

Economics, energy, and environmental assessment of diversified crop rotations in sub-Himalayas of India

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Abstract Reducing the carbon footprint and increasing energy use efficiency of crop rotations are the two most important sustainability issues of the modern agriculture. Present study was undertaken to assess economics, energy, and environmental parameters of common diversified crop rotations (maize-tomato, and maize-toria-wheat) vis-a-vis traditional crop rotations like maize-wheat, maize + ginger and rice-wheat of the north-western Himalayan region of India. Results revealed that maize-tomato and maize + ginger crop rotations being on par with each other produced significantly

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higher system productivity in terms of maize equivalent yield (30.2–36.2 t/ha) than other crop rotations (5.04–7.68 t/ha). But interestingly in terms of energy efficiencies, traditional maize-wheat system (energy efficiency 7.9, human energy profitability of 177.8 and energy profitability of 6.9 MJ/ha) was significantly superior over other systems. Maize + ginger rotation showed greater competitive advantage over other rotations because of less consumption of non-renewable energy resources. Similarly, maize-tomato rotation had ability of the production process to exploit natural resources due to 14–38 % less use of commercial or purchased energy sources over other crop rotations. Vegetable-based crop rotations (maize + ginger and maize-tomato) maintained significantly the least carbon footprint (0.008 and 0.019 kg CO₂ eq./kg grain, respectively) and the highest profitability (154,322 and 274,161 Rs./ha net return, respectively) over other crop rotations. As the greatest inputs of energy and carbon across the five crop rotations were nitrogen fertilizer (15–29 % and 17–28 %, respectively), diesel (14–24 % and 8–19 %, respectively) and irrigation (10–27 % and 11–44 %, respectively), therefore, alternative sources like organic farming, conservation agriculture practices, soil and water conservation measures, rain water harvesting etc. should be encouraged to reduce dependency of direct energy and external carbon inputs particularly in sub-Himalayas of India.

Keywords Carbon emission · Energy use efficiency · Maize · Rice · Tomato · Wheat