Feeding the future: the role of Integrated crop-livestock systems in enhancing food and energy production

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The Integrated Crop-Livestock Systems (ICLS) are an important source of animal-source foods, playing a pivotal role in meeting the current and future food demands of humanity. These systems can be more productive in terms of protein and energy production compared to pure non-grazed cropping systems. We aimed to evaluate the human-digestible protein (HDP) and energy production from these different systems, contrasting grazing intensities across 19 years of experimentation. Data were obtained from a long-term experimental protocol established as a randomized block design with three replicates, conducted since 2001 in Southern Brazil. The experiment included a winter pasture phase grazed by cattle (*Bos taurus*) followed by a summer crop phase of soybean (*Glycine max* (L.) Merr.). The pasture consisted of a mixture of black oat (*Avena strigosa* Schreb.) and annual ryegrass (*Lolium multiflorum* Lam.) managed under three grazing intensities defined by pasture height (10, 20, and 40 cm) and an ungrazed control (UG), constituting the treatments. Three tester animals were maintained under continuous stocking in each paddock while put-and-take animals were used to maintain the targeted heights. Data from the pasture phase were collected through forage sampling, allowing for the calculation of total herbage production (THP). Animals were weighed at the beginning and end of the grazing season to record the steers' live weight (LW). Soybean productivity (kg ha^{-1}) was evaluated at the end of the crop phase. The HDP (kg ha^{-1}) was calculated by summing the protein content from the different human-edible sources (beef and soybeans), adjusted for protein digestibility. Energy (GJ ha^{-1}) was calculated by multiplying the production during the pasture phase (THP and steers' LW) and crop phase (soybean yield) by their respective caloric values. All data were subjected to the analysis of variance (ANOVA) and Tukey's test, both at 5% significance level. The results suggest that incorporating animals and increasing grazing intensity continuously augments food yield. Specifically, the HDP production was highest under the 10 cm grazing intensity (1,009 ha^{-1}), followed by 20 cm (965 kg ha^{-1}), 40 cm (895 kg ha^{-1}), and UG treatments (778 kg ha^{-1}). Moderate grazing intensity (20 cm) achieved a 24% increase in food provision compared to the UG treatment. Energy was also influenced by grazing intensity, with low (40 cm) and moderate (20 cm) grazing intensities yielding better results (180 and 171 GJ ha^{-1}, respectively) than intensive grazing (10 cm) and UG treatments (150 and 138 GJ ha^{-1}, respectively). These findings indicate that well-managed ICLS offers a viable solution to enhance ecosystem services related to food provision while generating a higher amount of energy reutilized inside the system. This approach offers a viable solution for improving agricultural efficiency and sustainability.

Keywords: Food security, mixed crop-livestock, animal-source foods, nutrition, environmental sustainability

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