Productivity of soybean-maize-mung bean intercropping in East Java, Indonesia

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Introduction

- Indonesia is self-sufficient in maize but not in soybean
- We propose a soybean-maize intercropping system as a strategy to increase soybean production.
- When simultaneously sown and near simultaneously harvested (limited temporal complementarity), significant yield benefits from intercropping were not expected.
- Our objective is to explore a range of intercropping configurations for their effects on yields of the component species, addressing the following research questions:

1. What are yields of maize-soybean intercropping with replacement design and limited temporal complementarity in East Java, Indonesia?
2. How does placing maize rows closer and increasing the space between soybean and maize rows(narrow-wide design) affect the yields?
3. How does an additive intercropping system with narrow maize row spacing affect the yields?

Result

- The Land Equivalent Ratio (LER) for replacement designs approached 1 (Figure 2).
- In the narrow-wide-row configuration (B), soybean exhibited a slightly higher pLER, while maize showed no significant difference compared to the replacement system.
- The LER of additive systems was greater than 1, significantly outperforming the other configurations.

Methodology

- Field experiments were conducted in 2022 and 2023, covering two growing seasons each year.
- We tested monocultures of soybean, maize, mung bean, as well as four different intercropping systems (Fig. 1). For soybean we used as standard cultivar, Grobogan (cv 1) and as cultivar with improve processing quality Osoya (cv 2).
- The land productivity of the intercropping systems was assessed using the land equivalent ratio (LER, see Eq. 1).

$$LER = pLER_{\mathrm{m}} + pLER_{\mathrm{s}} + pLER_{\mathrm{u}} = \frac{Y_{\mathrm{m}}}{M_{\mathrm{m}}} + \frac{Y_{\mathrm{s}}}{M_{\mathrm{s}}} + \frac{Y_{\mathrm{u}}}{M_{\mathrm{u}}} \qquad \text{(Eq.1)}$$

Y_{m} , Y_{s}, Y_{u} : the yields in intercrops for maize, soybean and mungbean (g m^{-2}).
M_{m} , M_{s} , M_{u} : the yields in sole crops for maize, soybean and mungbean (g m^{-2}).
$pLER_{\mathrm{m}}$, $pLER_{\mathrm{s}}$, $pLER_{\mathrm{u}}$: the partial LER for maize, soybean and mungbean..

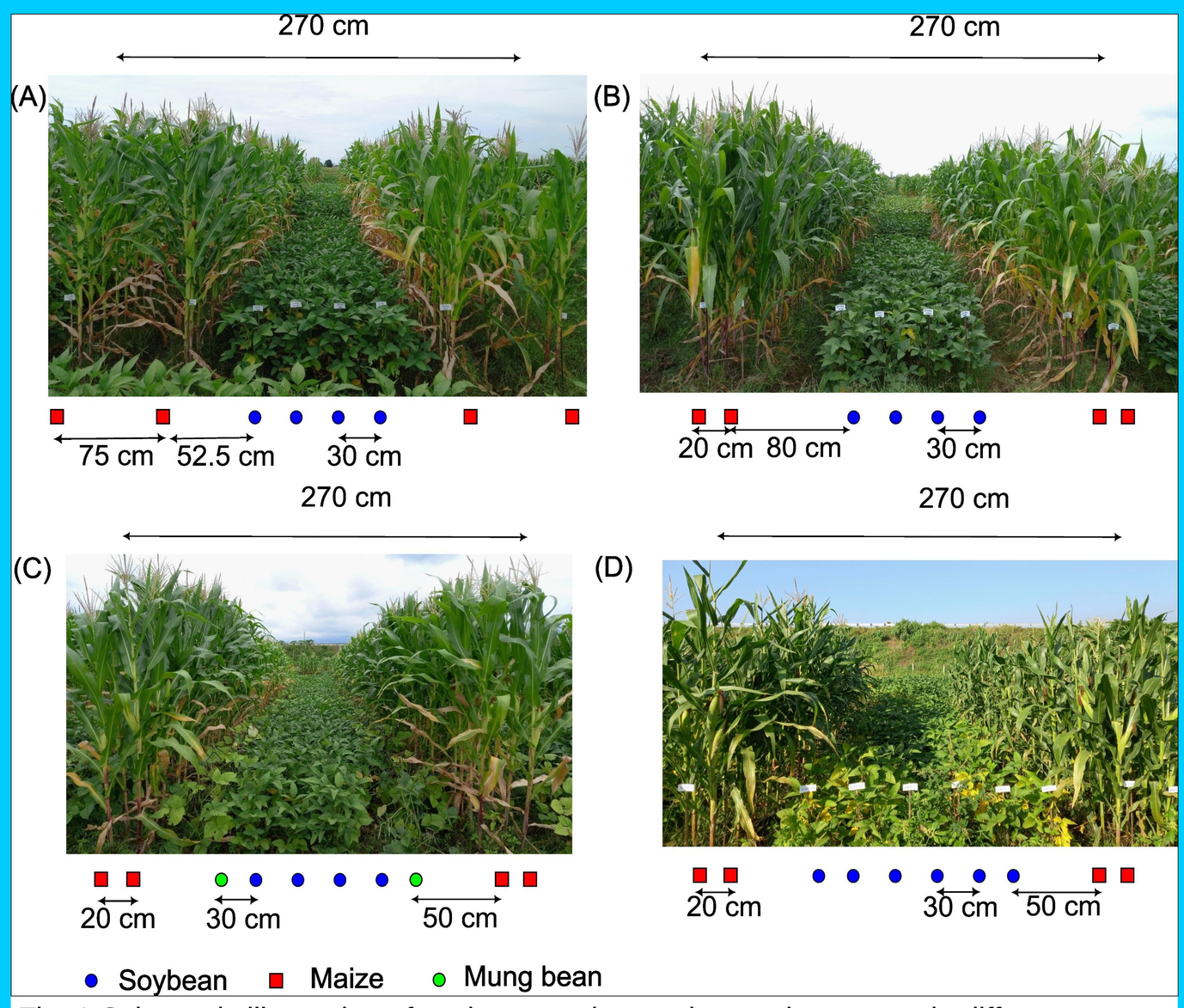
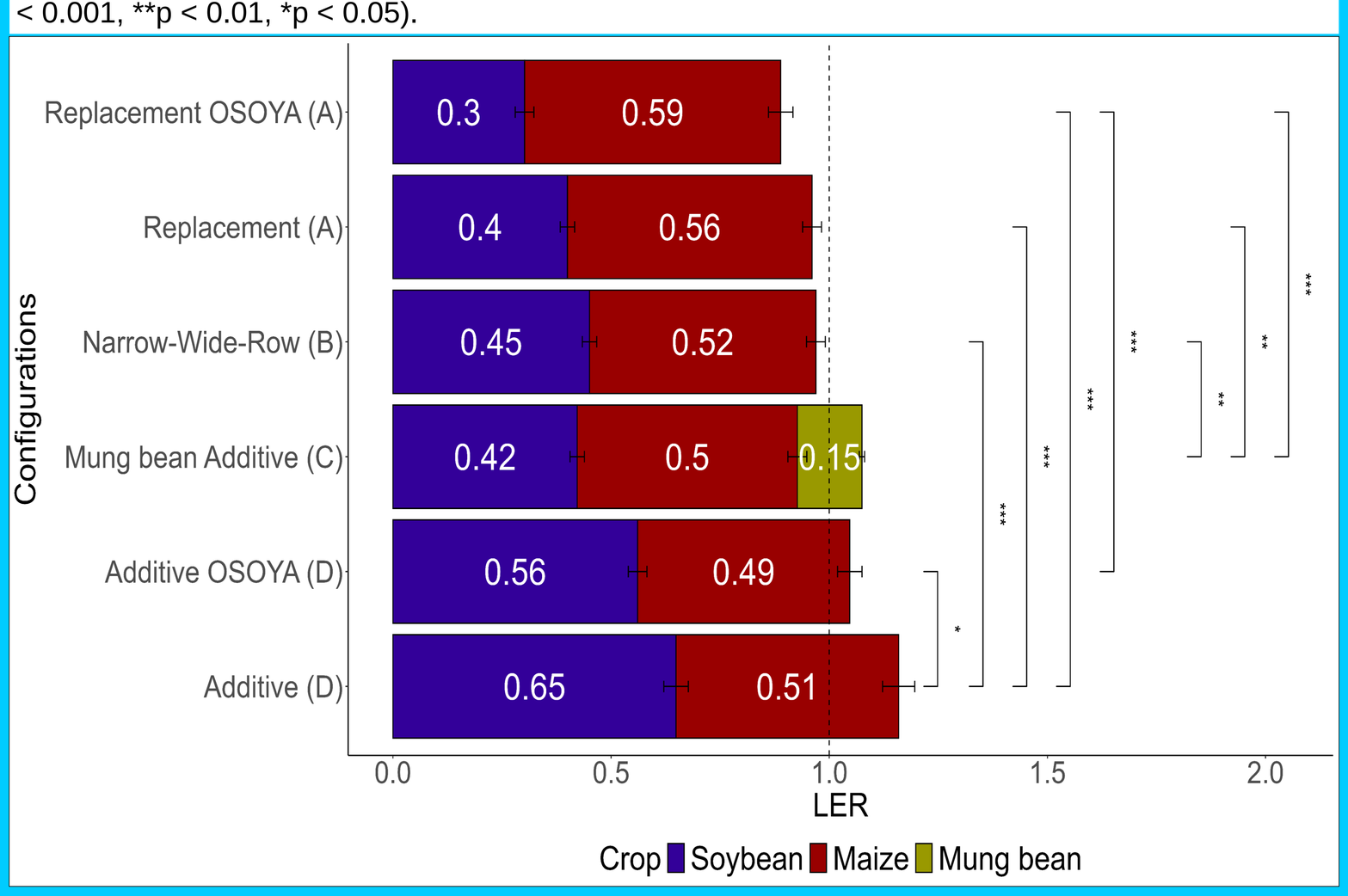


Fig. 1 Schematic illustration of soybean, maize, and mung bean rows in different intercropping configurations. (A) Maize-soybean 2:4 replacement intercropping, (B) Maize-soybean 2:4 narrow-wide-row intercropping, (C) Maize-soybean-mung bean 2:4:2 additive intercropping,(D) Maize-soybean 2:6 additive intercropping.

Figure 2. Land Equivalent Ratios (LER) and partial LER (mean ± standard error) for maize, soybean (two cultivars, see methodology), and mung bean across different configurations (see Fig. 1). Asterisks indicate significant differences between configurations according to Fisher's LSD test (***p < 0.001, **p < 0.01, *p < 0.05).



Conclusion

1. Only with an additive design did maize-soybean intercropping with limited temporal complementarity enhance land productivity.
2. Narrowing the row distance of maize hardly affected maize pLER but allowed higher soybean land productivity.
3. The yield advantage of the additive intercropping system differed between the soybean cultivars
4. Further research is required to test if maize sole crops could also be grown at the high density used in the narrow maize row systems.