CHAPTER 38

CONCLUSIONS

The challenges of creating a sustainable food future, to some extent, are reflected and addressed in the concept of "climate-smart agriculture." Our menu defines our understanding of that concept, which is less a specific set of practices and more a quality that emerges from highly efficient use of natural resources, innovation in technology and management, and protection of natural lands at a national or landscape level.

Creating a sustainable food future—simultaneously feeding a more populous world, fostering development and poverty reduction, and mitigating climate change and other environmental damage—presents a set of deeply intertwined challenges. Our definition of a sustainable food future overlaps in large measure with the term "climate-smart agriculture" (CSA) but our report offers several insights that differ in direction or emphasis from much prior work (Box 38-1).

The challenge of sustainably feeding nearly 10 billion people by 2050 is substantially greater than commonly presented in land-use or climate mitigation analyses

- **Global challenge:** We believe that many studies to date have failed to take account of the full magnitude and interrelated nature of the challenges ahead. Climate estimates generally pay little attention to rising agricultural emissions and often improperly assume that land-use-change emissions will stop. Some agricultural analyses have overestimated the trends of yield gains because, for example, they base their estimates on compound growth rates. Others have simply assumed that other human activities can convert large areas of pasture or woody savannas without food, carbon, or significant biodiversity effects. But the world is on a course (on existing trend lines) to require more than 50 percent more food per year by 2050, which, in our baseline scenario, would be produced by converting hundreds of millions of hectares of land to agriculture and generating 33 percent more GHG emissions from agricultural production relative to our base year of 2010.

- **Shifts in locations of agricultural land:** Loss of carbon and biodiversity result not merely from net land expansion but also from shifts in agricultural land locations both between and within regions. This shifting adds greatly to the challenge and makes land-use restrictions or pricing of carbon consequences necessary.

BOX 38-1 | The Menu for a Sustainable Food Future and "Climate-Smart Agriculture" (CSA)

Since the term was coined around 2010, CSA has become an important goal of international institutions, such as the World Bank and FAO. FAO identifies three pillars of CSA: sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing and/or removing GHG emissions. The overlap between this broad definition and the goals of this report is clear, which means that our report can help to define and identify priorities for CSA.

One school of thought, which we consider too restrictive, treats CSA as a set of specific practices, with a particular focus on those that build soil carbon. The original hope was that sequestering carbon in soils would provide a cheap method of reducing concentrations of carbon in the air, which factories and utilities might fund for carbon offsets. Measures such as mulching, agroforestry, and no-till farming would simultaneously mitigate climate change by removing carbon dioxide, boost output through the greater productivity of carbon-rich soils, and increase resilience to greater fluctuations in rainfall through the ability of carbon-rich soils to hold water longer.

As we discussed in Chapter 30, soil carbon sequestration in agricultural soils turns out to be far more difficult than previously thought, and several measures were more about moving carbon storage around than increasing total storage. The potential of soil carbon sequestration to mitigate other agricultural emissions is limited and is probably needed just to offset emissions not counted today from soil carbon loss. We believe that measures to build carbon in soils should be thought of not as easy climate mitigation or adaptation measures but rather as challenging yet valuable measures primarily to build agricultural productivity, with relatively modest direct climate mitigation through the carbon dioxide removed—but more potential climate benefits through the potential to reduce land conversion.

For these reasons, the menu items proposed in this report offer a broader set of strategies for climate-smart agriculture. They offer major synergies between productivity gains, greater resilience, and GHG mitigation. They support the goal of "produce, protect, and prosper." The core synergy lies in boosting efficiency in the use of land, animals, and inputs, which can raise agricultural incomes while reducing emissions and the demand for land. Yet because productivity gains can exacerbate shifting in locations of agricultural land, the synergy requires strong measures to prevent agricultural land expansion into natural ecosystems.

Because of this synergy—and even though some specific agricultural practices are necessary to mitigate production emissions, such as feed additives for enteric methane—low-emissions agriculture cannot just be one specific set of agricultural practices. Low-emissions agriculture can only emerge from a combination of strategies deployed at national or, at the least, landscape level.

- **Sub-Saharan Africa:** Sub-Saharan Africa presents a core challenge for a sustainable food future because of its low yields, high rates of malnutrition, rapid population growth, abundant opportunities to convert additional woody savannas and forests, and hundreds of millions of smallholder farmers. Improving the region's crop yields, focusing land expansion on the lowest-environmental-cost lands (above all by controlling the locations of road improvements), and accelerating progress in education and public health are all critical to success.

Productivity gains are critical

Under all scenarios, the growth in crop and pasture yields and other forms of agricultural productivity gains are the prime determinants of future emissions and land-use demands (although this fact can be obscured by the large productivity gains already assumed in baselines).

Productivity gains in land, animal, and chemical inputs already in our 2050 baseline are responsible for closing two-thirds of the GHG mitigation gap and more than 80 percent of the land gap that exist if we assume no improvements in efficiency or output relative to 2010 levels (our "no productivity gains after 2010" scenario). When adding in the various additional productivity gains required to meet our 4 gigaton/year GHG emissions target by 2050, the role of productivity gains must grow even larger. Productivity gains also provide the most important potential synergy between income, food security, and environmental goals.

- **Crops:** Replicating the large increases in chemical inputs and irrigation water associated with the Green Revolution is no longer possible or consistent with environmental goals. Fortunately, advances in molecular biology and related breeding technologies offer great potential for boosting productivity above trend lines—if research efforts receive sufficient financial support.
- **Pasture:** Every hectare of global pasture that is capable of and appropriate for sustainable intensification must be fully exploited to realize its potential to increase milk or meat output several times over.

Slowing the rate of growth in demand for food and other agricultural products is critical too

- **Food loss and waste:** Abundant technical opportunities exist to reduce food loss and waste. The deliberate reduction of food loss and waste, through action by governments, consumers, and food companies, is a newly emerging effort. At this time, it requires commitment, innovation, measurement, and then deployment of promising approaches.
- **Diets:** When properly factoring in the effects of diets on land use, dietary choices have far greater consequence for ecosystems and GHG emissions than typically estimated.
- **Bioenergy:** To date, the primary effect of public policy has been to make the challenge harder by increasing demand for bioenergy, based on mistaken GHG accounting. Because even a small amount of bioenergy from crops or feedstocks that make use of dedicated land requires a large amount of land, plans for more bioenergy could, alone, derail a sustainable food future.
- **Population:** Major economically and socially advantageous opportunities exist to hold down the growth in demand for agricultural products in sub-Saharan Africa. Key strategies are to increase educational opportunities for girls, increase access to reproductive health services, and reduce infant and child mortality. Realizing these opportunities will require major social and financial commitments.

Production of meat and milk from cattle, sheep, and goats needs to be a core focus of both demand-side strategies and productivity gains

- **Forage-based agriculture:** Demand for milk and meat from cattle, sheep, and goats is responsible for most projected future land-use expansion and roughly half of agricultural production emissions. No viable strategy for a sustainable food future exists that does not include huge increases in the efficiency of pasture- and forage-based agriculture and slower growth in demand for ruminant meat.

- **Ruminant meat consumption:** Analyses that have focused inappropriately on human-edible feeds only and have not fully factored in land-use consequences have sometimes masked the enormous role that ruminant meat consumption plays in agricultural land demand. A major effort to shift diets away from high levels of ruminant meat consumption is warranted by several factors. The environmental impacts of ruminant meat production are high, the number of people who consume large quantities of ruminant meats is relatively small, ruminant meats provide only 3 percent of calories and 12 percent of dietary protein even in the United States, and there is a historical precedent for shifting away from beef consumption in the United States and Europe.

Productivity gains must be explicitly linked to protection of carbon-rich ecosystems

- **Link "produce" and "protect":** Productivity gains by themselves cannot stop emissions and ecosystem degradation caused by shifts in the locations of agricultural land. Productivity gains will only solve the land-use challenge if countries simultaneously enforce protection of forests and savannas and—when some agricultural expansion is inevitable—use detailed, spatial plans to locate expansion in the areas with the lowest environmental opportunity costs.
- **Policy instruments:** Governments and private parties should explicitly link efforts to boost yields with ecosystem protection through financing, lending conditions, supply chain commitments, and public policies.
- **Road building:** New roads must be located in ways that minimize the incentives to convert natural areas to agriculture. The forest frontier should be closed to agriculture.

Reforestation of some lands, and restoration of peatlands, should proceed immediately, but larger-scale reforestation depends on technological innovation and changes in consumption patterns

- **Reforestation:** Important but limited opportunities exist today to reforest unproductive or abandoned agricultural lands with little improvement potential. However, the scale of reforestation necessary to fully achieve climate goals requires that more land be liberated from agriculture. Freeing up hundreds of millions of hectares of land can only be achieved through highly successful implementation of the measures proposed in our demand-reducing and productivity-boosting menu items (Courses 1 and 2).
- **Natural forests:** Because agricultural land tends to shift locations, programs that reforest abandoned land only with plantation forests will lead to steady declines in biodiversity and carbon stocks. More reforestation programs therefore need to focus on diverse, native species.
- **Peatlands:** Restoration of drained peatlands is a low-hanging fruit among climate mitigation options. Drained peatlands occupy perhaps 0.5 percent of total agricultural land but produce 2 percent of all human-generated GHG emissions, not merely those from agriculture.

Strategies should support rural livelihoods by helping farmers sell to markets, even as more farmers transition to urban jobs, but should not promote large land acquisitions.

- **Pushing large farms?** Pushing the replacement of small farms, particularly by supporting large acquisitions of communal land or land now farmed by small farmers, is not consistent with poverty reduction or environmental goals and is rarely helpful for productivity gains.

- **Focusing assistance for small farms:** Even so, subsistence agriculture offers poor prospects over the long term, and small farms in many parts of the world are dividing and becoming too small to allow households to avoid poverty without off-farm income. Policy should therefore encourage farming for markets, allow farms to consolidate "organically" through purchases and leases of land, create social welfare systems that reduce the risk inherent in farming for markets or specializing in cash crops, and otherwise support the inevitable shift toward off-farm incomes.

- **Appropriately formalizing property rights:** Formalizing property rights would probably be valuable in many parts of the world, and new geographic information systems make the effort less technically difficult. But the process can lead to greater inequity when controlled by powerful interests. Formalizing rights can even codify inequities such as limitations on property rights for women. Formalization should therefore proceed in ways that respect the variety of traditional uses, carefully safeguard equity, and modify traditional property approaches when necessary to rectify historic inequities.

Regulation and technological innovation will be essential to achieve the most ambitious levels of our menu items.

- **Regulation:** It is hard to reduce emissions and related environmental harms if efforts to reduce them are completely voluntary. Regulations must be crafted to spur innovation while allowing flexibility to develop cost-effective solutions. Regulations should apply mostly to manufacturers of agricultural inputs and to managers of concentrated livestock facilities.

- **Research and innovation:** Several types of innovations are necessary to close the food, land, and GHG emissions gaps. Many already exist but, despite their promise, receive minimal support today. Their further development requires large increases in public funding, which need to come from a variety of public agencies, not just traditional agricultural research agencies.

- **The "D" in R&D:** The actual deployment of low-emissions and productivity-enhancing technologies often requires the development of detailed plans, with regular monitoring and feedback. Today, most aspects of technological deployment receive only a fraction of the attention that is needed. Just as engineering costs are built into construction projects, development plans should be incorporated into virtually all agricultural development funding.

To summarize our conclusions, we believe that the challenge of sustainably feeding nearly 10 billion people by 2050 is greater than commonly appreciated.

Despite the many obstacles to be overcome, we believe that a sustainable food future is achievable. Our menu proposed in this report can create a world with sufficient, nutritious food for everyone. It also offers the chance to generate the broader social, environmental, and economic benefits that are the foundation of sustainable development. But such a future will only be achieved if governments, the private sector, and civil society act upon the entire menu quickly and with conviction.

PHOTO CREDITS

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