DOI : 10.58993/ijh/2025.82.2.9

Indian J. Hortic. 82(2), June 2025: 184-187

Yield and economic viability of ginger (*Zingiber officinale* Rosc.) based cropping systems in Nagaland

Nzanthung Ezung[1], Graceli I. Yepthomi[1*], C.S. Maiti[1], S.P. Kanaujia[1], Debika Nongmaithem[2] and Laishram Hemanta[1]

[1]Department of Horticulture, School of Agricultural Sciences, Medziphema Campus, Nagaland University, Nagaland 797106, India

ABSTRACT

A field experiment was conducted to evaluate the productivity and economic viability of ginger-based cropping systems under the agro-climatic conditions of Nagaland. The study was laid out in a Randomized Block Design (RBD) with seven treatments and three replications. The treatments included: T_1 (sole ginger), T_2 (ginger + fenugreek - coriander), T_3 (ginger + tomato - okra), T_4 (ginger + sweet corn - green mustard), T_5 (ginger + french bean - chilli), T_6 (ginger + soybean), and T_7 (ginger + colocasia). Sole ginger (T_1) recorded the highest yield (12.81 t/ha). Among intercropping systems, T_5 showed the highest ginger yield (10.34 t/ha), followed by T_3 (9.02 t/ha). However, T_4 exhibited the highest ginger equivalent yield (29.04 t/ha), net income (₹6.60 lakh/ha), and benefit-cost ratio (4.04), suggesting its superior economic performance. All intercropping treatments recorded land equivalent ratios (LER) above 1, indicating yield advantages over sole cropping, with T_7 (2.40) and T_3 (2.13) showing the highest LER values. The study concludes that ginger-based intercropping systems, particularly those involving sweet corn - green mustard and colocasia, can significantly enhance productivity and profitability under rainfed conditions of Nagaland. Conversely, the ginger + fenugreek - coriander system showed comparatively lower returns, making it a less suitable option.

Key words: Intercropping, ginger equivalent yield, land equivalent ratio, benefit cost ratio.

INTRODUCTION

Ginger is a versatile and economically significant crop cultivated worldwide for its culinary, medicinal, and industrial uses. Until the 20th century, the benefits of inter-cropping ginger with other crops were not widely accepted by the farmers. However, in recent times, the cultivation methods of ginger have evolved and inter-cropping with various crops has become more prevalent (Lyocks *et al.,* 3). In recent times, the potential of ginger within diversified cropping systems to enhance agricultural productivity and economic viability is starting to gain a wide interest. One of the primary advantages of intercropping is the ability to achieve higher yield per unit area by efficiently utilizing available growth resources through a combination of crops with different rooting abilities, canopy structures, heights and nutrient requirements. This complementary utilization of growth resources by the component crops enhances productivity (Dodiya *et al.*, 2). By evaluating the productivity and economic outcomes of ginger in diversified cropping systems, this research endeavors to provide sustainable agricultural strategies and support decision making processes in agricultural communities.

*Corresponding author email: graceli@nagalanduniversity.ac.in

[2]Department of Agronomy, School of Agricultural Sciences, Medziphema Campus, Nagaland University, Nagaland - 797106, India

MATERIALS AND METHODS

This study was conducted at the School of Agricultural Sciences (SAS), Medziphema, Nagaland, spanning from April 2022 to February 2023. Treatments encompassed T_1 (sole ginger), T_2 (ginger + fenugreek - coriander), T_3 (ginger + tomato - okra), T_4 (ginger + sweet corn - green mustard), T_5 (ginger + french bean - chilli), T_6 (ginger + soybean), and T_7 (ginger + colocassia). A planting ratio (R-R) of 3:2 was maintained across treatments, except for T_7 (ginger + colocassia) at 2:2. The study period experienced an average rainfall of 1469.9 mm, coupled with a relative humidity ranging between 70% and 80%. The experiment followed a randomized block design (RBD) with three replications. Healthy seed rhizomes weighing approximately 25-30 g were planted at a depth of 5-7 cm with the bud oriented upwards in late April 2022, on raised beds measuring 2 m × 2 m, spaced at 30 cm × 30 cm for sole ginger, with intercrops sown at 60 cm × 30 cm intervals between ginger rows. Intercrops were either sown or transplanted according to their respective growing seasons, adhering to specific row patterns. Standard agricultural practices were implemented, including the uniform application of farmyard manure (20 t/ha), N (120 kg/ha), P_2O_5 (80 kg/ha), K_2O (90 kg/ha), and lime (300 kg/ha) before planting across all treatments. Weeding was performed

manually and all crops were rainfed. Harvesting of ginger rhizomes occurred at maturity using spade and khurpi to minimize damage and maintain market value. Harvested rhizomes were segregated by plot for data collection. Intercrops were harvested upon maturity, employing various methods as per their requirements. Yield and yield attributes of ginger and intercrops were documented post-harvest, encompassing parameters such as rhizome weight per clump, rhizome length and width, number of primary and secondary fingers, plot yield and intercrop yield per hectare.

Ginger equivalent yield (GEY)

$$\text{GEY (t/ha)} = \text{Yield (ginger)} + \frac{(\text{Yield of IC1} \times \text{price of IC1}) + (\text{Yield of IC2} \times \text{price of IC2})}{\text{Price (ginger)}}$$

Land equivalent ratio (LER)

$$\text{LER} = \frac{\text{Yield of intercrop (a + b + c)}}{\text{Yield of sole crop (a)}}$$

here, a = ginger, b = intercrop 1, c = intercrop 2.

Net income per hectare was calculated by deducting total cultivation costs from gross returns, while the benefit-cost ratio (BCR) was obtained by dividing gross returns by cultivation costs. Statistical analysis included mean determination, range variation, standard error of mean, and critical difference using the method of analysis of variance under Randomized Block Design (Panse and Sukhatme, 6).

RESULTS AND DISCUSSION

As data shown in Table 1 and Fig. 1, T_1 (sole ginger) exhibited the highest yield at 12.81 t/ha but among the intercropping configurations, T_5 (ginger + french bean - chilli) demonstrated the highest yield of 10.34 t/ha, succeeded by T_3 (ginger + tomato - okra) with a yield of 9.02 t/ha, both utilizing a planting ratio of 3:2. Ginger intercropped with french bean gave a relatively higher yield as recorded by (Rymbai *et al.,* 8*)* in an experiment where ginger intercropped with french bean gave a relatively higher yield as compared to other cropping systems. Conversely, the lowest yield was documented in T_7 (ginger + colocassia) at 7.80 t/ha, employing a planting ratio of 2:2. (Thirumdasu *et al.,* 11) also recorded that elephant foot yam and ginger recorded highest yield as sole crops as compared to intercropping. The maximum weight of rhizomes per clump was observed in T_3 (ginger + tomato - okra) at 691.45 g, followed by T_5 (ginger + french bean - chilli) at 585 g, both utilizing a planting ratio of 3:2. In contrast, the lowest weight per clump was registered in T_7 (ginger + colocasia) at 426.67 g, with a planting ratio of 2:2 which is due to the probable reason that both the intercrops were root crops and there is more competition for space and nutrients between them as reported by (Devkota *et al.*, 1).

In regards to rhizome length, T_1 (sole ginger) displayed the longest rhizomes at 21.4 cm and among the intercropping systems, T_7 (ginger + colocasia) showcased the longest rhizomes at 21.28 cm, utilizing a planting ratio of 2:2 followed by T_2 (ginger + fenugreek

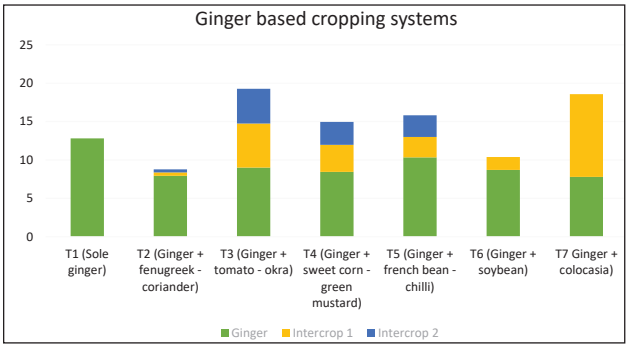

Fig. 1. Yield t/ha for ginger based cropping system.

Table 1. Yield and yield attributes of ginger based cropping systems.

Treatments	Yield of ginger (t/ha)	Weight/ clump (g)	Length of rhizome (cm)	Width of rhizome (cm)	No. of 1^0 fingers	No. of 2^0 fingers	Yield of IC1 (t/ha)	Yield of IC2 (t/ha)
T_1 (Sole ginger)	12.81	457.87	21.45	3.20	5.66	11.85	-	-
T_2 (Ginger + fenugreek - coriander)	7.94	431.54	21.00	3.13	5.22	8.29	0.44	0.41
T_3 (Ginger + tomato - okra)	9.02	691.45	16.44	3.18	4.43	8.07	5.73	4.53
T_4 (Ginger + sweet corn - green mustard)	8.46	546.67	16.67	3.41	6.08	9.62	3.51	3.00
T_5 (Ginger + french bean - chilli)	10.34	585.00	20.50	3.30	6.11	10.42	2.67	2.81
T_6 (Ginger + soybean)	8.70	489.43	18.28	3.09	5.58	8.58	1.70	-
T_7 (Ginger + colocasia)	7.80	426.67	21.28	3.23	4.51	8.36	10.78	-
Sem±	0.92	3.28	2.20	0.13	0.56	0.71	1.51	0.85
CD at 5%	2.85	9.47	6.79	0.40	1.74	2.19	4.76	2.94

Note: 1^0 - Primary, 2^0 - Secondary, IC1 - Intercrop 1, IC2 - Intercrop 2

- coriander) at 21.0 cm with a planting ratio of 3:2. Conversely, T_4 (ginger + sweet corn - green mustard) exhibited the shortest rhizome length at 16.67 cm with a planting ratio of 3:2. In terms of rhizome width, T_4 (ginger + sweet corn - green mustard) demonstrated the widest rhizomes at 3.41 cm, followed by T_5 (ginger + french bean - chilli) at 3.30 cm, both utilizing a planting ratio of 3:2. T_2 (ginger + fenugreek - coriander) displayed the narrowest rhizomes at 3.13 cm with a planting ratio of 3:2. T_5 (ginger + french bean - chilli) exhibited the highest number of primary fingers at 6.11, followed closely by T_4 (ginger + sweet corn - green mustard) at 6.08, both with a planting ratio of 3:2. In contrast, T_7 (ginger + colocasia) displayed the lowest number of primary fingers at 4.51, utilizing a planting ratio of 2:2. T_1 (sole ginger) showcased the highest number of secondary fingers at 11.85. Among the intercropping systems, T_5 (ginger + french bean - chilli) exhibited 10.42 secondary fingers, followed by T_4 (ginger + sweet corn - green mustard) at 9.62, both with a planting ratio of 3:2. Conversely, T_2 (ginger + fenugreek - coriander) displayed the lowest number of secondary fingers at 8.29, with a planting ratio of 3:2.

The highest ginger equivalent yield (GEY) was recorded in T_4 (ginger + sweet corn + mustard) at 29.04 t/ha. Following closely were T_3 (ginger + tomato - okra) with a GEY of 16.72 t/ha and T_5 (ginger + french bean - chilli) with a GEY of 16.44 t/ha. These findings are consistent with those of (Sanwal *et al.,* 10), who reported a GEY of 20.49 t/ha for ginger intercropped with cowpea. T_2 (ginger + fenugreek - coriander) exhibited the lowest ginger equivalent yield at 9.56 t/ha, notably lower than the GEY of sole ginger (12.81 t/ha) at a planting ratio of 3:2. Similar findings were recorded that ginger intercropped with coriander was not favorable (Paraye *et al*., 7). The Land Equivalent Ratio (LER) indicates the advantage of intercropping over sole cropping. In this study, as detailed in Table 2, LER values for all intercropping systems consistently surpassed 1 across treatments. The highest LER value was recorded in T_7 (2.4), followed by T_3 (2.13) and T_4 (1.77), while the lowest was observed in T_2 (1.1) among the intercropping treatments. Thirumdasu *et al.,* (11) also reported a maximum LER value of 1.43 in elephant foot yam intercropped with a double row of turmeric. It's important to note that the highest LER values may not necessarily translate to the highest monetary returns for farmers (Muoenke *et al.,* 5). Instead, they signify the sustainability of a production system influenced by economic returns (Sanwal *et al.,* 10).

The maximum gross returns were obtained in T_4 (ginger + sweet corn - green mustard) at ₹11.9 lakh/ha as sweet corn usually fetches a premium price in the market, followed by T_3 (ginger + tomato - okra) at ₹7.14 lakh/ha, and T_5 (ginger + french bean - chilli) at ₹6.57 lakh/ha. Conversely, the lowest gross returns were observed in T_2 (ginger + fenugreek - coriander) at ₹3.82 lakh/ha. Regarding net returns, the highest were documented in T_4 (ginger + sweet corn - green mustard) at ₹8.75 lakh/ha, succeeded by T_3 (ginger + tomato - okra) at ₹4.0 lakh/ha, and T_5 (ginger + french bean - chilli) at ₹3.41 lakh/ha. Conversely, the lowest net returns were recorded in T_2 (ginger + fenugreek - coriander) at ₹1.42 lakh/ha.

The benefit-cost ratio (BCR) reached its peak in T_4 (ginger + sweet corn - green mustard) with a value of 4.04 as sweet corn is a low volume high value crop which can fetch a premium market price leading to increased returns from the unit area added by the additional income from green mustard cultivation, followed by T_3 (ginger + tomato - okra) at 2.27 and T_5 (ginger + french bean - chilli) at 2.07. These treatments

Table 2. Ginger equivalent yield, land equivalent ratio and economics of ginger based cropping systems in Nagaland.

Treatments	GEY (t/ha)	LER	Cost of cultivation ₹/ ha in lakh	Gross returns ₹/ ha in lakh	Net returns ₹/ ha in lakh	Increased return over sole crop/ha (₹)	BCR
T_1 (Sole ginger)	12.81	1.0	2.98	5.12	2.14	-	1.71
T_2 (Ginger + fenugreek - coriander)	9.56	1.10	2.40	3.82	1.42	-33.87%	1.59
T_3 (Ginger + tomato - okra)	16.72	2.13	3.14	7.14	4.0	86.5%	2.27
T_4 (Ginger + sweet corn - green mustard)	29.04	1.77	2.87	11.62	8.75	307.96%	4.04
T_5 (Ginger + french bean - chilli)	16.44	1.47	3.18	6.58	3.40	58.79%	2.07
T_6 (Ginger + soybean)	12.12	1.2	2.40	4.85	2.45	14.5%	2.02
T_7 (Ginger + colocasia)	13.18	2.4	2.80	5.28	2.48	17.67%	1.91
SEm±	2.41	0.20	-	-	-	-	-
CD at 5%	14.22	0.44	-	-	-	-	-

Note: GEY - Ginger equivalent yield, LER- Land equivalent ratio, BCR - Benefit cost ratio

exhibited increased returns over sole crop ginger by 307.96%, 86.5% and 58.79%, respectively. Conversely, the lowest BCR was noted in T_2 (ginger + fenugreek - coriander) at 1.59, with a negative value of -33.87% over sole cropping indicating reduced returns compared to sole cropping, suggesting this intercropping system is less favorable. These findings are consistent with previous studies conducted by (Rymbai *et al*., 8), which reported increased net profit and BCR in various ginger-based cropping systems compared to monocropping. They also align with various research works conducted highlighting higher net returns and BCR in specific intercropping systems (Sangtam *et al.,* 9; Munda *et al.,* 4; Sanwal *et al.,* 10; Devkota, 1).

This study highlights the efficiency of various ginger-based cropping systems. Even though, sole ginger cultivation resulted in the highest yield per hectare due to increased planting density, intercropping systems such as ginger + french bean - chilli and ginger + tomato - okra showed promising yields despite having lower plant density as compared to sole ginger. Notably, ginger + sweet corn - green mustard demonstrated the highest ginger equivalent yield (GEY), net returns and benefit-cost ratio, followed by ginger + tomato - okra. Intercropping consistently outperformed sole cropping, as indicated by the land equivalent ratio (LER) values exceeding 1 in all intercropping systems. Ginger + colocassia and ginger + tomato - okra exhibited the highest LER values. Therefore, ginger-based cropping systems, particularly ginger + sweet corn - green mustard and ginger + tomato - okra, are recommended for farmers seeking increased yield and income per unit area, while the intercropping system of ginger + fenugreek - coriander may not be advisable based on its poor performance.

AUTHORS' CONTRIBUTIONS

Writing - original draft, Formal analysis, Software, Data curation (NE); Investigation, Writing – review & editing, Supervision, Validation (GIY); Writing – review & editing, Formal analysis, Conceptualization, Investigation (CSM); Methodology, Investigation, Writing – review & editing (SPK); Conceptualization, Validation, Resources (DN); Conceptualization, Investigation, Resources (LH).

DECLARATION

The authors declares that they have no conflict of interest.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the Indian Council of Agricultural Research for its support through the AICRP-Spices: Nagaland Centre in facilitating the research work.

REFERENCES

1. Devkota, P. 2022. Effect on the yield of ginger as intercropping with different crops.

2. Dodiya, T. P., Gadhiya, A. D. and Patel, G. D. 2018. A review: effect of inter cropping in horticultural crops. *Int. J. Curr. Microbiol. Appl. Sci.* **7**(2): 1512-1520.

3. Lyocks, S.W.J., Tanimu, J. and Dauji, L.Z. 2013. Growth and yield parameters of ginger as influenced by varying populations of maize intercrop. *J. Agric. Crop Res.* **1**(2): 24-29.

4. Munda, G.C., Patel, D.P. and Isalm, M. 2005. Productivity and economic performance of different cropping systems under mid-hills of Meghalaya. *Ann. Plant Physiol.* **19**(2): 137-140.

5. Muoneke, C.O., Asiegbu, J.E. and Udeogalanya, A.C.C. 1997. Effect of relative sowing time on the growth and yield of the component crops in okra/ maize and okra/cowpea intercropping systems. *J. Agron. Crop Sci.* **179**: 179-185.

6. Panse, V.G. and Sukhatme, P.V. 1989. Statistical methods for agricultural workers. ICAR, New Delhi.

7. Paraye, P.M., Mahobia, R.K., Pailra, K.K. and Singh, S.P. 2014. Ginger (*Zingiber officinale* Rosc.) based intercropping system for Chhattisgarh plain zone. *Environ. Ecol.* **32**(2): 791-793.

8. Rymbai, H., Das, A. N. U. P., Mohapatra, K. P., Talang, H. D., Nongbri, B., and Law, I. 2021. Ginger (*Zingiber officinale*) based intercropping systems for enhancing productivity and income–a farmers' participatory approach. *Indian J. Agric. Sci.* **91**(7): 956-60.

9. Sangtam K.S., Singh M.K. and Ahmed P. 2008. Yield and economics of maize based intercropping systems under foot hill condition of Nagaland. *Environ. Ecol.* **26**(4): 1683-1684.

10. Sanwal, S.K., Yadav, R.K., Yadav, D.S., Rai, N. and Singh, P.K. 2006. Ginger-based intercropping highly profitable and sustainable in mid hill agro climatic conditions of North East Hill Region. *Veg. Sci.* **33**(2): 160-163.

11. Thirumdasu, R.K., Devi, A.B. and Thokchom, M. 2015. Elephant foot yam (*Amorphophallus campanulatus* Roxb. Blume) cv. Gajendra introduction with spice intercropping: yield efficiency under sloppy foot hills of Imphal-East. *The Bioscan.* **10**(3): 1327-1329.

(Received : May, 2024; Revised : June, 2025; Accepted : June, 2025)