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Optimizing Microclimate for Maize–Mushroom Intercropping under Semi-Arid Conditions: A Climate-Smart Farming Approach

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Background

1. Climate variability and **rising temperatures** are major challenges affecting crop productivity and resource efficiency in semi-arid regions.
2. Conventional monocropping systems are often less resilient to microclimatic fluctuations and **inefficient in land and resource use.**
3. **Intercropping** is a sustainable strategy that enhances resource utilization, improves soil health, and stabilizes yields.
4. Paddy straw mushroom (PSM) (*Volvariella volvacea*) is a **fast-growing species** that thrives under **warm, humid conditions** **(Thiribhuvanamala et al., 2021).**
5. Integrating mushroom cultivation with maize provides mutual benefits; maize offers shade and **moderates temperature**, while mushrooms add value and utilize agricultural by-products.

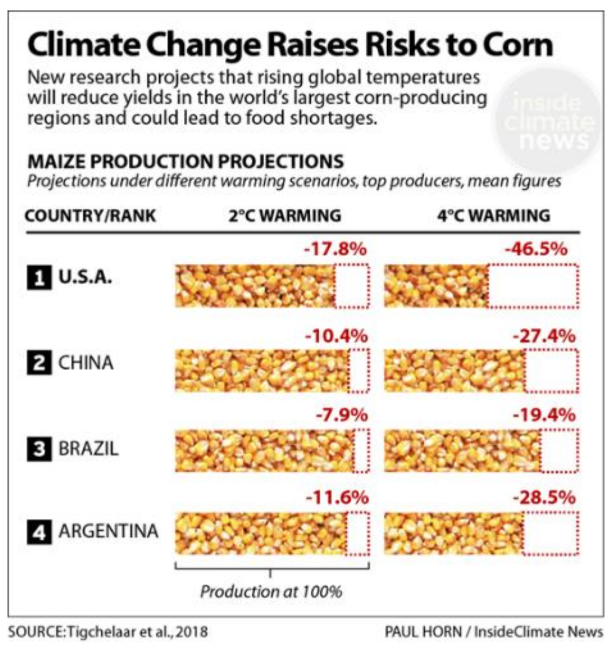

Fig 1. Projected decline in maize yields under global warming scenarios for the top producing countries

Aim

- To evaluate the effects of maize–mushroom intercropping, under different row spacings and mulching practices, on **microclimate, yield, and resource use efficiency** to develop a sustainable and climate-resilient farming system.

Methodology

1. Experimental Site

The study was conducted in field no.36 of Eastern Block, Central Farm Unit, **Tamil Nadu Agricultural University, Coimbatore.** The experimental field is geographically situated at the latitude of 11°01′ N, longitude of 76°93′ E and altitude of 426.7 m MSL.

2. Experimental design

A **randomized block design (RBD)** with three replications and eight treatments was used, along with a polyhouse control

Treatment details	
T_1	60 cm × 25 cm wide row spacing
T_2	45 cm × 25 cm close row spacing
T_3	45/75 cm × 25 cm wide paired row spacing
T_4	30/60 cm × 25 cm close paired row spacing
T_5	T1 + Mulching
T_6	T2 + Mulching
T_7	T3 + Mulching
T_8	T4 + Mulching
T_9	Polyhouse

Table 1. Details of Experimental Treatments

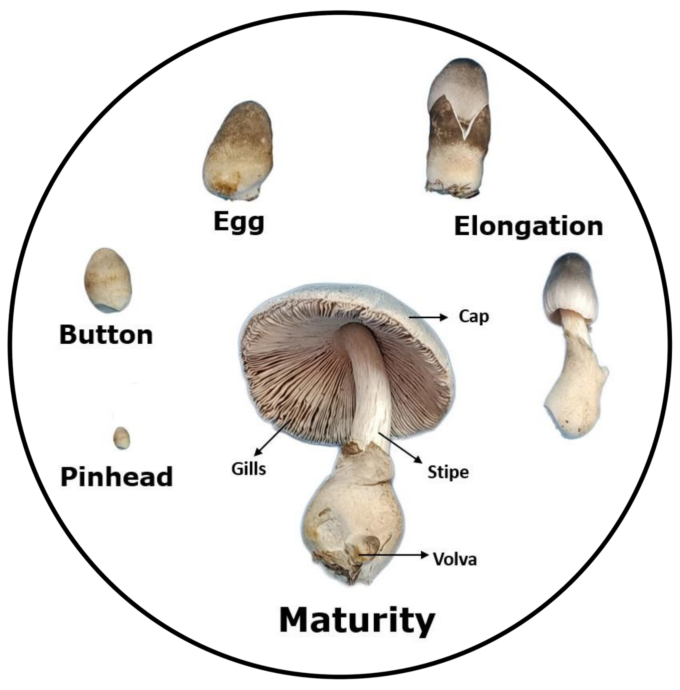

Fig 2. Development stages of PSM

3. Mushroom intercropping in maize

Mushroom beds were placed between two rows of maize; each bed was covered with a **semi-transparent blue polythene sheet** to prevent the entry of foreign particles and to retain moisture and warmth. The polythene cover was maintained throughout the entire mushroom cropping cycle. The layout of mushroom intercropping in normal and paired-row maize systems is shown in Fig. 2.

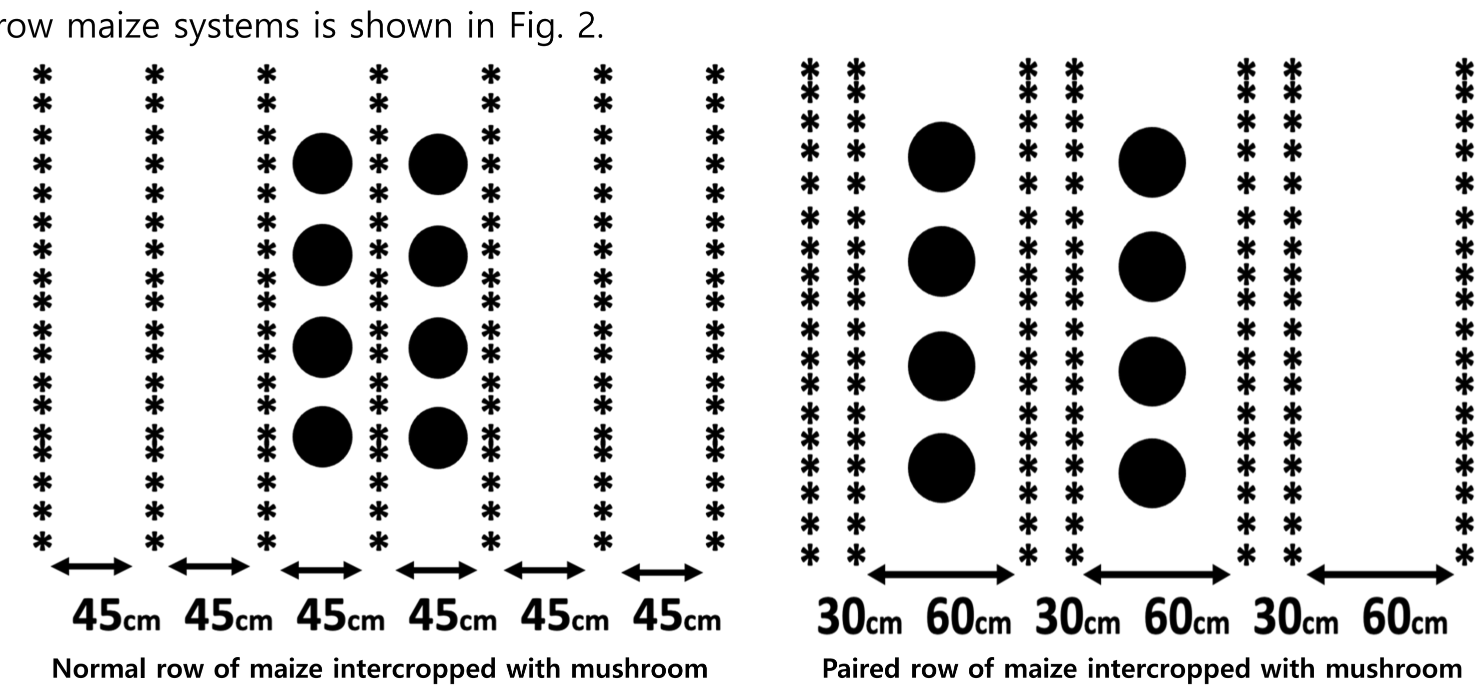

Fig 3. Layout of maize field intercropped with PSM beds

4. Biological efficiency (BE)

$$\text{Biological efficiency (BE)} = \frac{\text{Total weight (kg) of harvested fresh mushrooms}}{\text{Total dry weight (kg) of substrate used}} \times 100$$

- Luu et al., (2022)

5. Land Equivalent Ratio (LER)

$$\text{Land Equivalent Ratio (LER)} = \frac{\text{Yield of maize in intercrop}}{\text{Yield of maize in sole crop}} + \frac{\text{Yield of mushroom in intercrop}}{\text{Yield of mushroom in sole crop}}$$

LER > 1 Yield advantage; **LER < 1** Yield disadvantage; **LER = 1** No yield advantage

Results

Treatment	Temperature (°C)		Relative Humidity (%)	
	Summer	Kharif	Summer	Kharif
T_1 Wide row 60 x 25 cm	29.8	25.8	75.3	80.9
T_2 Close row 45 x 25 cm	29.9	25.7	77.2	81.6
T_3 Wide paired row 45/75 x 25 cm	29.9	26.1	73.6	79.6
T_4 Close paired row 30/60 x 25 cm	29.6	25.7	76.1	81.6
T_5 T1 + Mulching	29.5	25.5	75.9	80.7
T_6 T2 + Mulching	29.2	25.8	78.5	81.3
T_7 T3 + Mulching	29.4	25.4	74.5	79.4
T_8 T4 + Mulching	29.2	25.3	77.4	81.0
T_9 Polyhouse	33.8	29.6	87.1	84.8

Table 2. Microclimatic variables in different treatments during summer and kharif

Treatment	Yield (g bed⁻¹)		BE (%)	
	Summer	Kharif	Summer	Kharif
T_1	468	510	15.6	17
T_2	519	563	17.3	18.8
T_3	256	348	8.5	11.6
T_4	503	525	16.8	17.5
T_5	537	544	17.9	18.1
T_6	**580**	**589**	**19.3**	**19.6**
T_7	323	381	10.8	12.7
T_8	546	550	18.2	18.3
T_9	603	681	20.1	22.7

Table 3. Effect of microclimate modifications on the mushroom yield and BE

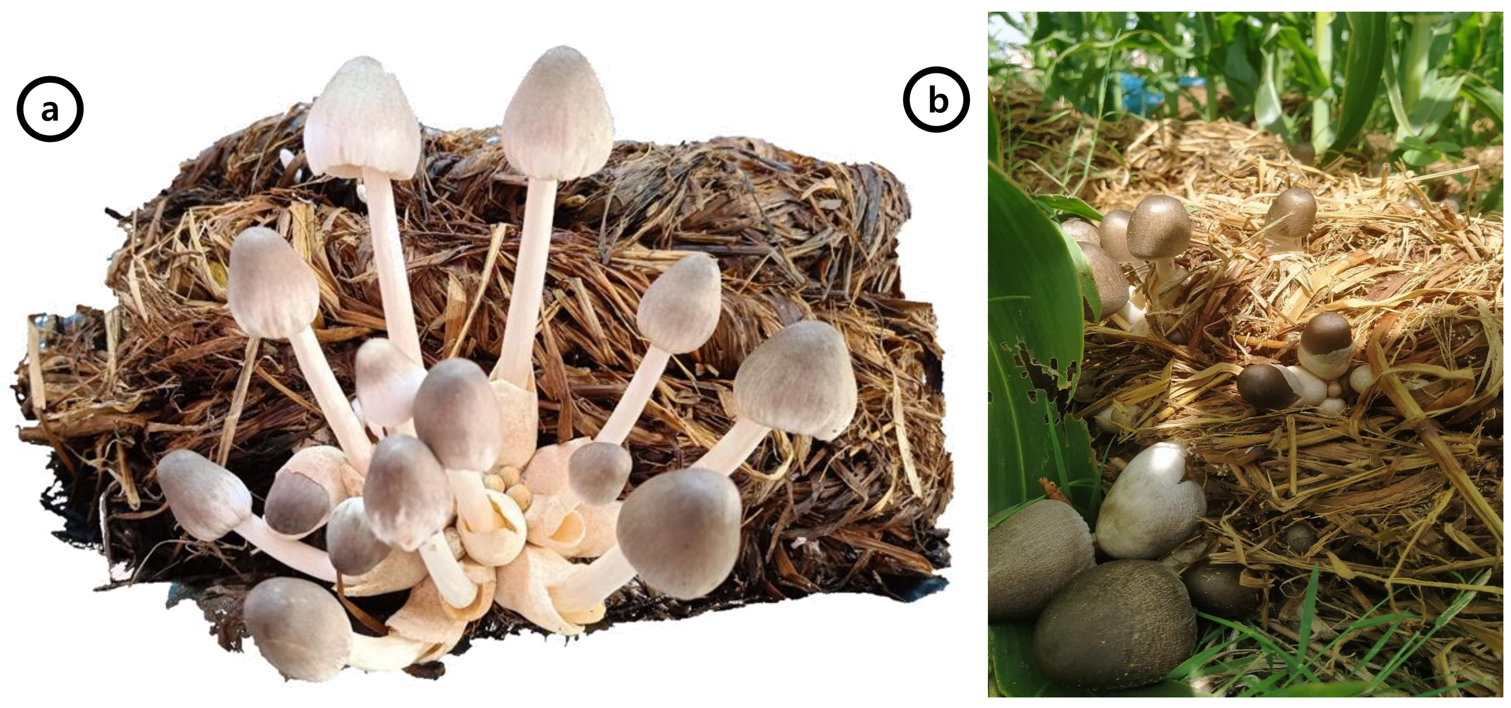

Fig 4. Fruiting bodies of *Volvariella volvacea* under (a) polyhouse and (b) maize field

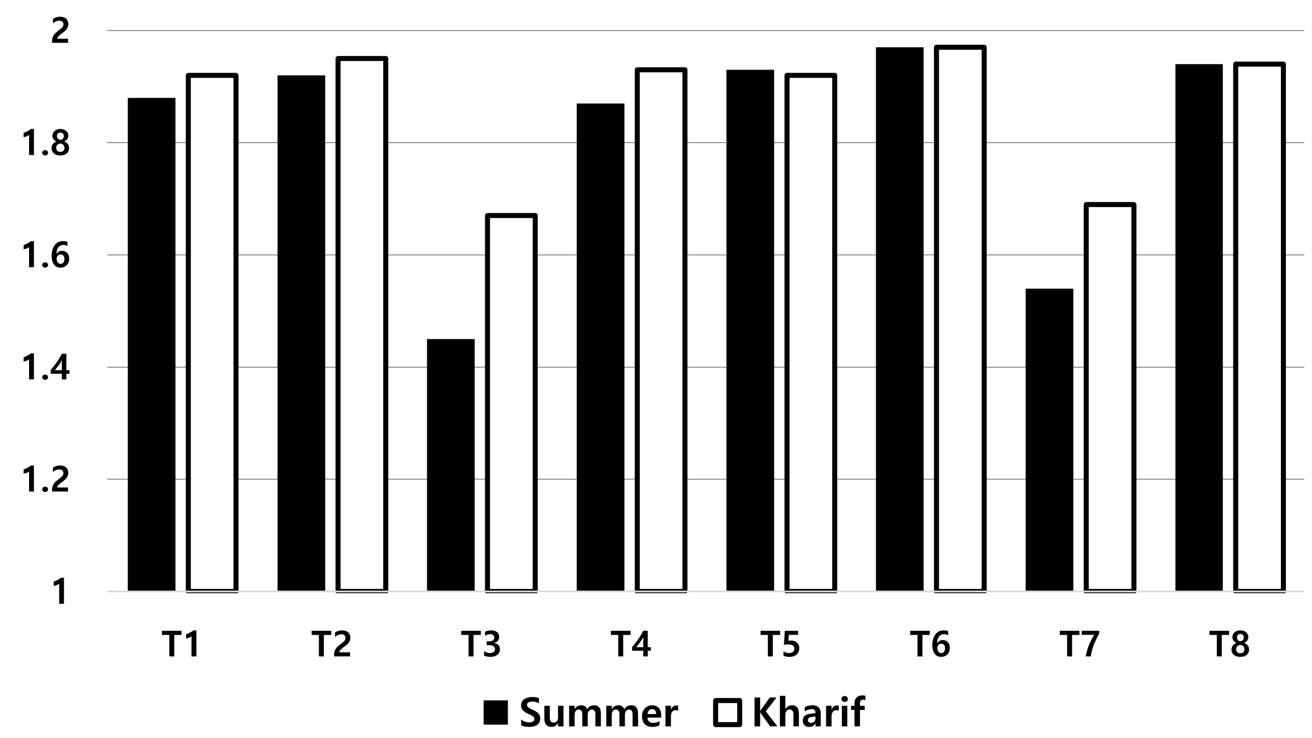

Fig 5. Effect of microclimate on LER of maize + mushroom intercropping system during summer and kharif season

Conclusion

- All intercropping systems achieved **higher land equivalent ratios**, indicating improved productivity per unit area.
- Maize–mushroom intercropping offers a **low-cost, climate-resilient, and resource-efficient** farming approach that promotes sustainable agroecosystems for smallholder farmers.

References

1. Thiribhuvanamala, G., A. S. Krishnamoorthy, C. Kavitha, Shwet Kamal, Anil Kumar, and V. P. Sharma. 2021. "Strategic Approaches for Outdoor Cultivation of Paddy Straw Mushroom (*Volvariella volvacea*) as Intercrop Under different Cropping Systems." Madras Agricultural Journal 108 (march (1-3)):1.

2. Luu, T. T. H., Bui, D. K., Huynh, N., Le, T. L., & Green, I. (2022). Effect of the Cultivation Technology on the Yield of Paddy Straw Mushroom (*Volvariella volvacea*). The Korean Journal of Mycology, 50(3), 161-171.