecosystems. Vital Signs metrics and indicators will verify that investments to improve food production also support healthy natural systems and robust livelihoods for smallholder farmers.

It fills a critical unmet need for integrative, holistic measurements of agriculture, ecosystem services and human well-being. The system will quantify sustainability and provide tools to evaluate risks and trade-offs by pooling multi-scale data into an open-access online dashboard for policy makers, the private sector and the scientific community.

For more information, see vitalsigns.org

SOILDOC

Soil nutrient replenishment in sub-Saharan Africa is critical for agricultural transformation. However, the actual application of soil science is minimal. SoilDoc is a revolutionary new tool that will enable extension workers to make on-the-spot diagnoses of soil constraints. It uses state-of-the-art battery-powered miniaturized instruments similar to those used in wet-chemistry labs.

Results are sent to a virtual soils laboratory through SMS with an android phone or tablet, allowing targeted recommendations to advise farmers in real-time. In this way, farmers will be advised on the best management of their farm to increase production and apply costly fertilizers only where needed.

SoilDoc, in concert with a newly trained cadre of tech-savvy agricultural extension workers, will provide farmers with the necessary support to carry the African Green Revolution to the next phase.

For more information, see agriculture.columbia.edu/projects/agriculture/soildoc