4.3 Economic implications

The benefit-cost analysis makes a fairly simple but important point: the highest-yielding treatment is not necessarily the most profitable one. Although T_4 (10%) and T_5 (12%) produced the greatest yield and biological efficiency, the additional spawn expenditure needed to move from 8% up to 10% or 12% was not fully recovered through extra revenue, so the 8% spawn rate came out as the most economical option under the price and cost assumptions used here. This lines up with the broader argument that input-use decisions in mushroom cultivation should be guided by marginal cost-benefit analysis rather than yield maximization alone (Bhandari et al., 2022), and it suggests that Nepalese growers who currently follow the 10% convention could trim their spawn expenditure with only a marginal yield penalty and a corresponding gain in profit margin. Given that inadequate technical guidance and thin profit margins are repeatedly flagged as constraints on the wider mushroom sector in Nepal (MOALD, 2023), even a modest, evidence-based adjustment of this kind could matter at the farm level.

4.4 Limitations and future research

This trial was conducted at a single research station over one cropping cycle, and substrate moisture and internal bag temperature during colonization were not logged continuously; as a result, the specific physiological mechanisms behind the observed responses could not be verified directly. The benefit-cost analysis also relied on a single assumed farm-gate price and a simplified fixed-cost structure, which may not capture the price variability seen across markets and seasons in Bardiya — similar sensitivity has been reported for other input variables in *Pleurotus* systems, such as fertigation timing (Naim et al., 2020). Future work should repeat this trial across multiple locations and cropping seasons, incorporate direct monitoring of substrate temperature and moisture, and test a wider range of spawn rates (for example, 7% and 9%) to pin down the economically optimum rate more precisely, alongside a sensitivity analysis of the benefit-cost ratio under varying mushroom prices, along the lines suggested by Oei (2003) and Pal et al. (2017) for other *Pleurotus* species.

5 Conclusion

This study shows that spawn rate has a real, measurable effect on colonization speed, yield, morphology, contamination incidence, and profitability of oyster mushroom cultivation under Nepalese Terai conditions. Raising the spawn rate from 4% to 12% shortened the cropping cycle and increased yield and biological efficiency, with the largest gains occurring up to 10%, beyond which returns clearly diminished. Once spawn cost was weighed against gross returns, however, the 8% spawn rate emerged as the more economical choice, giving a benefit-cost ratio of 1.34 compared with 1.30 for the conventional 10% farmer practice. Smallholder growers in Bardiya and similar Terai districts who are aiming to maximize profitability rather than raw yield may want to consider trimming their spawn rate from the traditional 10% down to around 8%, while growers who priorities the fastest possible cropping cycle and maximum yield should stick with the 10%-12% range. Multi-season, multi-location trials, together with sensitivity analysis under varying market prices, are recommended before this recommendation is generalized to other regions of Nepal.

Author contributions

BK conceived and designed the study, conducted the research, interpreted the results, and prepared the original manuscript. AG performed the data analysis, assisted with data interpretation, and critically reviewed the manuscript. SC and KB managed the experimental facility, supervised laboratory operations, and collected the experimental data. All authors read and approved the final manuscript.

Conflict of Interest Disclosure

The authors affirm that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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