Chapter 5.8

Putting the Sustainable Development Goals into Practice

Achim Dobermann
Director & Chief Executive, Rothamsted Research,
Harpenden, Hertfordshire, United Kingdom

"When tillage begins, the other arts follow. The farmers, therefore, are the founders of human civilization."

***Daniel Webster** (1782–1852), American senator and statesman.*

Key messages

- The new Sustainable Development Goals (SDGs) and their Targets provide a framework for **all** countries to develop roadmaps for sustainable development in all its dimensions.
- Agriculture contributes to many of the new SDGs and Targets, and therefore needs to receive particular attention.
- SDG 2 on sustainable agriculture is among the most challenging goals to achieve. Transformative changes will be required regarding how food is produced, processed and consumed in order to meet multiple needs.
- Agro-food systems in developed, as well as developing, countries need to be managed with greater precision. Many solutions exist, but new ways of working are necessary in order to achieve faster and greater impact.
- Long-term investment in public R&D is required to ensure that ground-breaking innovations continue to be developed and are widely accessible to all farmers, processors and other businesses.

1. The Sustainable Development Goals: Challenges and opportunities

The advent of agriculture was, in many ways, the advent of civilization as we know it. It was also the beginning of the human manipulation of natural systems on a large scale. It is from this transformation, occurring over thousands of years, that many of our modern challenges originate. What is needed to address these challenges is a dramatic change in the way mankind produces, processes, and consumes food and other agricultural products, but within a significantly shorter time frame than ever before. A new sustainable development agenda is called for that will spur rapid progress in developing as well as developed countries, with an even emphasis on social, economic, and environmental issues. We look for an agenda that is transformative and will encourage new ways of thinking and models of development, rather than business as usual. It must be ambitious, and it must inspire people of all ages and at all levels to act.

The 17 Sustainable Development Goals (SDGs) that were endorsed at a historic summit of world leaders in September 2015 provide the overall new framework for all countries to develop roadmaps towards sustainable development in **all** its dimensions.[1] They push the envelope by bringing together a great diversity of interconnected development issues. The SDGs are the most inclusive agenda the UN has delivered to date, with millions of people submitting input from around the globe and the Targets and Indicators applying in their entirety to all countries.

The new SDG 2 (Zero Hunger) on achieving food and nutrition security through sustainable agriculture is the most complex of all of the SDGs. Sustainable agriculture means at least six very different things:

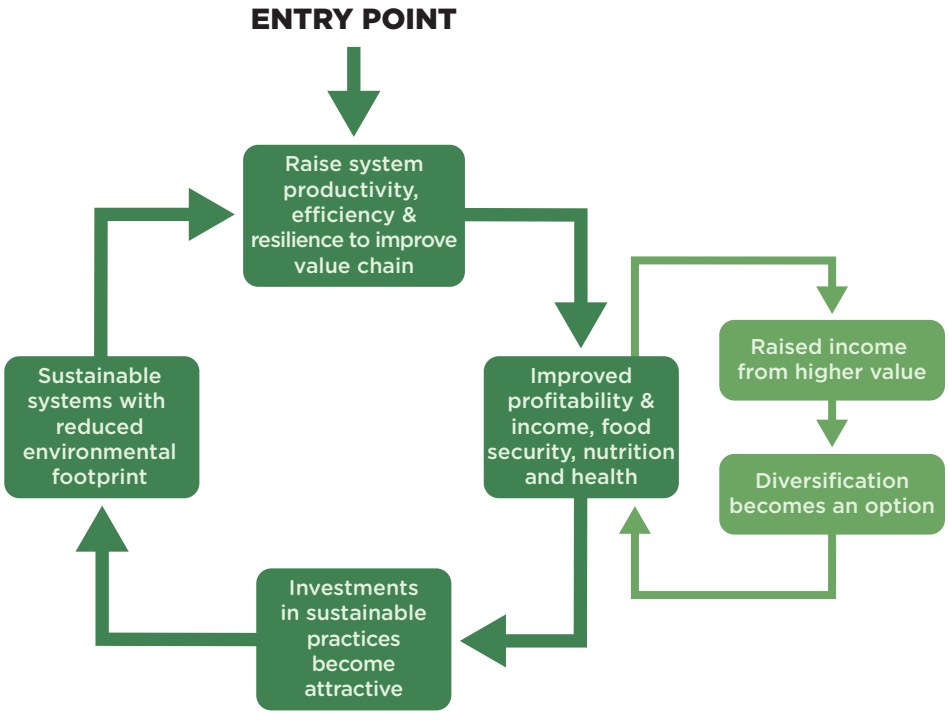
- Agriculture that offers a viable income and livelihood for farmers and business along the whole value chain in any country.
- Agriculture that provides nutritious foods for the entire world population, including the right mix of grains, legumes, vegetables, fruits, nuts, livestock and fish products to ensure adequate supply of energy, protein (with essential amino acids), micronutrients, omega-3 fatty acids, etc.
- Agriculture that will be resilient to future climate change.
- Agriculture that comprehensively reduces greenhouse gas emissions from energy use, deforestation, methane and nitrous oxide.
- Agriculture that reduces other environmental depredations (loss of biodiversity, invasive species, freshwater depletion, soil degradation, destruction of habitat, chemical pollutants from pesticides and herbicides, etc.)
- Agriculture that sustains local cultures, cuisines, etc.

Aquaculture is an integral component of farming systems in Bangladesh, generating extra income and contributing to better nutrition. Source: Achim Dobermann

Agriculture is the central contributor to food security, food quality and dietary diversity, and also to many improvements in nutrition. Investments made in agriculture, along with other sectors in rural societies, can be a key growth engine. Such investments are therefore also central to sustainable development, particularly in low-income settings. Although not always the case, economic growth within poor communities can have beneficial direct and indirect impacts on food and nutrition security through various pathways. Some observers therefore argue that agricultural growth is a precondition for broader growth. Recent evidence has also shown more clearly that household agricultural production has direct and important linkages with dietary patterns and nutrition, and that these are difficult to achieve and sustain through many alternative interventions.

In the coming decades, we need to see a truly transformative change, a Sustainable Agricultural Intensification (SAI). In essence, SAI means producing more food and other agricultural products on the same amount of land, while also using natural resources efficiently and preventing their degradation. As the world population grows, we will need to produce a greater volume of food, as well as more nutritious food, and we will also need to explore new opportunities for how agriculture can help grow the bio-economy as a whole. We also need to limit the expansion of agriculture into forests, wetlands, and grasslands, and to halt the loss of farmland to urbanization. We cannot continue current practices of over-using inputs such as water and pesticides, and must reverse soil degradation and make agriculture more resilient to climate shocks. We need to ensure that future generations of farmers will be able to carry out their fundamental role of feeding humanity, while also supporting their own families and communities. For this, all farmers need to be enabled to be part of a virtuous circle of highly productive agriculture (**Figure 1**).

Figure 1 | **Enhancing food system productivity and value is the entry point for enabling farmers to take their place within a virtuous circle of sustainable agricultural production and livelihood**

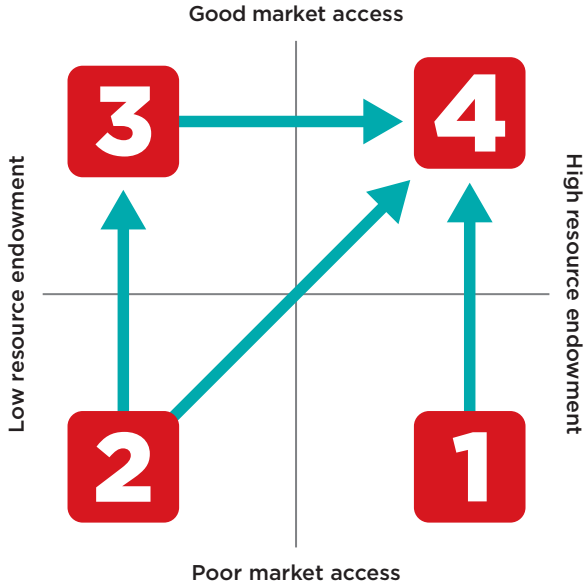


Source: Dobermann A, Nelson R, Beever D et al. 2013. Solutions for sustainableagriculture and food systems. Technical report for the post-2015 development agenda.Sustainable Development Solutions Network (SDSN), New York. http://unsdsn.org/resources/

2. Solutions available for action

Achieving such a transformation of agriculture and food systems on a global, regional and national scale is a massive challenge because of the huge diversity of agriculture. It will require a menu of solutions, as well as good choices that are tailored to the specific environmental and socioeconomic conditions. Farming systems are complex and highly heterogeneous at all scales, from regional and national to village or farm. So too are farming objectives, solutions and tradeoffs. Strategies for Sustainable Agricultural Intensification must provide viable options for farms that can produce substantial surpluses as well as for small farms that support the livelihood of millions of rural people. The specific policies and technology solutions for implementing SAI depend on the socioeconomic and biophysical contexts under which farmers operate, with resource endowment and market access being two main drivers across different scales in any country (**Figure 2**).

Figure 2 | **Resource endowment and access to markets are key determinants for tailoring different solutions to the local context in order to overcome current constraints and establish better business models for agriculture.**



Source: Dobermann A, Nelson R, Beever D et al. 2013. Solutions forsustainable agriculture and food systems. Technical report for thepost-2015 development agenda. Sustainable Development Solutions Network(SDSN), New York. http://unsdsn.org/resources/

The real new challenge is to move to better business models by choice. At the core of devising solutions for this lies a thorough understanding of the socioeconomic and biophysical factors that drive the needs of farmers, agribusinesses, small entrepreneurs, consumers, and many other actors. Solutions need to be flexible in terms of offering a suite of technologies and support systems provided by different sectors in a complementary mode, with a particular emphasis on business-driven models.

All farmers need help in obtaining good access to inputs, markets, information and other supporting services. Strategies that provide the necessary support base, as well as timely market information, will lower the barriers for participating in domestic and export markets.

Governments, civil society, the private sector and international agencies must work together with local extension services and farmers to support the tailoring of SAI solutions to the needs of farmers by:

- Understanding the context in which an effort or an intervention will be implemented, and also understanding its links to the best available scientific and local knowledge
- Identifying the right economic, social and ecological principles of relevance to farmers' needs
- Empowering local communities to improve the performance of the farming system or value chain based on scientific principles as well as local preferences
- Expanding the scope of the effort or intervention and creating the necessary value chains, services, support systems and self-sustained business models
- Monitoring and documenting the performance, as well as lessons learned, in order to enrich the local, national and global knowledge base and thus support further implementation.

Field scanalyzer at Rothamsted Research – the world's first fully automated field facility for measuring crop growth and health.
Source: Achim Dobermann

3. Solutions for early action

Practical solutions for transforming world agriculture need to address innovation, markets, people, and political leadership, and they also need to enable concrete action for change. Sharp focus must remain on solutions for reducing poverty and improving the livelihoods of rural households and communities, including more resilient crop and livestock systems that can stand extreme heat, drought, floods and other climatic extremes. Small farmers, service providers, processors, marketers and other local entrepreneurs must be central to any investment and policy strategy that enables the development and widespread adoption of new solutions.[3,4]

An important way to solve problems is through practical initiatives involving new technologies, business models, institutional mechanisms and/or policies that are promising, can take place in any country, and can also generate learning elsewhere. They need to address various components of Sustainable Agriculture Intensification and its enabling systems, but many are connected and must be integral parts of a systematic approach to SAI, from creating sustained change, to food production and consumption (Box 1).

Box 1 | **Ten key actions for improving nutrient use efficiency in food systems.**

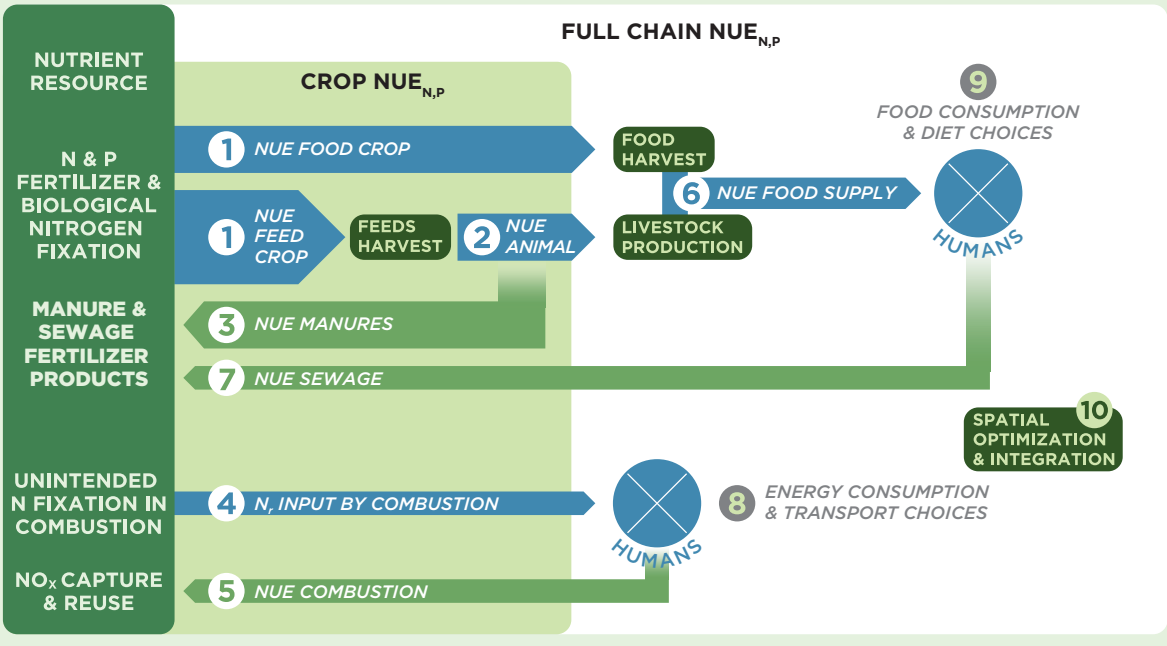
Improving the full-chain Nutrient Use Efficiency (NUE) of nitrogen and phosphorus, defined as the ratio of nutrients in final products to new nutrient inputs, is a central element in meeting the challenge to produce more food and energy with less pollution and better use of available nutrient resources.

Nutrient flow is a cycle from resources through stages of use (blue arrows) and recycling (green arrows). The system is driven by the 'motors' of human consumption (red), which are thus also a key part of the solutions needed for achieving future nutrient targets.

The poorest need to be allowed to increase their food and other nutrient consumption, while the richest must realize that it is not in their own interest to over-consume. There are significant differences in the cycles of nitrogen, phosphorus or other nutrients and in the current status of nutrient use among and within countries that need to be taken into account for determining specific targets and interventions. Hence, the targets for nutrient use and NUE will vary among countries, and so will the pathways for achieving them by addressing any of the specific components of the full-chain NUE relative to their current state.

Possible actions include (numbers in the graph): 1 Improve NUE in crop production; 2 Improve NUE in animal production; 3 Increase the fertilizer equivalence value of animal manure; 4 Low-emission combustion and energy-efficient systems; 5 Develop NOx capture and utilization technology; 6 Improve efficiency in fertilizer and food supply and reduce food waste; 7 Recycle N and P from waste water systems; 8 Energy and transport saving; 9 Lower personal consumption of animal protein and 10 Spatial and temporal optimization of nutrient flows.

Of the 10 solutions proposed, the first three are directly related to agricultural systems management. Specific targets and indicators can be defined for each of these steps.



Source: Sutton, M.A. et al. Our nutrient world: the challenge to produce more food and energy with less pollution. (Center for Ecology and Hydrology, Global Partnership on Nutrient Management, INI, Edinburgh, 2012).

Below we provide a few illustrative examples of solutions for early action, i.e., interventions that could be of high priority for many countries in the coming five to 15 years. The examples shown would all make major contributions to SDG 2, but also to various other SDGs. They are a basket of options for countries to consider and adapt to their specific needs. Many more exist and should be pursued.

3(a) New, more productive crop varieties

Crop yield growth rates in many farms remain too low, and farmers often experience periods of food or income insecurity due to yield losses caused by abiotic and biotic stresses. Every farmer should have access to affordable, quality seed from a wide range of well-adapted crop varieties or hybrids via government, private-sector and community seed systems. Enhanced breeding methods such as marker-assisted precision breeding or genetic engineering through genome editing can be deployed to speed up the rate of genetic gain, shorten the time it takes to develop new varieties, and breed new varieties more precisely for specific environments and market segments, thus better meeting farmers' needs.[5,6]

3(b) More nutritious food crops

A few staple food crops dominate the food supply of two billion people suffering from hidden hunger caused by deficiencies in iron, zinc, vitamin A and other micronutrients. Achieving better nutritional balance involves a wide range of measures, diversification of agricultural systems (crops, livestock and fish products), external mineral and vitamin supply, optimal feeding and caring practices, the breeding of more nutritious crops, agronomic biofortification, and other measures.[7] The promotion of home gardens or livestock and fish are limited in their ability to reach all of the poor; many poor people do not even have the land or other resources to grow their own more nutritious food. While the health benefits of a balanced diet are clear, biofortification is another effective strategy for overcoming specific nutritional deficiencies within rural populations in developing countries. Advances in crop genetics will also enable the growing of crops with health benefits for consumers in higher-income segments. This will help address problems such as the spread of type 2 diabetes, overweight and obesity through interventions such as the development of grains high in resistant starch or soluble fiber.

New super rice cultivars have been bred in China to accelerate yield growth.
Source: Achim Dobermann

3(c) New models for agricultural extension

Many unexploited gaps in income, productivity and resource efficiency can be closed by accelerating the transfer of new knowledge and technologies, enhancing farmers' access to markets and information, facilitating better interaction among farmers and knowledge providers, and assisting farmers and small businesses in developing their own technical, organizational and management skills and practices. This is the essence of good agricultural extension, and it has been the driving force for productivity enhancements in the most successful countries.[8]

3(d) Nutrient management and stewardship – from science to local solutions

Improving nutrient management is a central element in meeting the challenge to increase food production, increase farm incomes, improve soil quality, reduce nutrient losses to the environment, and protect natural ecosystems. Both governments and businesses play an important role in this process. Science-based principles for the integrated, site-specific use of fertilizers, organic materials and other nutrient sources have been developed through research. The site-specific nutrient management of crops such as rice, wheat and maize has demonstrated significant benefits in terms of yield, farm profit, increased nitrogen use efficiency, and better nutrient balances.[9] Countries, businesses and international donors should invest in initiatives that seek to systematically improve nutrient management for increased crop production, sustainability and associated benefits.

3(e) Micro-irrigation for smallholder farmers

Many smallholder farms in Sub-Saharan Africa, Asia, and other regions are trapped in poverty, and experience periods of food insecurity due to low cropping intensity and productivity caused by water stress. Irrigation is a key entry point for doubling or tripling crop yields and enabling diversification of cropping systems. Large-scale irrigation systems are capital-intensive and are restricted to lowland areas with suitable conditions. Solar-powered drip or other micro-irrigation technologies, on the other hand, can be customized to meet the needs of small farmers operating in diverse environments with limited capital. Micro-irrigation systems precisely deliver water, nutrients and other inputs directly to the root zone, resulting in high yields and high efficiency of these inputs. Equipped with additional filters, these systems can also supply clean drinking water. Smart-metered, local solar and wind power utility models can provide the electricity needed for irrigation pumps, as well as local households, schools, and small village enterprises, including processing or storing of food.

3(f) New livestock vaccines

Medical and veterinary vaccines inventions are among the most cost-effective disease control interventions ever deployed. They have enabled the global eradication of two lethal diseases: smallpox in humans (1979) and rinderpest in cattle and wild ungulates (2011). Vaccines against livestock diseases have the power to reduce livestock mortality, sustainably increase productivity, increase food and nutritional security, enhance the livelihoods of the poor, and help developing economies to grow. Extensive quarantine, diagnosis and slaughter of livestock are not sustainable disease control options in developing countries. Diseases of tropical origin are now threatening developed countries. Despite the importance of vaccines, many of the diseases that affect livestock in developing countries are neglected. In countries with a highly industrialized livestock production system, the management of animal health through a variety of interventions is required, thus reducing the dependence on antibiotics and the concomitant build-up of antimicrobial resistance.

3(g) Sustainable grazing – livestock systems

The increasing consumption of animal protein is generally considered at odds with the Earth's ability to feed its people. The 1 billion tonnes of wheat, barley, oats, rye, maize (corn), sorghum and millet poured annually into livestock troughs could feed some 3.5 billion humans. But such reasoning discounts the health benefits of eating modest amounts of animal-source foods and the fact that foraging animals can consume foods that humans cannot eat. A key solution lies in more productive, more sustainable livestock-grazing systems, which can be achieved through (i) improving pastures and feeding animals less human food, (ii) raising regionally appropriate animals, (iii) keeping animals healthy, (iv) adopting smart supplements, (v) eating quality not quantity, (vi) tailoring practices to local culture, (vii) tracking costs and benefits, and (vii) studying and exchanging best practice.[10]

Sustainable development of livestock systems is a key component for food security in South Asia and elsewhere.
Source: Achim Dobermann

Case Study

"Clean Cow" technology

Cows digest their food in four-part stomachs, including a "rumen," which is a site that allows for fermentation – a process that gives off a lot of carbon dioxide and methane gas, since microorganisms assist the process of digestion. Approximately 132 to 264 gallons of ruminal gas are belched daily by every cow on the planet, according to the Penn State College of Agricultural Sciences. Overall, the livestock supply chain emits 44% of the globe's human-induced methane, according to the UN's Food and Agriculture Organization – and a large slice of that comes from methane burps emanating from cattle.

One fundamental way of fixing the problem involves trying to change the chemistry of what's happening in cows' rumens. For some time now, the Dutch Life Sciences and Material Sciences company DSM has been pursuing such a solution, which it appropriately calls its "Clean Cow" project. The company has created a powder that can be added to cow feed that, it says, can produce "a reduction of over 30% in methane emissions with no negative impact on animal welfare, performance, or the amount of feed the animals consume."

DSM worked with a top dairy sciences researcher who focuses on methane emissions, Alexander Hristov of Penn State University, in order to study the clean cow. Hristov and colleagues, including several researchers from DSM, designed and carried out a trial in which 48 cows, receiving varying amounts of the inhibitor in their feed, were observed over 12 weeks. Their methane emissions were measured when they put their heads into feeding chambers which also had atmospheric measurement sensors, and also through nostril tubes attached to canisters on the backs of the cows.

The result was that the inhibitor "decreased methane emissions from high-producing dairy cows by 30%," the research found. The substance "blocks one of the steps of the enzymatic process that produces methane from carbon dioxide and hydrogen," explains Hristov. And he notes that in that process, energy is actually being lost in the form of methane. So with less methane generated, Hristov says, the cow has more energy that can instead be converted to growth and milk production.

Adapted from: *Mooney C. Meet the "clean cow" technology that could help fight climate change. Washington Post, July 31, 2015.*

3(h) Climate-smart agriculture

Climate-smart agriculture is not a single, specific agricultural technology or practice that can be universally applied. It is an approach that requires site-specific assessments in order to identify suitable agricultural technologies and practices that aim to increase productivity in an environmentally and socially sustainable way, strengthen farmers' resilience to climate change, and reduce agriculture's contribution to climate change by reducing GHG emissions and sequestering more carbon.[11] Typical climate-smart agriculture investment areas include:

- implementation of sustainable land management practices;
- climate risk management; and
- transformation of whole production systems.

3(i) Smart crop protection

As cropping systems intensify, the potential for losses due to insects, diseases and weeds will grow if it is not actively managed. Moreover, levels of resistance to currently available chemicals for insect, disease or weed control have been increasing dramatically in recent years, making it more and more difficult to achieve cost-effective control. This problem may be further exacerbated by climate change and increased climate variability, which could favor the rapid buildup of pest and disease populations. Pest risk will be compounded by increased movement of humans, food and natural products among countries. Over the past four decades, integrated pest management has emerged as a widely accepted approach to manage pests using host plant resistance combined with cultural, biological and chemical control methods. New solutions for next-generation crop protection require the integration of real-time surveillance and forecasting systems with agronomic, genetic and chemical control measures, including new, safer and more durable modes of action. Science is advancing fast in this direction.

The Long-Term Continuous Cropping Experiment (LTCCE) recently marked its 150th rice cropping season. It measures trends in yield and soil properties over its lifetime as indicators of the sustainability of continuous rice cropping on flooded soil. Source: Achim Dobermann

3(j) Innovative smallholder technologies to increase crop value, reduce post-harvest losses, and improve food safety

Because farmers are often unable to dry, store and process their produce, losses are high and there is widespread contamination of foodstuffs with microbes and mycotoxins. For example, most vegetables and high-value food crops are at peak quality at harvest but start to deteriorate soon afterwards. Moisture depletion and physical damage during harvest, packing, storage and transportation causes losses of 20–80%.[12] The loss of produce volume and the losses in nutritional content and quality mean that consumers pay more for products which are less beneficial to their nutritional security. Reducing post-harvest losses of these products will increase the incomes of the producers and the availability of micronutrients for all.

3(k) New business models for smallholder farming and marketing

Where structural transformation processes in urban and rural areas proceed fast, traditional smallholder farming will increasingly be supplemented by, or replaced with, the outsourcing of farming operations, the formation of small and medium-size farmer cooperatives or agribusiness enterprises, and contract farming.[12] Value chains for major agricultural commodities will become more tightly integrated because processors and consumers will demand more information and control over how food is being produced, with supermarket chains playing a particularly important role. For farmers, this is a chance to connect with rapidly growing domestic and export markets and thus become more direct beneficiaries of competitive food systems. The food industry in particular has increased investments in the direct sourcing of agricultural produce from small farmers worldwide. This trend is expected to continue due to increasing industry and consumer demands for tracing food and meeting certified, as well as non-certified, production standards.

Case Study

The growth of malls in Nigeria

Delta Mall opened in Warri, Nigeria, last spring, bringing to about a dozen the number of Western-style shopping malls catering to 180 million people in Nigeria, Africa's most populous nation. The emergence of malls – and mall culture – in Nigeria reflects broad trends on the continent, including a growing middle class with spending power and the rapid expansion of cities like Warri that are little known outside the region.

The malls, like the new cars that have replaced the beat-up *tokunbos* (roughly, "used cars") on Nigerian roads, provide visible confirmation that, despite the country's many problems, life has become materially better for many in recent years. Besides shops, the malls have brought leisure activities, like going to the movies and dining at food courts.

Nigeria's population, which is growing and urbanizing at one of the fastest rates in the world, is expected to increase from 180 million to 400 million by 2050, according to projections by the United Nations. That would place Nigeria behind only India and China.

The size of Nigeria's middle class, as well as Africa's, varies according to the definitions used. But many experts agree that Nigeria's size and population growth will drive the expansion of Africa's middle class. Standard Bank, a South African bank with branches across the continent, estimated that Nigeria's middle class grew by 600% from 2000 to 2014. While 4.1 million Nigerian households are now considered middle class, or 11% of the total population, an additional 7.6 million households would make it into that category by 2030, according to the bank's projections.

Informal shops, individually run, are still thriving. Street hawkers sell food, clothes and home appliances on sidewalks, or wherever they can find a captive audience, like Nigeria's epic traffic jams, known as go-slows. The hawkers often compete directly with the malls, selling their wares to people driving into parking lots next to retailers like Game, a discount superstore owned by Walmart.

Adapted from: *Onishi N. Nigeria Goes to the Mall. The New York Times, January 5, 2016.*

3(l) Digital agriculture

Digital technologies will be a key enabler to grapple with the complexity of Sustainable Agriculture Intensification and taking it to scale. Mobile phones, interactive radio, video and internet can enable farmers to access location-specific and timely recommendations that are actionable, but also to contribute to gathering large-scale datasets on the performance of different agricultural options (varieties, planting dates, biological information, etc.) Crowdsourcing can help fill data gaps and thus improve the tailoring of recommendations. Mobile technologies in particular are a vehicle not only to integrate improved varieties, agronomy and policies to support food systems, but also to integrate other key services such as credit, insurance, education and health. Digitally-enabled technologies can drive transparency that in turn supports accountability and ultimately leads to good governance – an essential ingredient for development.

3(m) Promoting integrated landscape management

To successfully address the challenges of food insecurity, persistent poverty, climate change, ecosystem degradation and biodiversity loss, it is critical to move beyond zero-sum strategies that solve one problem but exacerbate others. "Integrated landscape management" aims to realize synergies and reduce trade-offs among these multiple objectives. Farmers and land managers around the world are reaching out across traditional sectoral boundaries to forge partnerships with conservation organizations, local governments, businesses and others to solve problems that are interconnected. More than 107 such initiatives have been documented in Latin America, over 85 in Africa, and an Asian inventory is under way.[13] However, current institutions provide only weak support for these efforts.

3(n) Monitoring the world's agricultural systems

The development of effective monitoring networks is essential to track, anticipate and manage changes in the biophysical, economic, and social aspects of different farming systems around the world.[14] A global agricultural monitoring system should be established as a well-designed and well-directed network of partners engaged in collecting high-quality data required by a wide range of stakeholders. It would provide up-to-date information on the status of agriculture and progress toward meeting the agreed future SDG Targets, including environmental targets affected by agriculture. Simultaneously measuring indicators across SDGs in an integrated monitoring system will allow scientists, land managers and other decision-makers to find solutions to the most pressing problems facing global food security.

4. Investing in long-term change

Foresight is needed to avoid running into another food crisis 20 or 30 years from now. In addition to investing in early solutions or technologies that are likely to become available in the next five to ten years, strategic investments are needed to sustain, and even accelerate, the rate of progress over time. Besides significant private-sector investments, this requires large, stable investments in public-sector research to ensure that ground-breaking innovations continue to be developed and are widely accessible to all farmers and businesses. Open innovation and open access will be needed to achieve broader and faster impact.

There is a need to (i) move from supply-driven to demand-driven agricultural innovation systems that focus on the right priorities, including active participation by key stakeholders, and (ii) simplify the increasing complexity, fragmentation and lack of coordination of agricultural R&D funding that persists in many countries. New, visionary R&D funding models are needed that:

- are founded in strategic long-term thinking;
- have a clear outcome-focus and reward quality science and proven impact;
- enable public-private collaboration in R&D and extension to cover all areas sufficiently and make faster progress;
- encourage open access to information, data and other intellectual property;
- create a viable market for R&D outputs and innovation services;
- enhance cross-border learning, cooperation and technology spillover;
- stimulate more private investments in R&D and direct it to areas of public interest, including attracting new investors such as venture capital and social impact investors;
- systematically improve public R&D infrastructure; and
- build human capital.

Countries should also consider the following general targets:

- Low-income countries and agriculture-based or transition economies, particularly ones with significant food security concerns, should aim to spend at least 10% of their national budgets on accelerating agricultural growth.
- Annual government spending on agricultural research and extension should be at least 1–2% of agricultural

GDP, and should increase by at least 5% per year in low- and medium-income countries.

- All high-income countries should aim to meet the 0.7% of Gross National Income (GNI) target for ODA (Official Development Assistance), and spend at least 10% of their ODA funding on agriculture.

5. Planning and implementing action

Implementation of the new SDGs through targets, indicators, planning and investments should be scalable from local to global levels, and must also be measureable at all levels and scales. The pathways towards more sustainable agriculture and food systems will vary by country as well as within countries, but could follow some common principles.

Planning for success requires a roadmap to realize strategic goals. Action planning needs to be goal-oriented and systematic. National and local governments should apply structured assessment and business planning methodologies to analyze how various solutions could help meet one or more specific targets, and to assess the cost of different options. Researchers must play an important role in guiding that process. A structured assessment typically includes five steps:

1 Background analysis: data collection, past trends and future projections, possible scenarios

2 Analysis of data for problem relevance; definition of key problems/opportunities

3 Assessment of different technology / policy solutions;

4 Estimation of outcomes and effects at scale

5 Modeling of large-scale impact on development goals/targets.

Political will is needed to implement a more coordinated and business-minded approach to development, including behavior change on the part of all participants. One of the major challenges is the alignment of many actors who play different roles in development to ensure strategies are translated into tangible outputs and outcomes to improve food security and nutrition for the rural and urban poor.

One initiative which has shown some success is the development of "Innovation Platforms" to foster linkages between the many players in a given value chain. These "Innovation Platforms" or "Innovation Hubs" bring together the public and private sectors, research and development, and other actors at different places in the value chain to contribute to local innovation and strengthen links in the chain. Local and national governments are often overwhelmed by disparate programs operating within their borders, but such platforms can give a solid base from which to drive well-coordinated action. The range of relevant organizations includes:

- national governments and local authorities;
- national agricultural research and extension systems;
- universities;
- civil society organizations, including farmers' associations;
- private companies and industry associations;
- sustainable agriculture platforms, think tanks and round tables;
- UN organizations;
- global and regional political bodies and organizations;
- global, regional and national initiatives;
- large business-led initiatives, platforms and development corridors;
- donors, development banks and funds, private foundations, and social/impact investors; and
- international agricultural research centers.

Implementation of the new SDGs through targets, indicators, planning and investments should be scalable from local to global levels, and must also be measurable at all levels and scales. Source: Achim Dobermann

My personal view

Achim Dobermann

I have done research on agricultural systems on all continents and in very different political systems. I have visited and worked with well-supported, large commercial growers as well as farmers who have never seen an extension worker in their entire life. I have met many people who are extremely committed to the development of agriculture and nutrition and the protection of the environment. I have never met a farmer who did not care about the quality of the land, the quality and safety of food, or the condition of the environment.

I am convinced that it is possible to feed the growing world population in a sustainable manner, even in a time of climatic changes and extremes. Many of the requisite solutions already exist or could, with wise investments, become available in the next 10–20 years. Early action is good and important, but we also need political will and concrete mechanisms for long-term thinking and action. We need to leave behind national or personal interests as well as unproductive philosophical or ideological debates as to what is right and what is wrong. Instead, let us embrace science and focus on the positive changes that need to be made. We will have to adopt many new ways of working in order to generate new ideas and translate these into real-world impact. Everyone should have that ambition and a role in bringing it about. Only people can make the difference, at all levels.

Further reading

United Nations. Transforming our world: the 2030 Agenda for Sustainable Development. 2015. https://sustainabledevelopment.un.org/post2015/transformingourworld.

SDSN. An action agenda for sustainable development. Report for the UN Secretary General. New York: Sustainable Development Solutions Network 2013. http://unsdsn.org/resources/.

Dobermann A, Nelson R, Beever D et al. Solutions for sustainable agriculture and food systems. Technical report for the post-2015 development agenda. New York: Sustainable Development Solutions Network 2013. http://unsdsn.org/resources/.

SDSN. Indicators and a monitoring framework for sustainable development goals: launching a data revolution for the SDGs. New York: Sustainable Development Solutions Network 2015. http://unsdsn.org/resources/publications/indicators/.

The Royal Society. Reaping the benefits: science and sustainable intensification of global agriculture. London: The Royal Society, 2009.

Bertini C, Glickman D. Advancing global food security: the power of science, trade, and business. Chicago: The Chicago Council on Global Affairs, 2013.

References

1 *https://sustainabledevelopment.un.org/post2015/transformingourworld.*

2 *Conway G. One billion hungry: can we feed the world? Ithaca/London: Comstock Publishing Associates, 2012. http://www.cornellpress.cornell.edu/book/?GCOI=80140100695530*

3 *FAO. The state of food and agriculture. Rome: FAO, 2012. http://www.fao.org/publications/sofa/2012/en.*

4 *Vorley B, Cotula L, Chan M-K. Tipping the balance. Policies to shape agricultural investments and markets in favour of small-scale farmers. Oxford: IIED & Oxfam, 2012. http://www.oxfam.org/sites/www.oxfam.org/files/rr-tipping-balance-agricultural-investments-markets-061212-summ-en.*

5 *Xu Y and Crouch JH Marker-assisted selection in plant breeding: from publications to practice. Crop Sci 2008;48:391-407. https://www.crops.org/publications/cs/abstracts/48/2/391.*

6 *Jena KK, Mackill DJ Molecular markers and their use in marker-assisted selection in rice. Crop Sci 2008;48:1266–276. https://www.crops.org/publications/cs/abstracts/48/4/1266.*

7 *Graham RD et al. Nutritious subsistence food systems. Adv Agronomy 2007;92:1–74. http://oar.icrisat.org/4800.*

8 *Labarthe P, Laurent C. Privatization of agricultural extension services in the EU: Towards a lack of adequate knowledge for small-scale farms? Food Policy 2013;38:240–252. http://www.sciencedirect.com/science/article/pii/S0306919212001054.*

9 *Dobermann A. Et al. Site-specific nutrient management for intensive rice cropping systems in Asia. Field Crops Res 2002;74:37-66. http://www.sciencedirect.com/science/article/pii/S0378429001001976 .*

10 *Eisler MC, Lee MRF, Tarlton JF et al. Steps to sustainable livestock. Nature 2014;507:32–34.*

11 *FAO. Climate-smart agriculture sourcebook. Rome: FAO, 2013. http://www.fao.org/docrep/018/i3325e/i3325e.pdf .*

12 *Reardon T, Timmer CP, Minten B. Supermarket revolution in Asia and emerging development strategies to include small farmers. Proc Natl Acad Sci U S A 2012;109:12332–12337. ttp://www.pnas.org/content/early/2010/12/01/1003160108.*

13 *Milder JC, Hart, AK, Dobie P et al. Integrated landscape initiatives for African agriculture, development, and conservation: a region-wide assessment. World Development 2014;54:68–80. http://www.sciencedirect.com/science/article/pii/S0305750X13001757.*

14 *Sachs JD et al. Monitoring the world's agriculture. Nature 2010;466:558–560. ftp://ftp.fao.org/agl/agll/docs/wsr.pdf.*