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Coop Research Program

Sustainable intensification of organic Basmati rice production

This project investigated the environmental, social, and economic impacts of organic Basmati rice production by smallholder farmers in northern India. Conventional and organic management practices had similar greenhouse gas emissions. However, organic farming reduced nitrogen pollution. A major constraint was the low availability of organic fertilizers, leading to lower than potential yields. To help, the project identified simple but effective strategies to increase manure quantity and quality, which could increase farmers' net profit by up to 40%.

Motivation

Organic practices are often promoted as a way of reducing the impact of rice cultivation on climate change and of improving smallholder livelihoods. Organic practices that use adequate water management practices and fertilizer application are expected to reduce greenhouse gas emissions, but conclusive data is missing. In addition, smallholder farmers willing to adopt organic practices are often constrained by a shortage of organic soil amendments. Recommendations for crop management should address this nutrient gap but they are often based on research trials, where fertilizers are optimized to maximize yield.

Objective

This project assessed the impact of organic Basmati rice management practices on the environmental, social, and economic sustainability of farms in the state of Uttarakhand, India. A major goal was to provide management recommendations while considering complexities of the whole farm system. The project was set up within the framework of a multi-stakeholder agricultural development project on sustainable production of organic and fair trade rice in India.

Research Highlights

Researchers conducted a two-year controlled field experiment to assess the environmental impact of seven alternative organic treatments varying in water management techniques, from continuous flooding to supplemental irrigation during dry spells, and fertilizer application, such as biogas slurry, green manure, and farmyard manure. A key result from this project was that in comparison to conventional cultivation using chemical fertilizers and continuous flooding, organic management practices did not alter greenhouse gas emissions but often

Project researcher Monojit Chakraborty at the field experiment to test various organic rice management practices.

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decreased nitrogen environmental pollution due to leaching or volatilization. All organic treatments, regardless of their nitrogen inputs, had similar nitrous oxide (N_2O) emissions. Results from farm surveys, manure products sampling, and systems modeling showed that few farmers in Uttarakhand were able to supply the nutrient needs of Basmati crops (see figure). Farmers had few livestock, and fresh farm manure was scarce. As a result, farmers achieved lower than potential yields. To address the problematic nutrient gap, the project identified three local viable interventions: manure management modifications, in situ green manuring, and purchasing farmyard manure. Examples of manure management modifications are straw bedding to capture livestock urine and covering farmyard manure stockpiles with plastic sheeting. Green manuring involves growing legumes, such as *Sesbania aculeata*, in the rice fields and working them into the soil to improve its overall quality. Cost-benefit analysis predicted that the proposed interventions could increase farmers' net profit by up to 40%.

Relevance to Stakeholders

The similar levels of nitrous oxide emissions among all organic treatments suggests that nitrogen inputs in organic management could be increased without causing a drastic adverse environmental impact. Higher nutrient inputs can boost crop yields, prevent soil mining, and improve soil health. The project also made locally relevant recommendations to improve manure management, considering the complexities of the whole farm system. This integrated research approach helped to enhance the transferability of management recommendations from research trials to the farm scale and is relevant for farmers, field practitioners, and development agencies.

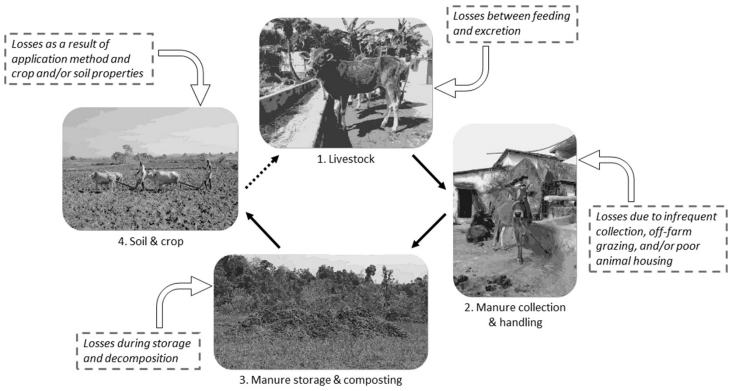

Figure: Conceptualization of farm-level manure nutrient availability and losses in mixed crop–livestock systems as the products of four manure management subsystems (Source: Ditzler, L.; Breland, T.A.; et al. 2018. CC BY 4.0).

Selected Publications

Ditzler, L.; Breland, T.A.; et al. **Identifying viable nutrient management interventions at the farm level: The case of smallholder organic Basmati rice production in Uttarakhand, India.** *Agr. Syst.* **2018**, 161, 61-71.

Media

Decock, C.; Chakraborty, M. **Sustainable intensification of organic Basmati rice production in Uttarakhand, India: a multidisciplinary systems approach**. *Swiss Agency for Development and Cooperation, Agriculture and Food Security Network Newsletter* [Online], **May 2015**.

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World Food System Center. **ETH Zurich at Expo Milano 2015: Focus on WFSC Projects**. Film presented at the EXPO 2015, Milan, Italy, **2015**.

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Food System Challenges Addressed Organic production systems, farm-level sustainability, greenhouse gas mitigation

www.worldfoodsystem.ethz.ch/research/research-programs/CRP/BasmaSus.html

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