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Abhay Bisen
Assistant Professor, (Horticulture), S.K.S College of Agriculture and Research Station, Rajnandgaon, IGKV, Chhattisgarh, India

Vinamarta Jain
Professor, (Agronomy) and Project Incharge Farmers FIRST, S.K.S College of Agriculture and Research Station, Rajnandgaon, IGKV, Chhattisgarh, India

SRK Singh
Director, ICAR ATARI Zone-IX, Jabalpur, M.P. India

Corresponding Author:
Abhay Bisen
Assistant Professor, (Horticulture), S.K.S College of Agriculture and Research Station, Rajnandgaon, IGKV, Chhattisgarh, India

An assessment of horticultural based interventions on livelihood security and increasing the tribal farmers income of Chhattisgarh

Abhay Bisen, Vinamarta Jain and SRK Singh

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Abstract
The study reveals that limited access to resources and infrastructure, lack of knowledge and skills, high upfront costs, limited market access, climate change and weather variability, and social and cultural barriers are the major challenges and constraints faced by tribal farmers in adopting horticultural practices. This strategy is cantered on improving the relationship between farmers and scientists while also advancing knowledge and incorporating technology into their working circumstances under the Farmer FIRST Programme. This project's approach is unique in that it provides a forum for scientists of all disciplines to regularly engage with the rural farm environment. This allows them to gather insightful feedback on issues, opportunities, and the state of horticultural based technology at the local level and develop technology modules that are appropriate for a variety of farm scenarios. The project's focus was on farmers' farms, resources, innovations, research, and technology. Technology integration modules are specifically designed to serve the needs of smallholders, landless farmers and farm women of tribal area. The Farmer FIRST initiative is operating effectively and farmers are responding well to it. Farmers were benefited from the different horticulture based interventions under this programme. The main response to the horticulture-based modules that were used as an intervention was a rise in the yield of fruits, vegetables, and spices. The performance and economic indicators directly shown in results contributed to increase the income and livelihood security of tribal farmers of Chhattisgarh.

Keywords: Horticultural based interventions, livelihood security, tribal farmers, performance and economic indicators

Introduction

Agriculture is the backbone of rural livelihoods in India, and tribal farmers are among the most vulnerable groups in the country. The Farmer FIRST Programme was launched to improve the livelihood security and income of tribal farmers through horticultural interventions. Horticulture has the potential to enhance farm income, improve food security, and promote sustainable agriculture practices. In the Chhattisgarh state, farmers are engaged for 4-months in rice farming thereafter majority of rainfed farmers have no on-farm employment opportunities. The region has a large number of small and marginal farmers (< 2 ha), approximately 76%, but they own hardly 34% of the cultivable land. The land holdings are not only very small but highly fragmented. Therefore, the future of sustainable agriculture growth and food security in India depends on the performance of small and marginal farmers. Farmer is the client of technology developed by the scientist at remote place with hypothesis that it will be adopted by the client. There is growing perception that the emerging demand of the farmers about the recent technological and intuitional needs are not adequately addressed. Also many times, research system is not getting adequate feedback to plan and conduct demand driven research thereby, a huge gap exists in the quality of research output required at the farm level and that being developed.

The 'Farmer FIRST' Programme is an initiative to move beyond the production and productivity and to privilege the complex, diverse & risk prone realties of majority of the farmers through enhancing farmers-scientists contact with multi stake holders-perception. Many aspects are multiple or multiple stakeholders, multiple perspectives, multiple realities, multi-functional agriculture, multiple - method approaches. There are concepts and domains that are new or new in emphasis like food systems, trade, market chains, value chains, innovation pathways and most of all innovation systems.Rice-rice or rice -wheat/gram adopting by farmers under irrigated condition even after availability of market for vegetables. Size of wadi's ranged from 0.05 to 2 acres in the study area that remained unproductive or growing seasonal vegetables in part of the area and have scope for livelihood and nutritional security of tribal farmers.Poor yield of vegetable under traditional cultivation, high labour requirement and fluctuation in market rate discourages farmers for growing vegetables even after high remunerative return. Rice bunds are not utilize in the area for productive purposes and remained unutilized even sizeable area i.e. 2-10% area of field. Rainfed or irrigated upland can be utilize for growing of high value vegetable crops for maximizing return and enriching knowledge of the farmers about the technological options.

The 'Farmer FIRST' Programme emphasized - providing access to advanced horticultural technologies, building capacities, enhanced farmer- scientist interface and institutional innovations. These interventions assume significance for attaining sustainable rural livelihoods. This study assesses the impact of horticultural interventions under the Farmers First project on the livelihood security and income of tribal farmers. The project introduced innovative practices such as low gravity drip, mulching, shed net, fruit crop plantation on bunds, spices cultivation, and multilayer farming to tribal farmers in Chhattisgarh state. The study aims to evaluate the effectiveness of these interventions in improving crop yields, income, and food security among tribal farmers. It also examines the empowerment of tribal farmers, particularly women, through capacity building and training. The findings of this study will inform policy and development initiatives aimed at promoting sustainable agriculture. Through this study, an attempt was made to assess the impact of improved horticultural based innervations on the livelihood security and increasing farmers income of small tribal farmers.

Challenges and constraints faced by tribal farmers in adopting new horticultural practices/technology

These challenges and constraints highlight the need for targeted interventions and support systems to enable tribal farmers to adopt horticultural practices and improve their livelihoods as follows:

1. Limited Access to Resources and Infrastructure

- Lack of irrigation facilities.
- Inadequate water supply.
- Limited access to credit and subsidies.
- Poor road connectivity and transportation facilities. Inadequate storage and marketing infrastructure.

2. Lack of Knowledge and Skills

- Limited awareness about horticultural practices.
- Inadequate training and capacity building programs.
- Limited access to extension services and technical support.
- Lack of knowledge about market trends and prices.

3. High Upfront Costs

- High cost of inputs (seeds, fertilizers, pesticides).
- High cost of irrigation and water management systems.
- High cost of land preparation and cultivation.
- High cost of marketing and transportation.

4. Limited Market Access

- Limited access to markets and market information
- Limited market demand for horticultural products
- High competition from other farmers and producers
- Limited bargaining power and negotiating skills

5. Climate Change and Weather Variability

- Frequent droughts and water scarcity.
- Erratic rainfall and flooding.
- Rising temperatures and changing weather patterns.
- Limited access to climate-resilient agriculture practices and technology.

6. Social and Cultural Barriers

- Limited social and cultural acceptance of horticultural practices.
- Limited participation of women in horticultural activities.
- Limited access to education and training opportunities.
- Limited social and cultural support networks.

Genuine planting material, farm machinery and PHM Issues

- Limited access to quality seeds and planting materials.
- Limited access to farm machinery and equipment.
- Limited access to post-harvest management and processing facilities.
- Limited access to insurance and risk management services.

Materials and Methods

The impact assessment of horticultural based interventions on the tribal farmers was carried out in the adopted villages of Farmers FIRST Programme in the Ambagarh Chowki block, Rajnandgaon district of Chhattisgarh during 2022-23. Rajnandgaon is one of the tribal districts of Chhattisgarh state and nearly 80 km away towards west from Raipur capital of the state. Five villages namely Kaudikasa, Bhagwantola, Murethitola, Arajkund and Netamtola were selected in the project. These villages are nearly 55 km away from district headquarters. Geographical area of the five village cluster is 1485 ha with 1189 ha Culturable area. Irrigated area is only 13% against 30% in the state. Mostly mono cropping of rice is prevalent in the cluster of villages and cropping intensity is 113%. Farmers are rearing large number of animals and birds as alternate livelihood activity. Scientist team will visit to all the villages and discuss with farmers about the Farmers FIRST Programme. Visit and group discussions were organized to identify the research problems. Thereafter problems were prioritized.

Basic information of the study was collected and analyzed. Regular meetings and group discussions were organized to fit each farmer in one or more activities of the project. According to prioritized research problem, farmers expressed their interest and agreed to test the proposed technology on his field. The farmers also give necessary suggestions for desired modifications before execution. In this way proposal was prepared. Scientist team will visit to all the villages and discuss with farmers again about the Farmers FIRST Programme. When scientist and farmers familiarize then start discussing with farmers about the technologies to be tested in participatory mode because farmer may have different opinion over consent during project preparation. Efforts will be made to involve all the farmers and interested women group in various experiments depending their interest and problem facing by them.

Results and Discussion

Analysis of innervations under the horticulture based module, the technology was conducted on the farmer's field of the adopted village in the year 2022-23, the details of which are as follows. A comparative study of farmer practice and applied intervention was done using performance indicators. The increase in the per hectare income of the farmers shown through the performance and economic indicator (Table 1 to 5).

Technological interventions and Strategies for enhancing Yield and Income

1. **Intervention: Low-cost gravity drip irrigation system for vegetable cultivation**

The production of the vegetables in the drip method increased by 20-30% than the crop cultivated by conventional non-drip method of irrigation. Size of wadi ranged from 0.05 to 2 acres in the study area that remained unproductive or growing seasonal vegetables in part of the area and have scope to grow good crops for livelihood and nutritional security of tribal farmers. The practice of regularly applying little amounts of water at low pressures and flow rates is known as drip or trickle irrigation. Unlike sprinklers, which irrigate the whole field surface, drip irrigation directs water directly to the plant, where almost all of the water is utilized for plant development (Hari and Krupavathi, 2017) [4]. Water is not lost on weed growth or surface evaporation because very little water seeps into the soil between crop rows. The low-cost drip system created for this investigation demonstrated excellent water emission uniformity over the entire study area Jain *et al.* (2000) [7]. Raphael *et al*. (2019) [11] conducted an experiment on gravity drip irrigation system for small scale vegetable gardens. These results showed to the emitter flow variation permitted by the gravity drip irrigation system, which is less than 20% for lateral lines and less than 5% for sub-mains. The irrigated crops' performance from laterals 1 to 4 was both better than and comparable to the control, according to the statistical analysis of crop performance. In the control group, the mean crop height was 19.93 cm, compared to the lowest crop height measured from the lateral of the drip system, which is 35.79 cm. The crop grew to the predicted minimum crop height of 23.45 cm, which is required for a waterleaf crop, it can be determined. Similar to this, the stem diameter of 2.48 mm was obtained from the control as against the 3.58 mm, which was the least from the drip system. This demonstrates that the irrigation system was suitable for use in small-scale vegetable gardens and is advised for usage in order to improve crop production, irrigation efficiency, and the initial outlay required of prospective irrigators.

Low gravity irrigation intervention was applied in a wadi situation for vegetable cultivation in which 25 farm families had a farm size of 0.4 hectares. Brinjal, Chilli, Tomato, Pan and Root Crops were grown in this intervention. Water tanks were placed at a height of 3 to 5 meters for drip irrigation. About 25 to 30% increase the production of vegetable crops was observed in this intervention. After analysis of economic indicators, among different vegetable crops grown in this intervention the highest B:C ratio 1:4.9 was observed in leafy vegetable. It is good technology for getting round the year green vegetable for the farm family and also fulfill the nutritional requirement shown in Table 1.

Table 1: Performance and economic indicators of low-cost gravity drip irrigation system for vegetable cultivation in wadi

Crop	Area (ha)	Yield (q/ha)		Cost of cultivation (Rs. /ha)		Net return (Rs. /ha)		B:C Ratio	
		Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention
Brinjal	0.08	7.89	13.10	9130	11830	22430	34020	1 :3.4	1 :3.8
Chilli	0.06	9.27	14.39	7650	9840	18306	30452	1:3.3	1:4.0
Tomato	0.12	7.10	9.92	8170	10250	20230	29430	1:3.4	1:3.8
Leafy vegetable	0.01	1.30	2.0	1380	2040	5120	7690	1:4.7	1:4.9

Intervention 2: Yield maximization of vegetable with High tech Cultivation

Soil and water-related issues are a major concern for the current irrigation techniques and infrastructure. Percolation, transpiration, and evaporation are the three main ways that water is lost in nature. By supplying plants with water using drip irrigation systems, percolation losses may be prevented. By using mulches such agricultural wastes and polyethylene plastics, the amount of evaporative losses can be reduced. The most common mulch used for vegetable cultivation these days is black plastic. When considering other mulches, the cost per acre is greater for this one. However, black plastic mulch also works to improve crop output early on by warming the soil and preventing the majority of weed development within rows.

Biswas *et al.* (2015) [1] reported that the combined impacts of mulches and drip irrigation on tomato output, water consumption efficiency and economic return were examined in this study. The study's treatments included varying combinations of two mulches (black polyethylene sheet and paddy straw) and three drip irrigation levels (100, 75, and 50% of crop water need, ETc). For all irrigation levels, the mulched treatments had yield and yield-contributing characteristics that were considerably higher than those in the unmulched treatments. In the unmulched treatment, the tomato production rose when irrigation water was used more often. When mulches were added to drip watering, the tendency was reversed. 50% of the required water was provided to get the maximum yield for each mulch (81.12 t/ha for HDPE and 79.49 t/ha for straw). Poor yield of vegetable under traditional cultivation, high labour requirement and fluctuation in market rate discourages farmers for growing vegetables even after high remunerative return and livelihood security under hi-tech cultivation. By using high-tech technology like drip and mulching, higher production of grown vegetables and efficient use of water can be done by using drip irrigation. In this intervention, 45 farm families were covered, whose farm size was 0.45 hectares. Tomato, chilli, bitter gourd, brinjal, cabbage and watermelon were grown in the fields by high-tech cultivation technology. About 30 to 35% increase in net income was observed in the vegetable crops grown through this intervention. The economic indicators shown in Table 2, among different vegetable crops grown in this intervention the highest B:C ratio 1:4.2 was observed in Chili vegetable. This technology good for high return per unit area and quality vegetable production.

Table 2: Performance and economic indicators of yield maximization of vegetable with High tech Cultivation

Crop	Area (ha)	Yield (q/ha)		Cost of cultivation (Rs. /ha)		Net return (Rs. /ha)		B:C Ratio	
		Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention
Water melon	0.10	163.47	197.18	45360/-	50500 /-	118110/-	146680/-	1:3.6	1:3.9
Chilli	0..07	113.27	146.12	49370/-	67980/-	120535/-	222260/-	1:3.4	1:4.2
Bitter guard	0.08	119.28	141.17	115360/-	129890/-	242450/-	293620/-	1:3.1	1:3.2
Brinjal	0.05	123.05	150.17	98210/-	115290/-	270940/-	335220/-	1:3.7	1:3.9
Cabbage	0.06	117.32	140.28	88950/-	98570/-	204350/-	252130/-	1:3.2	1:3.5
Tomato	0.09	91.36	108.63	107360/-	110820/-	258080/-	323700/-	1:3.4	1:3.9

Intervention 3: Efficient Utilization of field bunds through fruit crop plantation

In many places of the world, bunds make up a sizable fraction of the land used to produce arable rice. Bunds are important because they help to define ownership boundaries, keep moisture and water on sloping terrain, and provide access to fields. However, if they are not properly maintained, bundles might become a source of weed seeds. The development of fruit crops, however, may offer a revenue stream for well maintained bunds (Rao and Johnson, 2017) [10]. Pandey *et al.* (2012) [9] observed that cultivation of fruit crops model on bunds gave129% higher productivity than growing crops i.e. conventional practice alone. Field bunds contributed nearly 5-10 % area of the total land area but farmers are not utilizing these bunds for fruit cultivation The main purpose of a fruit crop cultivation in field bunds is to maximize the yield crop per area unit through planting fruit trees and exploiting efficient use of different resources. The use of this intervention, it was found that tribal farmers can use their small land lying vacant as planting of fruit plants for additional income and nutritional security. Mango, guava, papaya, Apple ber and Drum Stick fruit plants were planted in the study area. For this intervention, fruit crops were planted in the field bunds of 40 farm families. Using this technology, the net income of farmers was found to increase by 20 to 35%. Among different fruit crops grown in this intervention the highest B:C ratio 1:3.8 was found in Papaya fruit crop after analysis of performance and economic indicators (Table 3). This technology good for additional income and space utilization.

Table 3: Performance and economic indicators of utilization of field bunds through fruit crop plantation

Crop	Area (ha)	Yield (q/ha)		Cost of cultivation (Rs. /ha)		Net return (Rs. /ha)		B:C Ratio	
		Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention
Mango	0.88	28.3	34.32	27380/-	30910/-	57520/-	72050/-	1:3.1	1:3.3
Papaya	0.88	93.24	133.5	24785/-	34270/-	68455/-	99230/-	1:3.7	1:3.8
Guava	0.88	34.8	39.18	21860/-	22640/-	45920/-	55720/-	1:3.1	1:3.4
Drumstick	0.88	12.34	19.37	18230/-	27570/-	44830/-	69280/-	1:3.3	1:3.5

Intervention 4: Yield maximization of different fruit vegetables under protected structure

In this project area farmers are not using shed net for cultivation of any fruit/vegetable. Due to these farmers are not getting higher yield and good quality vegetable/fruits. In the market farmers not getting good price for their produce.The growing limitations of weather extremes, water scarcity, insect pests, and soil-borne illnesses are impeding the cultivation of vegetables in open fields. In order to safeguard crops, more pesticides are being utilized, which might lower the quality of vegetables because of residues. Since protected horticulture offers an additional and alternative production approach to traditional open field agriculture, it may be very beneficial in raising productivity and yield Mishra *et al.* (2010) [8]. Vegetable crops are subject to a number of constraints, including high wind speed, atmospheric CO_2, temperature stress, photostress, moisture stress, weed development, and a lack of nutrients in the soil. Variations in temperature, humidity, UV radiation ranges, and cost implications among shielded cultivation structures can lead to increased fruit quality, increased output, and more advantageous market pricing for farmers and producers. In the vegetable industry, protected farming offers a lot of potential to become self-sufficient on a smaller footprint (Sirohi and Bahera, 2000) [12]. These structures support the growth and development of crops that require partial shade or shield crops from the intense heat of the summer by using UV stabilized agro-shade net materials to generate partial shade conditions inside the structure. This partial shade impact decreases water loss through evapo-transpiration while promoting faster and better development of leafy plants. Crops including capsicum, tomato, okra, cauliflower, cabbage, brinjal, beans, parthenocarpic cucumber, and other cucurbits may be grown year-round in net homes or poly houses with less chemical residues and a decreased frequency of insect pests and illnesses. Local timber products like bamboo or wooden poles can help save expenses dramatically. Because protected horticulture enables producers to cultivate vegetables throughout the off-season and prolong their growing seasons longer than in open fields, it can significantly enhance growers' incomes (Yadav and Choudhary, 2014) [15]. There has been an increase in the production of vegetables grown using low cost protected structures like shed net for higher production of vegetables. The quality of vegetables grown under shed net was found to be very good. Also, the vegetables were free from insect, pest and diseases.

20 farm families were selected for this intervention, whose farm size was 0.8 hectares. Under this intervention, watermelon, bitter gourd, cowpea and sponge gourd were grown in the low cost protection structures built in the farmers' fields. Under this intervention, it was found that there was an increase of about 20 to 25 percent in the net income of the farmers revealed inTable 4. After analysis of the performance and economic indicators, among different vegetable crops grown in this intervention the highest B:C ratio 1:3.9was evaluated in Bitter gourd vegetable.

Table 4: Performance and economic indicators of different fruit vegetables grown in low cost shed net condition/ open field for Yield maximization

Crop	Area (ha)	Yield (q/ha)		Cost of cultivation (Rs. /ha)		Net return (Rs. /ha)		B:C Ratio	
		Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention
Water melon	0.040	15.29	19.14	8950/-	10870/-	21630/-	27410/-	1:3.4	1:3.5
Cow pea	0.040	3.12	3.92	3980/-	4210/-	8500/-	11410/-	1:3.1	1:3.7
Bitter gourd	0.040	8.07	11.58	8470/-	11830/-	23810/-	34490/-	1:3.8	1:3.9
Sponge gourd	0.040	9.72	14.23	8760/-	12240/-	20460/-	33090/-	1:3.3	1:3.7

Intervention 5: Cultivation of spices as sole and intercropping for increases revenue generation in tribal farmers community

Farmers are not growing spices with suitable package of practices due to these farmers are not getting good yield and quality spices.Spice farming in India has been forecast to grow in the future years. The amount of land cultivated has grown, indicating a significant growth in India's output of spices. Due to the transformation in the spice economy from producer-driven to consumer-driven businesses, there is fierce rivalry (Ganga and Jadav 2018) [3]. In addition to improving the sustainability of the system and production, intercropping lowers the risk of climatic anomalies and changes and increases farmer income and employment. By preserving natural resources and enhancing ecosystem services, intercropping pulses, green manure, and cover crops with spices, vegetables and fruits improves the sustainability of the system. Food, nutrition, and environmental security can thus be advanced by encouraging intercropping (Hershon *et al.*,2018) [5].

Chitra and Hemalatha (2017) [2] reported that turmeric growth, yield, and economy in three treatments: Sole crop turmeric (T_1), Turmeric + Fodder maize (T_2), and Turmeric + chilli (T_3). Of these, T_1 and T_3 closely match growth attributes such as total dry yield (48.2 and 48.1 q/ha) and number of tillers per clump (5.5 and 5.4), respectively. When compared to the single crop turmeric (T_1), the largest significant income was recorded in T_3, totaling Rs. 1,48,150.00 /ha (58%) and CEY 70.2 q/ha (45.7%). Therefore, it can be inferred that growing an intercrop of turmeric and chilli, spaced 120 cm apart on one side of the beds and 240 cm apart in bed technique farming, greatly increases revenue without compromising the development and output of the main crop, turmeric.

In this intervention, spice crops were grown as sole and intercropping in the fields of 20 farm families whose farm size was 0.43 hectares. During this demonstration, spice crops like chilli, onion, coriander, fenugreek and turmeric were grown in the fields of selected farmers. During this demonstration, it was found that among all these spice crops, coriander (Leafy) gave the highest net income with B:C ratio was 1:4.6 shown in Table 5. After harvesting of spices crops, threshing /winnowing, curing and drying of spice crop under plastic house. This technology good for quality production of Spices**.**

Table 5: Performance and economic indicators of demonstration of cultivation of spices as sole and intercropping

Crop	Area (ha)	Yield (q/ha)		Cost of cultivation (Rs. /ha)		Net return (Rs. /ha)		B:C Ratio	
		Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention
Onion	0.08	118.16	148.09	59970/-	69920/-	176350/-	226260/-	1:3.9	1:4.2
Coriander (Leafy)	0.09	28.83	40.08	46190/-	60890/-	155620/-	224710/-	1:4.3	1:4.6
Fenugreek (Leafy)	0.07	25.90	35.98	45340/-	56945/-	135960/-	194915/-	1:3.9	1:4.4
Chilli	0.09	134.2	159.98	79985/-	85240/-	189535/-	233220	1:3.3	1:3.7
Turmeric	0.10	62.15	90.28	69150/-	86845/-	179450	274275/-	1:3.5	1:4.1

Intervention 6: Crops grown in multilayer farming system for maximum utilization of land space

Poor yield of vegetable under traditional cultivation, high labour requirement and fluctuation in market rate discourages farmers for growing vegetables even after high remunerative return. This technology good for higher production in minimum land. Using vertical space to develop many layers of crops inside a single agricultural system, multilayer farming is an innovative agricultural method that remains classic farming processes. This strategy aims to address issues related to inadequate land usage and shortage of land. According to the principle, various crops are arranged in layers, making the most of the vertical space. A multitiered environment may be created by the layers, which can comprise crops growing at ground level, vines clinging to trellises, and even trees or bushes. Increased production is the outcome of this layout, which maximizes water use, fertilizer distribution, and solar exposure. The ability to greatly raise the total output per unit of land is one of the main benefits of multilayer farming. Farmers may build a symbiotic ecosystem that maximizes the use of available resources by intentionally pairing plants that complement each other in terms of growth patterns, resource requirements, and ecological interactions (Solanki *et al.*, 2024) [14].

The main goal of multilayer farming is resource efficiency. Diverse plant species intercropping promotes nitrogen cycling and lessens the demand for outside inputs. Additionally, the variety of plants can ward against pests and illnesses, lowering the need for chemical treatments. Crop vertical stacking facilitates effective water management via integrated irrigation systems. Beyond its usefulness, multilayer farming supports the preservation of biodiversity. The cohabitation of different plant species promotes an agricultural environment that is more robust and ecologically diversified. Pollination, soil health, and general ecological stability may all benefit from this. According to Jakhar *et al.* (2012) [6], the system of papaya + ginger: pigeonpea (8:2) + gliricidia had the highest net return,. In contrast, the solo pigeonpea recorded the greatest in the case of the B:C ratio. According to Sankaranarayanana *et al.* (2012) [13], the root system of cotton, radish, cluster beans, and beets had the highest net return and daily profitability. The greatest B:C ratio was achieved with a multilayer system consisting of cotton, radish, beet root, and coriander.

This multilayer farming intervention was demonstrated in the field of 15 selected farmers with a farm size of 0.2 hectares. The primary material used for multilayer farming was Bamboo stick, GI pole, wire and low cost constructed shed. Under this farming system, cowpea, bitter gourd, brinjal, chilli and sponge gourd were grown. The highest income from the among the various crops grown in this intervention was obtained from the chilli crop whose B:C ratio was found to be 1:4.3 (Table 6).

Table 6: Performance and economic indicators of different type of crops grown in multilayer farming system for maximum utilization of land space

Crop	Area (ha)	Yield (q/ha)		Cost of cultivation (Rs. /ha)		Net return (Rs. /ha)		B:C Ratio	
		Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention	Farmers practice	Intervention
Bottle gourd	0.06	2.75	4.05	3140/-	4450/-	7740/-	11750/-	1:3.4	1:3.6
Chilli	0.10	3.87	4.97	3750/-	4620/-	11510/-	15260/-	1:3.8	1:4.3
Sponge gourd	0.05	3.07	3.43	3675/-	3740/-	8605/-	9980/-	1:3.3	1:3.6

Conclusion

The horticultural-based modules implemented under the Farmers First Programme have had a transformative impact on the livelihood security and income of tribal farmers. The adoption of innovative practices such as low gravity drip, mulching, shed net, fruit crop plantation on bunds, spices cultivation, and multilayer farming has resulted in significant improvements in crop yields, income, and food security. These interventions have not only enhanced the economic well-being of tribal farmers but also empowered them with sustainable agricultural practices, improved market access, and reduced poverty and vulnerability. The project's success demonstrates the potential of horticultural-based initiatives in improving the livelihoods of marginalized communities and contributing to sustainable agricultural development. The findings of this study can inform policy and development initiatives aimed at promoting sustainable agriculture and improving the livelihoods of tribal farmers. The Farmer First Programme serves as a model for replicating similar initiatives in other regions, promoting a sustainable and prosperous future for tribal farming communities.

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