The Sustainable Agriculture Matrix, First Edition

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Ratification of the Sustainable Development Goals (SDGs) by all member countries of the United Nations demonstrates the determination of the international community in moving towards a sustainable future. To make the commitment accountable, independent and transparent measurements of sustainability are essential. Agriculture is fundamental to all three pillars of sustainability, namely environment, economy, and society. However, the definition of sustainable agriculture and the feasibility of measuring it remain elusive, in part because it encompasses both biophysical and socio-economic components that are still poorly integrated.

We have developed a Sustainable Agriculture Matrix (SAM) using 30 indicators (see Figure) that measure sustainable agriculture at national scales from environmental, economic, and social dimensions. The goals are: (1) to provide a consistent and transparent measurement of each nation’ s performance; (2) to investigate the socioeconomic and ecological drivers for achieving sustainability; and (3) to quantify and visualize the impacts of current agricultural production on future sustainability. SAM reports indicators by country and year, so that end-users can track a country’ s progress along time and make comparison across countries among different dimensions of sustainability. SAM aims to serve as a platform to engage conversations among stakeholders involved in agriculture and to forge positive changes towards sustainability while avoiding unintended consequences. We envision that this first edition of SAM will be updated annually as we learn more about the utility of each indicator.

The current edition demonstrates several new insights (see Figure for examples of three countries; indicator values with low sustainability are plotted near the center and high values are plotted near the perimeter of each circle). In the USA, for example, all of the efficiency indicators of agricultural production per unit of water, land, or nitrogen used or greenhouse gases produced have been increasing since the 1960s, but the actual environmental impacts of land use change, groundwater depletion, nitrogen surplus and total greenhouse gas production have not decreased, indicating the importance of tracking indicators that reflect both production efficiency and actual environmental impacts. Agricultural GDP per capita in China has been increasing and approaching the USA level, but the agriculture GDP per rural population (RGDP) is still much lower than the in the USA, indicating the impact of dense rural population in China and the great challenges for China to improve the livelihood of its rural community. While prevalence of undernourishment has been decreasing globally, the obesity ratio has also been increasing, especially in developed countries. The energy and nutrition provided by 100 grams of food has been stagnant (e.g., USA) or largely reduced (e.g., China and Malawi), indicating that crop yield has been partly disconnected from its nutritional value. These examples demonstrate how the Sustainable Agriculture Matrix tracks and helps visualize the complex impacts of agriculture on all three pillars of sustainability and the tradeoffs among economic benefits and social and environmental cost that are characteristic of each country or region.

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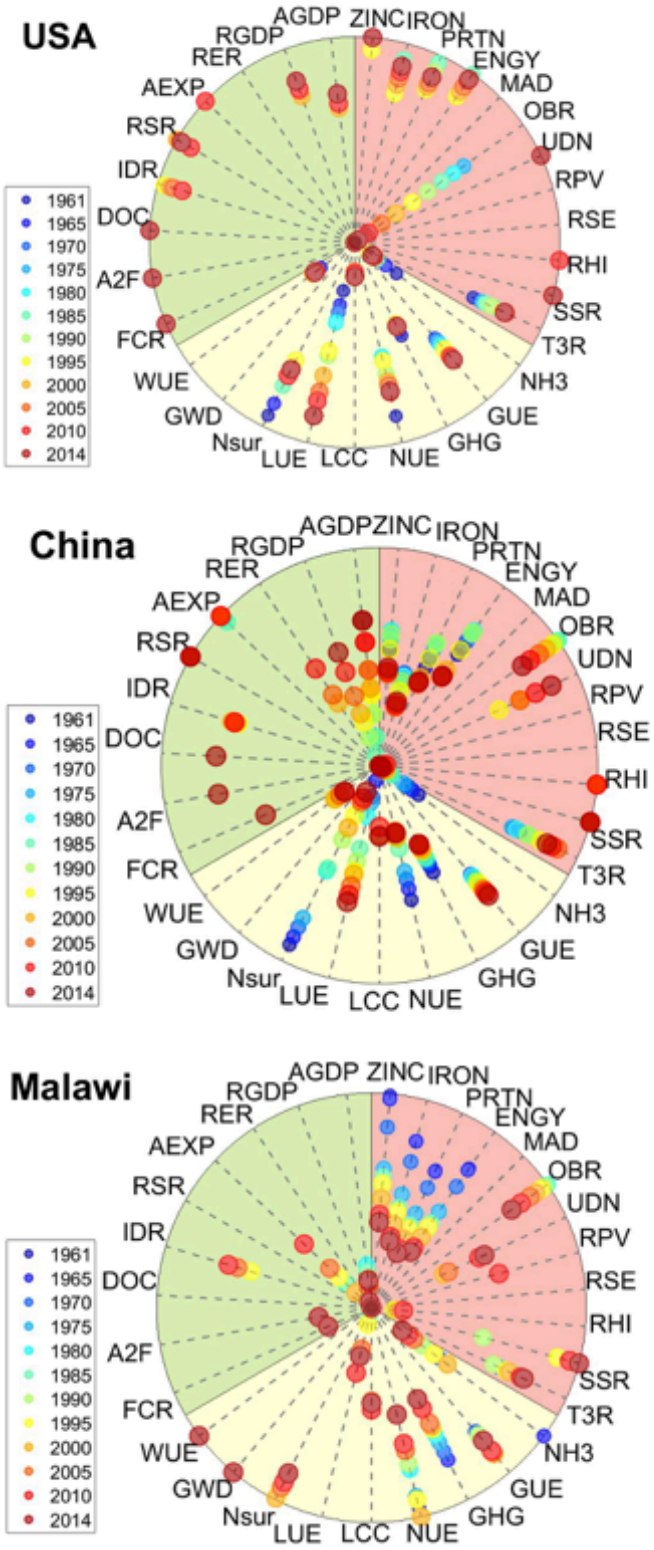

ABBR	Indicator names
WUE	Water use efficiency
GWD	Groundwater depletion rate
Nsur	Nitrogen surplus
LCC	Land cover change
LUE	Land use efficiency
GUE	Agriculture Productivity of GHG
NUE	Nitrogen use efficiency
NH3	NH_3 emission
GHG	Greenhouse gas emission
AGDP	Real agriculture GDP per capita
RGDP	Agriculture GDP per rural population
RER	Agricultural research expenditure
AEXP	Agricultural expenditure
RSR	Reserve (stock to consumption) ratio
IMD	Agriculture import dependency
DOC	Depth of credit
A2F	Access to finance
FCR	Food consumption expenditure ratio
T3R	Share of top 3 crops
SSR	Self-sufficiency ratio
RSE	Socio-economic indicator
RHI	Production diversity indicator
UDN	Prevalence of undernourishment
OBR	Obesity ratio
MAD	Minimum acceptable diet
ZINC	Zinc values of crops
IRON	Iron values of crops
PROT	Protein values of crops
ENGY	Energy values of crops
RPV	Rural poverty ratio

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