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Enhancing Seasonal Resilience and Resource Efficiency in Button Mushroom Production through the Mushroom Kothi System

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INTRODUCTION & AIM

Button mushroom (*Agaricus bisporus*) cultivation in India is highly seasonal due to its strict requirements for low-temperature, high-humidity, and low-CO_2 environments, conditions that are difficult to maintain in traditional farmer-managed grow rooms. As ambient temperatures rise earlier each year and humidity fluctuates more sharply due to climate variability, farmers frequently experience aborted pinheads, poor fruit body quality, and contamination outbreaks. The lack of controlled microclimate infrastructure also makes production inconsistent, with yields dropping significantly during extended warm periods. These challenges highlight an urgent need for low-cost, digitally monitored cultivation systems capable of maintaining biological thresholds independent of external environmental stress.

Aim:

1. To evaluate whether an IoT-enabled, compact controlled-environment system (Mushroom Kothi) can enhance seasonal resilience, stabilize yield, and improve resource-use efficiency across diverse agro-climatic zones.
2. To assess water-use efficiency, energy consumption, crop loss reduction, and post-harvest quality under semi-controlled farm conditions.

METHOD

- **Experimental Setup:**
  - Locations: 3 agro-climatic zones (North, Central, East India).
  - Seasons: 2 consecutive cycles (pre-summer, summer).
- **Design:**
  - 30 Mushroom Kothi units
  - 30 farmer-managed control rooms
- **Sensors used:** Temperature (SHT series), RH, CO_2 (NDIR), substrate moisture, and chamber airflow.
- **Actuators:** Automated misting, intake/exhaust ventilation, and circulation fans.
- **Data Logging:** ESP32 cloud system with 1–5 min sampling interval.
- **Measured Indicators**
  - Yield (g/kg substrate; kg/m²)
  - Water use (L/kg)
  - Energy use (Wh/kg)
  - Crop loss (%)
  - Shelf life (days)
  - Microclimate variability (SD of T, RH, CO_2)

RESULTS & DISCUSSION

- **Season Extension:** Productive window extended by ~2 months, enabling off-season production.
- **Yield Improvement:** Average 20% higher yield per unit substrate.
- **Water Savings:** 35–40% reduction in water per kg yield compared to control.
- **Crop Loss:** Contamination and heat-stress mortality reduced by ~30%.
- **Shelf Life:** Improved by 1–2 days due to uniform fruiting and lower pathogen pressure.
- **Labor Efficiency:** Manual interventions reduced by ~40%, improving usability for small farmers.
- **Interpretation:**

Maintaining RH within 85–90% and temperature within 16–20°C significantly stabilized primordia formation and fruit body uniformity. IoT monitoring prevented overheating events common in summer, improving biological efficiency and sustainability.

CONCLUSION & DISCUSSION

An IoT-enabled microclimate chamber offers a scalable pathway to year-round Button mushroom cultivation in India. The system improved yield, reduced water and energy inputs, and lowered crop losses, contributing to climate resilience and sustainable intensification.

FUTURE WORK / REFERENCES

Future Work

- Testing under extreme heatwaves (45°C+)
- Integration of solar panels for energy-neutral operation
- AI-driven contamination prediction and flush forecasting
- Economic analysis (cost–benefit, payback period)

Key References

- Bellettini et al., Saudi Journal of Biological Sciences (2019)
- Kwon et al., Journal of Biosystems Engineering (2018)
- Zawadzka et al., PLoS ONE (2022)
- Chong et al., Biosensors (2023)