Sustainable Agriculture Decision Support Tool

Agricultural technologies can contribute significantly to greenhouse gas emissions. This decision support tool quantifies and monetizes such impacts to inform scale-up of innovative technologies that deliver "win–win" agricultural and environmental outcomes.

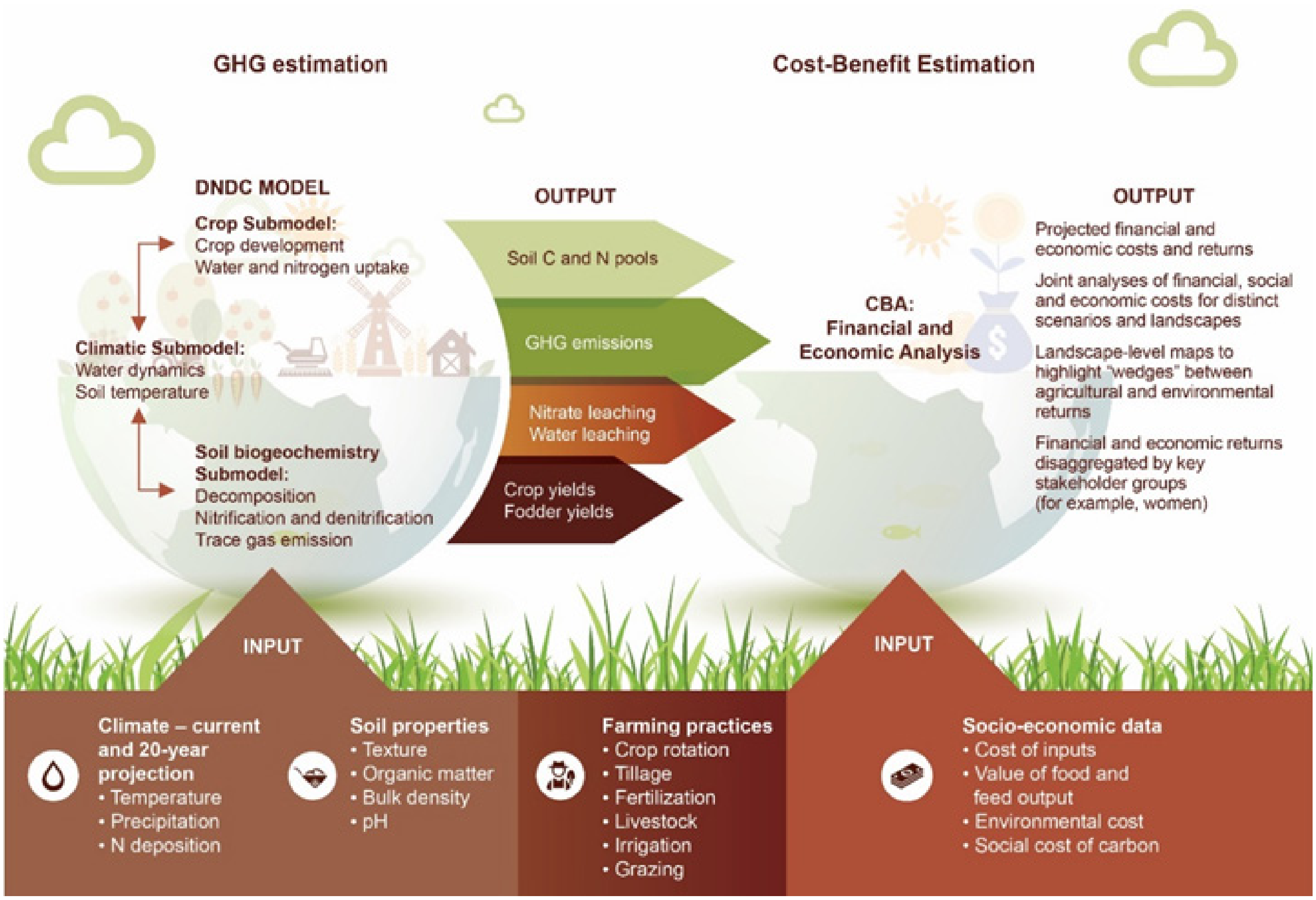
Agricultural and environmental outcomes are inextricably linked.

Soil health, water availability, air quality, and climate change all influence crop productivity. Yet agriculture also drives deforestation, biodiversity loss, soil erosion, and soil and water pollution, and is responsible for over one-quarter of total greenhouse gas (GHG) emissions. Promising agricultural technologies that increase both productivity and positive environmental outcomes can greatly improve the sustainability of agriculture. Therefore, a fuller accounting of the benefits and costs of agricultural innovations can help optimize investments. Under the USAID-supported consortium led by Mathematica, Applied GeoSolutions, the Institut Sénégalais de Recherches Agricoles, and the Feed the Future Sustainable Intensification Innovation Lab, we are developing a sustainable agriculture decision support tool (DST) to fill this information gap and inform scale-up of innovative technologies that can help achieve "win–win" agricultural and environmental outcomes.

Analytical approach to identifying win-win agricultural interventions

The DST's two components will **(1)** estimate the GHG emissions impact of agricultural interventions, using the Denitrification–Decomposition (DNDC) model; and **(2)** conduct cost-benefit analyses (CBAs) to identify the financial and economic returns (Figure 1). The DNDC model uses data from scientific trials on treatment and control plots (with and without project agronomic practices) as inputs. Combining these data with information on soil type and current and 20-year climatic projections of temperature and precipitation projections, the model estimates crop and feed yields and GHG impacts for the treatment and control scenarios for a 20-year time horizon. The outputs from the DNDC model are inputs for the CBA. The CBA uses data on agricultural input use (from scientific trials on agronomic practices) and primary data on input and output prices to estimate financial returns from crop production. It also estimates the financial returns from feed production and livestock systems using primary data. To estimate economic returns, the CBA uses the social cost of carbon to value GHG emissions impacts. It quantifies benefits streams that cannot be monetized.

Figure 1. Decision support tool's analytical approach



The DST will present these results in maps of financial and economic returns for landscapes. It will allow users to change assumptions about the specific extent of technology adoption, social cost of carbon, and discount factors, to understand the financial, social, and economic costs under various intervention scenarios for different landscape types.

It will highlight areas where "wedges" between agricultural and environmental returns create opportunities for innovative, private-sector investment to fill financing gaps (such as at agricultural frontiers, which often have pervasive land-use and land-cover change). The tool will also show financial and economic returns by key stakeholder groups, particularly women. To estimate economic returns, it uses the social cost of carbon to value GHG emissions impacts. It quantifies benefits streams that cannot be monetized.

An application to dual-purpose millet and cowpeas in Senegal

We will develop, refine, and demonstrate the DST's multi-landscape tractability through a pilot targeting dual-purpose millet and cowpeas in two landscapes in Senegal: the New Peanut Basin zone and the Eastern Senegal and Upper Casamance zone. These crops offer the ability to produce nutritious grains and legumes for human consumption and high-quality fodder for livestock. Yet there are tradeoffs exist between these two uses. Removing aboveground biomass as feed can affect soil health, which may affect future yields. In addition, the impacts of enhanced cultivation of these crops on GHG emissions and the environment remain unknown. The DST will facilitate fuller accounting of these costs and benefits to inform scale-up.

To develop specific use cases of the DST, we will organize an initial workshop to gain buy-in of key stakeholders from research institutions, extension organizations, farmer groups, and donors. The stakeholders will help identify **(1)** the key benefits and costs streams that result from the selected agricultural interventions (such as the dual-purpose crops in Senegal), **(2)** the associated indicators the tool should track, **(3)** the landscapes the tool should focus on, and **(4)** key subgroups for distributional analysis, such as women and vulnerable populations.

Agriculture plays an important role in the economies of sub-Saharan Africa. At the same time, agriculture, forestry, and other land use-related dynamics contribute over half of the region's GHG emissions.

Fostering sustainable agricultural practices will be central to meeting the ambitious GHG emissions reduction targets adopted by the region's governments. The DST pilot will show how the tool can foster agricultural improvements within large, interconnected networks and help meet these goals. It will also generate insights on ways to strengthen local capacity to deploy and replicate the DST, to inform the scale-up of other sustainable agricultural technologies across sub-Saharan Africa and beyond.

Resources

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