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Energy budgeting and carbon footprint of transgenic cotton–wheat production system through peanut intercropping and FYM addition

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Abstract Two of the most pressing sustainability issues are the depletion of fossil energy resources and the emission of atmospheric green house gases like carbon dioxide to the atmosphere. The aim of this study was to assess energy budgeting and carbon footprint in transgenic cotton–wheat cropping system through peanut intercropping with using 25–50 % substitution of recommended dose of nitrogen (RDN) of cotton through farmyard manure (FYM) along with 100 % RDN through urea and control (0 N). To quantify the residual effects of previous crops and their fertility levels, a succeeding crop of wheat was grown with varying rates of nitrogen, viz. 0, 50, 100, and 150 kg ha^{-1}. Cotton+peanut–wheat cropping system recorded 21 % higher system productivity which ultimately helped to maintain higher net energy return (22 %), energy use efficiency (12 %), human energy profitability (3 %), energy productivity (7 %), carbon outputs (20 %), carbon efficiency (17 %), and 11 % lower carbon footprint over sole cotton–wheat cropping system. Peanut addition in cotton–wheat system increased the share of renewable energy inputs from 18 to 21 %. With substitution of 25 % RDN of cotton through FYM, share of renewable energy resources increased in the range of 21 % which resulted into higher system productivity (4 %), net energy return (5 %), energy ratio (6 %), human energy profitability (74 %), energy productivity (6 %), energy profitability (5 %), and 5 % lower carbon footprint over no substitution. The highest carbon footprint (0.201) was recorded under control followed by 50 % substitution of RDN through FYM (0.189). With each successive increase in N dose up to 150 kg N ha^{-1} to wheat, energy productivity significantly reduced and share of renewable energy inputs decreased from 25 to 13 %. Application of 100 kg N ha^{-1} to wheat maintained the highest grain yield (3.71 t ha^{-1}), net energy return (105,516 MJ ha^{-1}), and human energy profitability (223.4) over other N doses applied to wheat. Application of 50 kg N ha^{-1} to wheat maintained the least carbon footprint (0.091) followed by 100 kg N ha^{-1} (0.100). Our study indicates that system productivity as well as energy and carbon use efficiencies of transgenic cotton–wheat production system can be enhanced by inclusion of peanut as an intercrop in cotton and substitution of 25 % RDN of cotton through FYM, as well as application of 100 kg N ha^{-1} to succeeding wheat crop.

Keywords Cotton · Carbon footprint · Energy · FYM ·