TECHNOLOGY, BEST PRACTICES, AND ATTENTION TO ECOSYSTEM SERVICES DRIVE PRODUCTIVITY GROWTH

Agricultural technologies that enable producers to increase their output using the same amount, or less, land, labor, capital, and other inputs, are the primary drivers of productivity growth. Yet, technology alone is insufficient to achieve long-term TFP gains.

A farm management system that utilizes the appropriate agricultural technologies and practices, complemented by the attention to ecosystem services, can realize short-term productivity gains and increase them over time, while strengthening their resilience to weather and economic shocks.[33]

Agricultural ecosystems are defined by the plants, water, soil, air, microbes, and animals in and around areas where agricultural activity takes place. The interaction between these elements create benefits, or *ecosystem services*, that make agriculture more productive, sustainable, and resilient.

Ecosystem services include pollination, erosion prevention, carbon sequestration, nutrient cycling, soil fertility, air and water quality control, and pest and disease management. The economic value of ecosystem services is not captured in TFP, yet they **are the "natural capital" of the agricultural system.**

The **CGIAR Research Program on Water, Land and Ecosystems** estimates that the value of pollination services provided by wild bees, insects, and birds exceeds $150 million annually.[34]

Consumer demand plays an important role in determining how and what food and agricultural goods are produced.

However, a strategy that relies primarily on consumer behavior to drive systemic change neglects what research has shown: **wide-spread and lasting changes in agriculture are driven by policies, investments, and partnerships that facilitate the adoption of agricultural technologies, best practices, and attention to ecosystem services,** such as:

- **Providing training and financial support to producers to identify and enhance ecosystem services.**
- **Developing tailored interventions to reduce GHG emissions from small-scale livestock production**.
- **Scaling-up R&D investments to make staple and non-staple food crops more productive, climate resilient, and nutritious.**
- **Using smart land-use policies to ensure that productivity growth does not stimulate land expansion.**
- **Strengthening rural economies by investing in infrastructure, sanitation, healthcare, and education.**

Waste not, conserve more

Sustainable agriculture systems cannot be achieved without drastic reductions in food loss and waste (FLW). SDG2 calls for a 50 percent reduction in global FLW by 2030. Reducing FLW keeps critical nutrients in the food system and preserves the investment of natural and capital resources used to produce them.[35]

By combining agricultural technologies with best practices and attention to ecosystem services, agricultural producers can reduce net GHG emissions to half of current levels by 2050, while still providing for global food and agriculture needs.*

CROP GENETICS: Improved crop genetics increase yield, preventing the conversion of biodiverse habitats to crop production. Locally cultivated crop varieties contain genetic material that improves the productivity and climate resilience of hybrid and biotech seeds.

SOIL HEALTH: Rotating crops with legumes and planting cover crops can preserve soil nutrients, increase the soil's water-holding capacity, and improve soil carbon sequestration.

TILLAGE MANAGEMENT: Reduced or no-till systems prevent erosion, soil degradation, and carbon loss. Improvements in precision agriculture and data analytics, in combination with high yielding, herbicide-tolerant crops, make it easier for farmers to adopt tillage management systems.

WATER AND NUTRIENT MANAGEMENT: When nutrients are properly managed, particularly through precision systems, over-application can be avoided, runoff reduced, and emissions minimized. Precision and drip irrigation, ensure efficient use of minimal amounts of water to increase yields.

DIVERSIFICATION: Combining livestock production and food crops on land where timber and trees are grown conserves carbon and nutrients in the soil, improves the profitability of tree production, prevents erosion, and provides shade for animals.

PEST CONTROL AND POLLINATION: Flowering strips, hedgerows, and small forest patches near cropped areas create habitats for insects and animals that provide pollination and pest control.

INTEGRATED AQUACULTURE: Integrating animals, feed crops, and aquaculture production increases productivity and reduces producer costs by recycling nutrients through a closed system.

RUMINANT RECYCLERS: Cows, goats, and sheep eat agricultural by-products that are not consumable by humans and recycle them into nutritious animal proteins and fertilizer. Improved feed and forages, advanced animal genetics, and better animal care practices reduce methane emissions created in the digestive process, while increasing milk, egg, and meat output per animal.

*Climate Change 2014: Mitigation of Climate Change, Contribution of Working Group 3 of the Fifth Assessment Report of the Inter-Governmental Panel on Climate Change.