Evaluating Tradeoffs and Synergies Between Agricultural Productivity and Sustainability: Summary

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Agricultural systems provide food, feed, fiber, and fuel to society, and can contribute to socio-economic sustainability (such as providing livelihoods). However, the functioning of agricultural systems relies heavily on natural resources, and these systems potentially have negative impacts on the natural environment and human health. Consequently, inherent tradeoffs, as well as synergies, exist between the productivity of these agricultural systems and the environment. **The pursuit of sustainable agriculture should go beyond the single target of improving agricultural productivity and also consider environmental and socio-economic sustainability in policymaking**.

Complex tradeoffs exist among normative concerns of sustainable agriculture production and across multiple spatial and temporal scales. The tradeoff suggests an opposing relationship between two objectives or the negative impact of one objective on another. The normative concerns include economic, social, and environmental impacts of agricultural production. This report provides an overview of the tradeoffs examined in the existing literature, and a framework for exploring "the full range of potential tradeoffs" and identifying tradeoffs that are often ignored but potentially important, such as the tradeoffs between productivity increase and nutrition security. The relationships (synergies or tradeoffs) between agricultural productivity and sustainability vary by temporal and spatial scales, depending on the agricultural system's local context, management practices, and production and consumption patterns.

To achieve sustainable agricultural production with multiple goals (e.g., providing nutritious food, improve farmer's livelihood, minimize environmental impacts), the complex tradeoffs involved in agricultural production need to be carefully considered and assessed. **Many tradeoffs could be transformed into synergies with changes in ecological and socio-economic conditions and production and consumption patterns**. But the approaches to minimize the tradeoffs vary by many factors, such as spatial and temporal scales, targeting stakeholders, cultural background, political landscape, and resource availability.

Navigating among the complex tradeoffs requires a clear understanding of a) the goals and priorities for agricultural production at a given spatial scale or multiple spatial scales; **b) the critical thresholds** for each goal to be achieved; **c) potential mechanisms** leading to the tradeoffs. Based on this case-specific information, policies and technologies need to be crafted accordingly to minimize tradeoffs and achieve optimal environmental and socio-economic outcomes for all stakeholders across multiple goals and priorities.

Policy Recommendations

1) **Changing the metrics for evaluating the success of agriculture.** Agricultural productivity, often measured as per hectare yield or profitability, has been commonly used as an indicator to evaluate the performance of agriculture. It has been driving the development of technologies and markets, as well as decision-making from farmers to policymakers. However, traditionally defined agricultural productivity, which overemphasizes the value of calories or weight, is insufficient for ensuring healthy and nutritious food supply; meanwhile, it ignores vast environmental and socio-economic services, including negative impacts, that agriculture provides to society. To guide agriculture production towards sustainability, it is critical for policymakers to develop and adopt new metrics that evaluate the performance of agriculture production, considering nutritional, environmental, and socio-economic outcomes. Led by the United Nations, the ongoing development of indicators for Sustainable Development Goals (SDGs), and the SDG

2.4.1 indicator in particular, is among many efforts in improving the metrics for assessing agriculture sustainability.

2) **Improving the distribution and utilization of current agricultural production.** Unbalanced distribution and inappropriate utilization of agricultural products are two major barriers to achieving synergies between agricultural production and food security. We are producing enough calories and protein to meet the basic needs of the current global population. Even Africa, the region often considered to have serious food availability issues, has a 17% surplus in calorie production. Given the complex tradeoffs associated with increasing agricultural productivity, it is critical for policymakers to consider options to improve the efficiency and equity of the distribution of agricultural products, and to reduce food waste.

3) **Developing region-specific strategies to address tradeoffs between agricultural productivity and sustainability.** Each country or region has its own ecological and socio-economic characteristics, and consequently, the major tradeoffs, their causes, and the strategies for addressing those tradeoffs can differ widely. This review provides a general overview and a framework to identify the potential tradeoffs involved in agricultural production, including both the tradeoffs among normative concerns and across spatial and temporal scales. A selection of options for addressing those tradeoffs is also presented. However, there is no universal formula for addressing tradeoffs and achieving agricultural sustainability; region-specific research and policy-design are needed that incorporate regional priorities for both the short term and the long term. It is important to recognize that some tradeoffs are difficult to avoid; consequently, it is necessary to identify acceptable thresholds for sustainability goals to allow certain levels of tradeoffs and to prioritize improvements for certain outcomes during the process of achieving sustainability.

4) **Coordinating global efforts to enable synergies for agriculture sustainability.** While actions towards sustainable agriculture are ultimately applied on a local scale and based on regional characteristics, improved global coordination is needed, because a) sharing experiences and lessons learned from past agricultural development in different countries and regions can better inform decision making; b) for those environmental impacts of global concern (e.g., emission of greenhouse gases such as N_2O, deforestation and biodiversity loss), policymakers from all countries need to work together to set goals and action plans, and facilitate cross-country collaboration to ensure necessary financial and knowledge support for implementing the plan; c) given the important role of international trade in allocating global agricultural production and contributing to spatial tradeoffs, it is critical for the policy and business communities to work together towards more responsible global supply chains. FAO and many other organizations have already been coordinating several global efforts (e.g., the Hand-in-Hand Initiative) to empower farmers and to support government to achieve Sustainable Development Goals (SDGs).

Priority areas for research

1) Farm scale: synthesize best management practices for different ecological and socio-economic conditions and develop databases and decision-support tools that are accessible to farmers and other stakeholders.

2) Farm to regional scale: the impacts of agriculture on various normative concerns, across spatial and temporal scales, and the associated tradeoffs are not yet fully understood and remain poorly quantified. Policy analysis tools are needed to assist policymakers in navigating complex tradeoffs and to help optimize policy choices and their outcomes.

3) Besides applying the currently available metrics (such as SDGs) to evaluate agricultural sustainability on the national and global scales, we also need to further develop these metrics to include a comprehensive evaluation of tradeoffs across spatial and temporal scales. It is critical to develop improved indicators and databases for such metrics in order to expand the current productivity and sustainability metrics and further guide agricultural production towards sustainability.