

Approaches in cropping systems research and challenges

Opinion

Agriculture in the U.S. has undergone several changes in the past century. Although highly productive and economically successful, there is increasing concern regarding negative environmental impacts of the current agriculture. Producers are interested in sustainable practices including integrated cropping and crop-livestock production. In such cropping systems, the goal of agricultural sustainability, economic profitability, and environmental quality is achieved by observing multiple components of the system and long-term monitoring of system responses that reflect changes in production practices and interaction among system components.¹ Short-term and discipline-specific research may provide a fraction of the story, but may not be helpful in untangling complex interactions among system components to enhance agricultural system sustainability in the context of changing climate, technology, and economic priority of farmers.

Adoption of conservation practices such as reduced- and no-tillage, crop rotations and diversification, legume integration in the rotation, and cover cropping are important for increasing high-quality food production and strengthening ecosystem services. Sustainability of cropping systems is possible through championing crop selection and crop, soil, and environmental management strategies.² Crop rotation and adoption of soil and water management and conservation strategies can improve crop production and enhance ecosystem services compared to the traditional system that relies on chemical fertilizers, pesticides, and soil amendments and uses repeated tillage for land preparation. The greater benefits from cropping systems are associated with additional challenges in the crop, soil fertility, and pest management. For example, there is a concern of nutrient and pesticide carryover from a crop in the rotation to the succeeding crop.³ Use of organic amendments may have smaller environmental footprints than traditional chemical-based systems, but optimizing nutrient release that meets timing and nutritional needs of crops is a greater challenge for achieving high productivity and profitability in organic production. Knowledge of interactions among diverse components of cropping systems is required to reveal the benefits from the conservation practices.

Long-term agro ecosystem research may help in understanding cropping system responses to agricultural management. This is because environmental changes we are experiencing today are partly due to human activities in the past century. For example, lower biomass carbon input and greater disturbance associated with farming in the last century has depleted 50-70% of soil organic carbon Stock. Soil carbon stock was expected to reach in equilibrium after 70-75 years of conversion from native grassland to annual cropping. Studies revealed that change in cropping systems and production practices continuously modifies the time required to reach the new equilibrium.⁴ In such scenario, long-term cropping systems research may help in the decision-making process.

Livestock integration in cropping systems can provide additional

Volume 3 Issue 2 - 2016

Rajan Ghimire

Department of Plant and Environmental Sciences, New Mexico State University, Clovis, NM

Correspondence: Rajan Ghimire, 2346 State Road 288, Clovis, NM 88101, USA, Email rghimire@nmsu.edu

Received: January 18, 2016 | **Published:** February 1, 2016

agronomic and environmental benefits by capturing positive ecological interactions while sustaining crop production and profitability. Despite additional economic pressure and complexity in agro ecosystem management practices, a crucial factor in livestock-integrated systems is the use of nutrients contained in livestock manure and compost. Continued applications of nutrients can cause nutrient accumulation, leaching, and environmental pollution.⁵ Similarly, effects of livestock-integrated systems on carbon sequestration, greenhouse gas emission, and nutrient leaching and stratification need additional attention.

Suitable evaluation frame and statistical approach are required to capture variability in systems-level studies. Development of the assessment framework that considers system components and interactions are needed in drawing system-level conclusions on crop production and ecosystem services. Existing agricultural systems studies compared diverse aspects of cropping systems, management approaches, and production environments but focuses on a particular aspect of the system using univariate evaluation models. Cropping systems models are used as decision support tools for adjusting system components, but such model has not been developed to evaluate system performance and interactions among system components.¹ Use of multivariate models and analysis approaches that has helped to understand complex ecological interaction can help in elucidating the relative influence of system components in cropping systems research. Therefore, cropping systems research should focus on interaction among system components, their responses to alternative production practices, and development of suitable evaluation framework to harness agronomic, economic, and environmental benefits.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

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