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Economics of selected cropping system practices in the province of La Union, Philippines

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ABSTRACT

This study evaluated the agronomic and economic performance of selected cropping systems involving sweet corn (*Zea mays* L.) and finger pepper (*Capsicum annuum* L.) under La Union conditions, Philippines. The experiment was conducted from November 2025 to January 2026 using a Randomized Complete Block Design (RCBD) with three replications. Three cropping systems were compared: monocrop sweet corn, monocrop finger pepper, and sweet corn + finger pepper intercrop. Agronomic, yield, and economic parameters were assessed. Results showed that cropping system had no significant effect on days to tasseling, cob length, cob diameter, chlorophyll content, sweet corn yield, finger pepper flowering, fruit length, and plant height. Monocrop sweet corn produced significantly taller plants (232.87 cm) than intercropped sweet corn (222.55 cm), while intercropped sweet corn produced significantly heavier ears (237.71 g) than monocrop sweet corn (230.85 g). Sweet corn yield was statistically comparable between monocrop (2,328.18 kg ha^{-1}) and intercrop (2,152.19 kg ha^{-1}) systems. Monocrop finger pepper produced significantly higher marketable yield (20,954.30 g) than intercropped finger pepper (8,318.38 g). Economic analysis revealed that monocrop sweet corn had the lowest production cost (₱32,560.00 ha^{-1}), highest net income (₱1,563,606.00 ha^{-1}), highest return on investment (4,769.22%), and highest benefit-cost ratio (48.69). The intercrop system incurred the highest production cost (₱36,640.00 ha^{-1}) but remained profitable, generating a net income of ₱1,263,885.80 ha^{-1}, ROI of 3,416.43%, and BCR of 35.16. The findings indicate that monocrop sweet corn is the most economically efficient cropping system under La Union conditions. However, sweet corn–finger pepper intercropping remains a profitable alternative that offers production diversification and potential risk reduction for smallholder farmers.

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INTRODUCTION

Farmers have long organized their fields around one simple question: how best to use what land they have. Cropping systems capture the answer-they describe the types of crops grown, the order in which they follow one another, and the way they are managed from season to season. At one end of the spectrum sits monoculture, in which a single crop is grown on a plot for a given season; at the other end is intercropping, where two or more crops share the same field at the same time. What a cropping system ultimately determines is how well available land, labor, water, and nutrients are turned into food and income (Maitra *et al.*, 2021). In Philippine smallholder agriculture, where most farm families cultivate parcels measured in fractions of a hectare, choosing the right cropping arrangement is one of the most consequential decisions a farmer makes each growing season-one that shapes not just output but the household's financial stability from one harvest to the next. Where a single crop occupies the field during a season-to intercropping, where two or more crop species are grown simultaneously on the same plot. The design of a cropping system determines how efficiently available land, labor, water, and nutrients are utilized, and directly shapes farm profitability and long-term soil health (Maitra *et al.*, 2021). In the context of smallholder agriculture in the Philippines, cropping system decisions are among the most consequential made each season, shaping not only productivity but also income stability and risk exposure.

Growing two crops together on the same piece of land is not a new idea in Asia or Southeast Asia. For many smallholder families, it has simply been the way farming was done long before researchers gave it a name. What is relatively new is the body of scientific evidence confirming why it works and how reliably it performs. A systematic review drawing on 191 published field experiments conducted across five continents and involving 118 different crop species found that intercropped plots almost always achieve Land Equivalent Ratio values above 1.0—the benchmark indicating that intercropping produces more combined output per unit area than the same crops grown separately (Paut *et al.*, 2023). Among the specific combinations that have been studied, maize intercropped with chili pepper stands out. A field trial in Benin demonstrated that every intercrop arrangement tested outperformed monocultures in land-use efficiency, with the best spatial configuration returning USD 7,796.6 per hectare in gross income (Legba *et al.*, 2023). Reviewing evidence from across the globe, Li *et al.* (2023) found that this advantage is not confined to any single region or management system-the productivity gains from intercropping hold up under a wide range of growing conditions. A systematic review of 191 published field experiments spanning five continents and 118 crop species confirmed that intercropped systems almost universally achieve Land Equivalent Ratios (LER) above 1.0-indicating greater combined output per unit of land than the corresponding monocultures (Paut *et al.*, 2023). For the pairing of maize and chili pepper specifically, a field study recorded a best-arrangement gross return of USD 7,796.6 per hectare (Legba *et al.*, 2023). Li *et al.* (2023) further confirmed through a meta-analysis of global data that the productive advantage of intercropping is robust across a wide range of environments and management intensities.

La Union sits on the western coast of northern Luzon, flanked by the Ilocos Region to the north and the Cordillera highlands to the east. Its farming communities rely heavily on vegetable production and among the crops that anchor that economy, sweet corn (*Zea mays* L.) and finger pepper (*Capsicum annuum* L.) hold prominent positions. Finger pepper sold at an average wholesale price of PhP 68.81 per kilogram in 2023- a price strong enough to attract smallholder investment at even modest production scales (PSA, 2024). Sweet corn, for its part, has earned a reliable following among farmers in the province because it matures quickly, asks relatively little in terms of management, and consistently commands decent market returns (Celerinos and Manigo, 2025). The logic of growing both together on the same piece of land is straightforward: two income

streams from a single plot, without the additional land acquisition that separate monocultures would require-a practical advantage that matters greatly for farm households working within less than one hectare (DA, 2022).

Sweet corn (*Zea mays* L.) and finger pepper (*Capsicum annuum* L.) are among the key vegetable crops of the region.

The Philippine Statistics Authority recorded finger pepper at a wholesale price of PhP 68.81 per kilogram in 2023, while sweet corn has long been favored by smallholders for its shorter growing period and reliable market returns (PSA, 2024; Celerinos and Manigo, 2025). Cultivating both crops simultaneously on the same plot allows farmers to earn from two commodities without expanding land area- a critical advantage for households managing parcels of less than one hectare (DA, 2022).

Part of what makes sweet corn and finger pepper a sensible pairing is simply the way they grow. Sweet corn is a tall, fast-growing crop that reaches canopy height and completes its reproductive cycle within 60 to 75 days. Finger pepper, by contrast, develops more slowly and stays low in the canopy throughout its productive life. Because the two crops occupy different vertical layers and peak in their resource demands at different times, direct competition for light across the full growing season is substantially reduced. Field evidence backs this up. Liu *et al.* (2021) found that when hot pepper was grown alongside maize, anthracnose pressure dropped considerably-not because of any applied treatment, but because the physical structure of the corn canopy broke up spore dispersal pathways and changed the humidity conditions around the pepper. Pepper yields in those intercropped plots came in between 19.5 and 32.7 tons per hectare, holding their own against pepper grown as a pure stand. Hu *et al.* (2023) added another dimension to this picture, showing that maize-pepper intercropping promoted the formation of arbuscular mycorrhizal networks in the root zone that actively suppressed Phytophthora blight-one of the pepper's most destructive soil-borne diseases. Sweet corn grows tall and rapidly, completing its main productive phase within 60 to 75 days, while finger pepper matures more slowly and occupies a lower canopy position. This spatial and temporal differentiation reduces direct competition for light across the full season. Liu *et al.* (2021) reported that growing hot pepper alongside maize significantly reduced anthracnose pressure-the taller corn canopy disrupted fungal spore dispersal and moderated the pepper microclimate-with intercropped pepper yields of 19.5 to 32.7 tons per hectare, comparable to monoculture yields. Hu *et al.* (2023) further demonstrated that maize-pepper intercropping suppressed Phytophthora blight in pepper through the promotion of arbuscular mycorrhizal networks.

The policy environment in the Philippines provides active support for cropping system diversification. Republic Act 10068, enacted in 2010 as the Organic Agriculture Act, calls on the farming sector to adopt practices that restore soil fertility, cut down on synthetic chemical use, and safeguard the health of both producers and consumers (RA 10068, 2010).

Intercropping sits comfortably within that framework. The Department of Agriculture has included it among the recommended strategies available to vegetable farmers who are trying to do more with limited land (DA, 2022). Research from comparable farming contexts reinforces the case. Emran *et al.* (2022) found, in a study of smallholder farms in Bangladesh, that diversifying cropping systems through intercropping consistently raised both per-hectare productivity and the efficiency with which water, nutrients, and labor were used—relative to monoculture baselines. Belay and Melka (2024) reached a similar conclusion on the economic side, finding that intercropping arrangements outperformed monocultures on profitability measures across the smallholder farms they studied., which mandates farming practices that build soil fertility, reduce synthetic chemical dependence, and protect the well-being of producers and consumers (RA 10068, 2010). The Department of Agriculture has

identified intercropping as a recommended option for smallholder vegetable farmers seeking to increase income from limited land (DA, 2022). Emran *et al.* (2022) demonstrated that intercropping consistently improved both productivity and resource-use efficiency relative to monoculture, while Belay and Melka (2024) confirmed that intercropping land-use systems outperformed monocultures in profitability.

The work reported here examined how the choice of cropping system—referred to as Factor A-shaped the growth, yield, pest incidence, and economic returns of sweet corn intercropped with finger pepper under La Union field conditions. Three arrangements were compared: sweet corn grown as a pure stand, finger pepper grown as a pure stand (A2), and sweet corn and finger pepper grown together as an intercrop (A3). To keep the presentation of finger pepper data manageable across seven successive harvest periods, mean fruit length and mean plant height were each expressed as a computed average-the sum of measurements from the first through seventh priming divided by ten-yielding a single season-wide value for each cropping system. The goal of this paper is to give farmers, extension staff, and agricultural planners in La Union a clear, data-grounded basis for evaluating cropping system options. of sweet corn intercropped with finger pepper under La Union conditions. Mean fruit length and plant height of finger pepper across all seven primings were expressed as computed averages (sum of primings 1–7 ÷ 10) to provide a concise single-value summary for each cropping system. The objective is to provide evidence-based guidance for farmers, extension workers, and agricultural planners in the province.

MATERIALS AND METHODS

Research design and experimental layout

The experiment was conducted from November 2025 to January 2026 at Dasay, San Juan, La Union, on a flat, fully sun-exposed area of approximately 1,045 m². A composite soil sample was submitted to the Regional Soils Laboratory, Sta. Barbara, Pangasinan, for standard analysis prior to land preparation. The study followed Randomized Complete Block Design three replicated blocks, yielding 9 plots in total, each measuring 3 m × 5 m. Alleys of 100 cm separated the blocks and plots, resulting in 3 treatments per block: (T1) Monocrop Sweet Corn; (T2) Monocrop Finger Pepper and (T3) Sweet Corn + Finger Pepper Intercrop.

Plant materials and site preparation

Sweet corn seeds (var. Purple Sweet) and 18 trays of finger pepper seedlings were sourced from Charryver Agrivet Trading, San Gabriel, La Union. MykoVam biofertilizer was obtained from La Union Agro Service and Sales, San Fernando City, while Vermicompost came from Caarusipan Farm, San Juan, La Union.

Fertilizer application

Fertilizer rates were based on the Bureau of Soils Recommendation (BSR) derived from soil analysis results provided by DA-RFO 1. Applications were split into three doses: basal (0–15 DAP), second at 30 DAP, and third at 40 DAP. MykoVam and Vermicompost were applied at 100 g/plot during each application. Treatments under B5 received no synthetic fertilizer.

Crop management and harvesting

Soil moisture was monitored regularly with spot irrigation applied as needed. Weeding was done weekly by hand-pulling. Pest and disease incidence was monitored and recorded using a standard rating scale throughout the growing period. Sweet corn was harvested 65–70 days after sowing when silk turned brown and dry, the husk remained green, and kernels were soft and milky. Finger pepper was harvested using a seven-priming method starting 60–75 days after transplanting, at 5–7 day intervals, collecting only marketable green fruits free from defects.

Data gathered

For sweet corn, data collected included: days to tasseling, plant height (cm), corn ear length (cm) and diameter (mm), fresh weight of corn ear per piece (g) and per hectare (kg/ha), and chlorophyll content (SPAD units) at vegetative, tasseling, and fruiting stages using a SPAD meter (9:00 AM–12:00

NN on clean, dry leaves). For finger pepper, data collected included: days to flowering, fruit length (cm), plant height (cm), and marketable fruit weight (kg/ha)- all recorded across seven primings from 10 randomly selected plants or fruits per plot. Insect pest and disease incidence was also monitored for both crops.

Economic analysis

Economic performance was evaluated using farm gate prices of PhP 65.00/kg for sweet corn and PhP 200.00/kg for finger pepper. The following indicators were computed: The area was cleared of weeds, stubble, and debris and then prepared using two rotavator passes. Sweet corn was direct-seeded at 75 cm × 25 cm × 25 cm double rows. Finger pepper seedlings (40 days old) were transplanted at 75 cm × 35 cm × 35 cm double rows, with roots dipped in MykoVam solution before planting.

Indicator formula and statistical analysis

Gross Income; ROI%; BCR *and* LER . All data were analyzed using the Statistical Tool forAgricultural Research (STAR) software under a RCBD. Analysis of Variance (ANOVA) was performed to determine significant differences among treatments, and mean comparisons were conducted using the Least Significant Difference (LSD) Test at the 5% and 1% significance levels.

RESULTS AND DISCUSSION

Vegetative stage parameters

Table 1 shows the effect of cropping system on vegetative stage parameters of sweet corn (*Zea mays* L.) intercropped with finger pepper (*Capsicum annuum* L.) under La Union conditions. No significant differences are observed among the cropping systems, and little the cropping arrangement mattered for the timing of tasseling. Plants in both Monocrop Sweetcorn system and Sweetcorn + Finger Pepper Intercrop system flowered at exactly 39 days after planting, thus, with no statistically detectable difference between them. Sweet corn's internal clock, it appears, runs on genetics rather than neighbors — a conclusion already drawn by Maitra *et al.* (2021), who found that days to tasseling in maize is controlled primarily by the variety's genetic program and is largely unresponsive to the surrounding cropping arrangement. at 39 days, with no significant difference between them.

Table 1. Effect of cropping system on vegetative stage parameters of sweet corn (*Zea mays* L.) intercropped with finger pepper (*Capsicum annuum* L.) under La union conditions

Cropping system	Days to tasseling	Plant height (cm)	Cob length (cm)	Cob diameter (mm)	Chlorophyll vegetative (SPAD)
Monocrop sweetcorn	39	232.87 a	18.78	46.63	369.07
Monocrop finger pepper	-	-	-	-	-
Sweetcorn + Finger pepper intercrop	39	222.55 b	18.80	46.02	365.83
Significance	ns	*	ns	ns	ns

Means in a column followed by the same letter are not significantly different at 5% level of significance (LSD test). ns=not significant; *significant at 5%.

This implies that the cropping arrangement did not influence the phenological timing of sweet corn. This finding is consistent with Maitra *et al.* (2021), who reported that days to tasseling in maize is primarily governed by genotypic characteristics rather than cropping arrangement. In the table 1, monocrop Sweetcorn system has an averaged 232.87 cm, taller than the 222.55 cm recorded for the intercropped corn in Sweetcorn + Finger Pepper Intercrop system -and the difference was statistically significant. The most straightforward explanation is that monocrop plants had uncontested access to soil moisture, nutrients, and rooting space, allowing full expression of their growth potential. Once finger pepper was introduced into the same bed, some degree of below-ground competition for those resources appears to have constrained vertical development in the corn, though only moderately. Li *et al.* (2022) observed a similar pattern, noting that monoculture corn consistently achieves greater height than corn grown alongside companion crops, largely

because resource competition at the root level is eliminated. The taller stature of monocrop Sweetcorn cropping system is likely due to unimpeded access to light, water, and soil nutrients under monoculture conditions. Li *et al.* (2022) similarly noted that monocropped plants tend to exhibit greater plant height due to the absence of interspecific resource competition. In contrast, the intercropped sweet corn in Sweetcorn + Finger Pepper Intercrop cropping system experienced competition from finger pepper for these resources, resulting in slightly reduced vertical development.

Tasseling/Flowering stage parameters

Table 2 shows the effect of cropping system on tasseling /flowering stage parameters of sweet corn (*Zea mays* L.) intercropped with finger pepper (*Capsicum annuum* L.) under la union conditions. Where the cropping system made no practical difference was in the size of the corn ears themselves. Cob length was virtually identical between Monocrop Sweetcorn cropping system (18.78 cm) and Sweetcorn + Finger Pepper Intercrop cropping system (18.80 cm), and cob diameter followed the same pattern -46.63 mm in the monocrop versus 46.02 mm under intercropping-with neither difference reaching statistical significance.

The implication here is worth noting: although the taller canopy of monocrop corn might suggest a more vigorous plant overall, this advantage in height did not carry through to the reproductive structures. The cobs that formed under intercropping were just as long and as wide as those from the pure stand. Chlorophyll content at the vegetative stage reinforced this picture. Readings of 369.07 SPAD units for Monocrop Sweetcorn cropping system and 365.83 for Sweetcorn + Finger Pepper Intercrop cropping system were statistically comparable, indicating that the photosynthetic machinery of the corn leaves was equally active in both systems during early growth. This implies that while monocropping supported taller vegetative growth, it did not translate into significantly larger or wider cobs-the reproductive organ development of sweet corn was maintained even under intercropping conditions. Chlorophyll content at the vegetative stage was likewise not significantly different between Monocrop Sweetcorn cropping system (369.07 SPAD) and Sweetcorn + Finger Pepper Intercrop cropping system (365.83 SPAD), indicating that the cropping arrangement did not affect the photosynthetic capacity of sweet corn during early growth.

Table 2. Effect of cropping system on tasseling/flowering stage parameters of sweet corn (*Zea mays* L.) intercropped with finger pepper (*Capsicum annuum* L.) under La union conditions

Cropping system	SC chlorophyll – Tasseling stage (SPAD)	FP days to flowering
Monocrop sweetcorn	495.34	–
Monocrop finger pepper	–	14.93
Sweetcorn + Finger pepper intercrop	504.99	15.08
Significance	ns	ns

ns-not significant; –parameter not applicable for this cropping system.

At tasseling-the stage when corn pollen is shed and grain filling begins-the photosynthetic status of the leaves remained unaffected by whether the plants were growing alone or alongside finger pepper. Monocrop Sweetcorn cropping system corn registered 495.34 SPAD units at this stage, while Sweetcorn + Finger Pepper Intercrop cropping system, corn came in at 504.99 SPAD units, a difference that did not clear the threshold for statistical significance. This matters because chlorophyll levels at tasseling are a reasonable proxy for the plant's capacity to fuel grain development-plants that maintain adequate chlorophyll through tasseling tend to produce more viable pollen and set grain more reliably, as Liu *et al.* (2021) have noted in related work on maize nutrition. Monocrop Sweetcorn cropping system recorded 495.34 SPAD units while Sweetcorn + Finger Pepper Intercrop cropping system, recorded 504.99 SPAD units, with no statistically confirmed difference between them. This finding implies that the photosynthetic performance of sweet corn at this critical reproductive stage was maintained regardless

of whether it was grown alone or alongside finger pepper. Liu *et al.* (2021) similarly found that plants with comparable chlorophyll levels at tasseling tend to exhibit similar pollen viability and grain set potential.

On the finger pepper side, the timing of first flowering showed no sensitivity to cropping arrangement. Monocrop pepper (A2) produced its first flowers at 14.93 days, while intercropped pepper (Sweetcorn + Finger Pepper Intercrop cropping system) did so at 15.08 days—barely a day's difference and one that meant nothing statistically. The competitive presence of sweet corn in the Sweetcorn + Finger Pepper Intercrop cropping system plots simply did not alter when the pepper plants decided to flower. This outcome makes agronomic sense. Pepper flowering responds mainly to daylength and to the internal cues built into the variety's genetic makeup, not to what is growing nearby. Choi *et al.* (2023) made the same observation, reporting that anthesis in pepper is driven by photoperiod and genotype and is therefore relatively insensitive to the arrangement of companion crops in the field. Monocrop Finger Pepper cropping system averaged 14.93 days to flowering while Sweetcorn + Finger Pepper Intercrop cropping system averaged 15.08 days—a difference of only 0.15 days that was statistically negligible. This implies that the competitive presence of sweet corn in the Sweetcorn + Finger Pepper Intercrop cropping system arrangement did not delay the onset of flowering in finger pepper. The result is consistent with Choi *et al.* (2023), who reported that days to anthesis in pepper is predominantly controlled by genetic and photoperiod responses rather than by cropping system arrangement, and is therefore largely insensitive to the presence of a companion crop.

Fruiting stage

The fruiting stage data in Table 3 continued the pattern established at earlier growth stages: the cropping arrangement made little difference to most of the parameters measured. Chlorophyll readings at the fruiting stage were 468.91 SPAD for Monocrop Sweetcorn cropping system in corn and 458.29 SPAD for Sweetcorn + Finger Pepper Intercrop cropping system in corn — comparable values that did not differ significantly.

This result indicates that the grain-filling period proceeded with equivalent photosynthetic support in both systems. From a practical standpoint, it means that the presence of finger pepper in the field did not deprive the corn of the leaf chlorophyll it needed during the stage when carbohydrates are mobilized from leaves into the developing ear., with Monocrop Sweetcorn cropping system recording 468.91 SPAD units and Sweetcorn + Finger Pepper Intercrop cropping system recording 458.29 SPAD units. This confirms that the photosynthetic capacity of sweet corn during the grain-filling period was sustained under both monocrop and intercrop arrangements, implying that the presence of finger pepper did not compromise sweet corn's ability to mobilize and accumulate carbohydrates during this critical yield-determining stage.

Individual ear weight, however, departed from that pattern in a way that was both statistically significant and somewhat counterintuitive. Corn grown in the Sweetcorn + Finger Pepper Intercrop cropping system- where it had to share space with finger pepper- produced ears averaging 237.71 g, while corn from the Monocrop Sweetcorn cropping system, averaged 230.85 g. The intercropped ears were heavier. One plausible explanation lies in the microenvironment created by the shorter finger pepper plants occupying the lower canopy: they may have slowed soil moisture evaporation and moderated ground-level temperatures around the corn root zone, creating conditions that were marginally more favorable for ear filling than those experienced in the more exposed monocrop plots. This advantage in individual ear weight did not translate into a yield advantage at the field scale — the per-hectare yields of Monocrop Sweetcorn cropping system (2,328.18 kg/ha) and Sweetcorn + Finger Pepper Intercrop cropping system (2,152.19 kg/ha) were statistically on par, confirming that integrating finger pepper into a

sweet corn plot does not erode corn productivity at the farm level. This unexpected result may be attributed to the complementary microenvironment created by the shorter finger pepper plants, which could have moderated soil temperature and reduced moisture loss around the corn root zone, creating marginally more favorable conditions for ear development. In terms of yield per hectare, however, no significant difference was found between Monocrop Sweetcorn cropping system (2,328.18 kg/ha) and Sweetcorn + Finger Pepper Intercrop cropping system (2,152.19 kg/ha), indicating that the field-scale corn productivity was maintained under intercropping.

Table 3. Effect of cropping system on fruiting stage parameters of sweet corn (*Zea mays* L.) intercropped with finger pepper (*Capsicum annuum* L.) under La union conditions

Cropping system	SC chlorophyll fruiting (SPAD)	SC ear weight (g)	SC yield (kg/ha)	FP mean fruit length (cm)[1]	FP mean plant height (cm)[1]
Monocrop sweetcorn	468.91	230.85 b	2,328.18	–	–
Monocrop finger pepper	–	–	–	12.64	50.52
Sweetcorn + Finger pepper intercrop	458.29	237.71 a	2,152.19	12.51	59.16
Significance	ns	*	ns	ns	ns

[1]FP Mean Fruit Length and FP Mean Plant Height = sum of 1st–7th priming values ÷ 10. Values represent a season-wide average across all harvest periods. Means followed by the same letter are not significantly different at 5% level (LSD test). ns=not significant; *=significant at 5%.

For finger pepper at the fruiting stage, the cropping arrangement left fruit length and plant height essentially unchanged. The season-average fruit length was 12.64 cm for Monocrop Finger Pepper cropping system and 12.51 cm for intercropped pepper (Sweetcorn + Finger Pepper Intercrop cropping system)- too close to distinguish statistically. Fruit elongation in pepper appears to be driven far more by fertilizer availability than by the identity of neighboring plants, which aligns with the broader pattern seen in the Factor B data across this study. Mean plant height told a numerically interesting story-Sweetcorn + Finger Pepper Intercrop cropping system at 59.16 cm was noticeably taller than Monocrop Finger Pepper cropping system at 50.52 cm across the season- but the difference was not statistically confirmed across the priming periods. The taller stature of Sweetcorn + Finger Pepper Intercrop cropping system plants may reflect a mild elongation response to the partial shading provided by the sweet corn canopy above them, a phenomenon sometimes observed when low-canopy plants experience slightly reduced light intensity. This implies that the cropping system arrangement did not alter fruit size development in finger pepper-fruit elongation appears to be primarily responsive to fertilizer input rather than to interspecific competition. Mean plant height was numerically higher under Sweetcorn + Finger Pepper Intercrop cropping system (59.16 cm) than Monocrop Finger Pepper cropping system (50.52 cm), though the difference was not statistically significant across priming periods. The taller stature of Sweetcorn + Finger Pepper Intercrop cropping system pepper plants may reflect a photoperiodic elongation response to the partial shading from sweet corn.

Agronomic indicators

Table 4 brings together the key agronomic indicators for all three cropping systems in a single view. For sweet corn, the picture that emerges is reassuring for intercrop advocates:

Monocrop Finger Pepper cropping system produced slightly but significantly heavier ears than Monocrop Sweetcorn cropping system, and per-hectare yields were statistically comparable between the two systems. Villanueva *et al.* (2021) reported similar results from intercrop work with corn in the Philippines, finding that corn ear development can be sustained or even marginally improved when the companion crop is a shorter plant that occupies a lower canopy position and

does not block overhead light. For sweet corn, individual ear weight was slightly but significantly higher under intercropping (Monocrop Finger Pepper cropping system: 237.71 g) than monoculture (Monocrop Sweetcorn cropping system: 230.85 g), while yield per hectare showed no significant difference, confirming that field-scale corn productivity is not compromised by the intercropping arrangement.

Table 4. Summary of agronomic parameters as affected by cropping system of sweet corn (*Zea mays* L.) intercropped with finger pepper (*Capsicum annuum* L.) under La union conditions

Cropping system	SC ear weight (g)	SC yield (kg/ha)	FP days to flower	FP mean fruit length (cm)[1]	FP Mean plant height (cm)[1]	FP marketable weight (g)
Monocrop sweetcorn	230.85b	2,328.18	–	–	–	–
Monocrop finger pepper	–	–	14.93	12.64	50.52	20,954.30a
Sweetcorn + Finger pepper intercrop	237.71a	2,152.19	15.08	12.51	59.16	8,318.38b
Significance	*	ns	ns	ns	ns	*

[1]FP Mean Fruit Length and FP Mean Plant Height= sum of 1st–7th priming values ÷ 10. ns= not significant; *=significant at 5%; –=not applicable. SC=Sweet Corn; FP=Finger Pepper; Mktable Wt=total marketable weight across all primings.

This result is consistent with findings reported by Villanueva *et al.* (2021), who observed that corn ear development in intercrop systems can be maintained or even marginally improved when the companion crop occupies a lower canopy layer that does not compete directly for light with the corn plants. For finger pepper, the story is more complicated. The most striking number in Table 4 is the gap in marketable weight between Monocrop Finger Pepper cropping system (20,954.30 g) and Monocrop Finger Pepper cropping system (8,318.38 g)- a difference exceeding 150 percent. Monocrop pepper produced more than twice the marketable fruit weight of intercropped pepper. That gap is the direct consequence of what sweet corn does to the pepper growing beneath it: as the corn grows tall and its canopy expands, it intercepts a disproportionate share of incoming sunlight, leaving the pepper in partial shade for much of the productive season. Less light reaching the pepper leaves means less photosynthesis, slower fruit development, and ultimately lower yields. None of this negates the value of the Monocrop Finger Pepper cropping system. The pepper that did form under intercropping still contributed to farm income, and the corn component performed without penalty. When both crops are counted together, the Monocrop Finger Pepper cropping system arrangement offers something monocultures cannot: two marketable commodities from the same piece of land, grown at the same time- a hedge against price volatility and crop failure that matters enormously for smallholder households. Monocrop Finger Pepper cropping system produced a considerably higher marketable weight of 20,954.30 g compared to intercropped finger pepper (Monocrop Finger Pepper cropping system) at only 8,318.38 g- a difference of more than 150 percent. This sharp contrast reflects the well-documented yield dilution that occurs when crops share limited resources.

The taller sweet corn in Monocrop Finger Pepper cropping system intercepted a disproportionate share of available sunlight, limiting the photosynthetic efficiency and fruit production of the pepper below. Despite this yield reduction, the pepper component of the intercrop still contributed meaningfully to the overall economic output of the Monocrop Finger Pepper cropping system The agronomic data taken together suggest that while monoculture systems excel in individual crop productivity, the intercropping system (Monocrop Finger Pepper cropping system) provides the strategic advantage of dual-commodity production from the same land- a consideration that extends beyond agronomic performance alone and carries significant practical weight for smallholder farm management.

Economic analysis of sweet corn and finger pepper production

In terms of production expenses, a clear trend emerges where the intercropping system incurs the highest total cost (₱36,640.00 per hectare), followed by monocrop finger pepper (₱34,950.00), while monocrop sweet corn remains the most economical (₱32,560.00). The higher cost associated with intercropping is primarily driven by the complexity of simultaneously managing two distinct crops (Table 5). This dual-crop management typically demands increased labor for specialized planting, weeding, and harvesting, alongside higher initial input costs for both seeds and seedlings.

When evaluating yield and income dynamics, monocrop sweet corn emerged as the most lucrative system, yielding the highest gross and net incomes. Within the intercropping system, sweet corn accounted for the lion's share of revenue (₱893,815.00) compared to finger pepper (₱406,710.80). However, the combined gross income of the intercrop (₱1,300,525.80) fell short of monocrop corn. This shortfall points to a competition factor, suggesting that mutual shading or nutrient competition between the sweet corn and finger pepper may have led to a slight yield depression for both crops when compared to their pure, monocrop stands.

Table 5. Economic parameters of sweet corn (*Zea mays* L.) intercropped with finger pepper (*Capsicum annuum* L.) as affected by cropping system and fertilizer rate under La union conditions (per hectare)

Treatment	Total cost (₱)	Gross income SC (₱)	Gross income FP (₱)	Total gross income (₱)	Net income (₱)	ROI (%)	BCR
Monocrop sweetcorn	32560	1596166		1596166	1563606	4769.22	48.69
Monocrop finger pepper	34,950		1,315,271	1,315,271	1,280,321	3,620.0	37
Sweetcorn + Finger pepper intercrop	36640	893815	406710.8	1300525.8	1263885.8	3416.43	35.16

[1]Farm gate prices used in analysis: PhP 65.00/kg for sweet corn; PhP 200.00/kg for finger pepper. ROI=Return on Investment; BCR=Benefit-Cost Ratio; SC=Sweet Corn; FP=Finger Pepper; –=not applicable.

This dual-crop management typically demands increased labor for specialized planting, weeding, and harvesting, alongside higher initial input costs for both seeds and seedlings. When evaluating yield and income dynamics, monocrop sweet corn emerged as the most lucrative system, yielding the highest gross and net incomes. Within the intercropping system, sweet corn accounted for the lion's share of revenue (₱893,815.00) compared to finger pepper (₱406,710.80). However, the combined gross income of the intercrop (₱1,300,525.80) fell short of monocrop corn. This shortfall points to a competition factor, suggesting that mutual shading or nutrient competition between the sweet corn and finger pepper may have led to a slight yield depression for both crops when compared to their pure, monocrop stands. Consequently, the return on investment (ROI) and benefit-cost ratio (BCR) favor monocropping. Monocrop sweet corn achieved a BCR of 48.69, indicating that for every ₱1.00 a farmer spends, they receive ₱48.69 in return. While the intercropping system yielded a lower BCR of 35.16, it remains an incredibly profitable venture, albeit mathematically less efficient than pure sweet corn within this specific dataset.

Despite the financial superiority of monocrop corn on paper, intercropping offers practical, long-term agricultural advantages under La Union conditions that standard economic tables fail to capture. Chief among these is risk spreading; if a crop-specific pest or disease wipes out the sweet corn, the farmer retains the finger pepper as a financial safety net. Furthermore, intercropping promotes resource efficiency. The taller sweet corn canopy creates a favorable microclimate with slight shade that finger pepper can tolerate, while their varying root structures allow for more efficient utilization of nutrients across different soil depths.

Nevertheless, the exceptionally high ROI percentages (exceeding 3,000%) and BCRs (greater than 35) warrant a cautious review, as typical open-field agricultural ventures generally yield a BCR between 2.0 and 4.0. To ensure data robustness, it is highly recommended to

verify if comprehensive overheads-such as mechanized land preparation, intensive labor, irrigation, and post-harvest marketing-were fully accounted for in the total cost. Additionally, it is worth confirming whether the calculations relied on standard, average seasonal farm-gate prices rather than temporary peak-market spikes.

CONCLUSION

Based on the economic analysis of Sweet Corn (*Zea mays* L.) and Finger Pepper (*Capsicum annuum* L.) under La Union conditions, the following conclusions are drawn:

Monocropping sweet corn is the most economically efficient system: Pure stands of sweet corn required the lowest total production cost (₱32,560.00/ha) while yielding the highest net income (₱1,563,606.00/ha), Return on Investment (4,769.22%), and Benefit-Cost Ratio (48.69).

Intercropping increases production complexity and cost: The sweet corn and finger pepper intercropping system incurred the highest total cost (₱36,640.00/ha), reflecting the increased labor and input requirements of managing a dual-crop setup.

Evidence of crop competition: The combined gross income of the intercrop system was lower than that of monocrop sweet corn. This suggests that competitive interactions-such as shading or nutrient competition-moderately depressed the yields of both crops when grown together.

Intercropping provides non-monetary stability: While mathematically less efficient than monocrop corn in a single season, the intercrop system still proved highly profitable (BCR of 35.16) and offers vital ecological buffers, such as pest risk diversification and improved resource utilization.

RECOMMENDATIONS

For immediate profit maximization: Farmers aiming for the highest immediate financial returns with lower labor inputs should prioritize monocrop sweet corn, provided the market demand is stable.

For risk mitigation and sustainable farming: Smallholder farmers should consider the intercropping system as a strategy to spread financial risk and maximize land-use efficiency, particularly in areas prone to crop-specific pest outbreaks or market fluctuations.

Review and validation of production costs: Future trials should conduct a rigorous auditing of total input costs. It is recommended to ensure that all hidden expenses-such as mechanized land preparation, irrigation fuel, family labor, logistics, and post-harvest handling-are fully integrated to validate the exceptionally high ROI and BCR values.

Adjust spatiotemporal arrangements: Further research should explore adjusting the spatial planting geometry (e.g., wider row spacing) or temporal planting dates (relay cropping) to minimize the competitive shading effects of corn on finger pepper.

Fertilizer rate optimization: Future studies should isolate and analyze the interactions between specific fertilizer rates and the cropping systems to identify the exact nutrient levels that maximize yield while minimizing excessive input costs.

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