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Has the implementation of front line demonstration had a significant influence on the adoption rate and widespread cultivation of tomato *(var. Swarna sampad)* in the north eastern ghat region of Odisha, India

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ABSTRACT

The aim of this study was to determine the yield gap in tomato crops using FLDS. To achieve this, the Krishi Vigyan Kendra, Ganjam-I conducted frontline demonstrations on tomato crops in different locations of Ganjam district. The demonstrations involved 10 farmers each year from 2019-20 to 2021-22 and aimed to improve tomato production potential through the active participation of farmers. The demonstration tested various technologies such as the use of *hybrid (Swarna sampad)* varieties, balanced fertilization based on soil testing reports, and integrated pest and disease management. Tomato is a significant vegetable crop in the Ganjam of Odisha, but its productivity is low due to the inadequate knowledge and partial adoption of recommended practices by tomato cultivators. The study collected data on the cost of cultivation, production, productivity, gross return, and net return, which were then analyzed. The results showed that the average highest yield in the demonstration plots was 605.80 q/ha, which was higher than the control plot yield of 505.30 q/ha, resulting in an additional yield of 100.50 q/ha and an average increase in tomato productivity of 19.88%. During the demonstration years, the extension gap and technology gap ranged from 101.10 to 113.0 and 44.20 to 69.60 q/ha, respectively, with a technology index of 9.40%. Furthermore, the demonstrated plots generated higher gross returns and net returns with a higher benefit-cost ratio when compared to farmers' practices. The study also examined the impact of FLD on horizontal spread and found that it increased by 209.52% when appropriate practices and packages were followed.

Key words : *Tomato, Front line demonstration, Impact, Adoption*

Introduction

The tomato (*Lycopersicon esculentum* Mill.) is a flowering plant from the nightshade family (Solanaceae) and is widely cultivated for its edible fruits. Although commonly referred to as a vegetable for nutritional purposes, tomatoes are an excellent source of vitamin C and the phytochemical lycopene. They can be eaten raw in salads, cooked as a vegetable, used as an ingredient in various dishes, or pickled.

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A significant portion of the global tomato crop is used for processing into products such as canned tomatoes, tomato juice, ketchup, puree, paste, and dehydrated pulp or "sun-dried" tomatoes.

Tomatoes are known for their productivity and protective health benefits. They are a short duration crop and can be grown in various cropping systems, including cereals, grains, pulses, and oilseeds, and yield high returns, making them of high economic value. Tomato is one of the most important vegetable crops grown worldwide under both field and greenhouse conditions (Kumar, 2017). In India, tomatoes are the third-largest vegetable crop, after potatoes and brinjals, with a production of approximately 7.60 million tonnes (FAO, 2007) . India ranks third in both area and production after China and Japan. Major tomato-growing countries include the USA, Italy, Spain, Portugal, and Turkey.

Cultivated tomatoes originated in the Andes region of Peru, Ecuador, and Bolivia in South America. As a warm-season vegetable crop, tomatoes are sensitive to frost and can be killed by freezing temperatures. Until about 10-12 years ago, tomatoes were grown seasonally. However, modern farming techniques have made year-round cultivation possible.

Andhra Pradesh is the highest tomato producer in India, followed by Madhya Pradesh, contributing 14.42 % and 12.70 %, respectively, to the total tomato production in India (Source: Food Grains and Economics and Statistics). India's tomato production accounts for 11.2% of the world's total, with a production of 4.25% where as in Odisha stands 5th with a contribution of 6.77 % to the national production.

Tomatoes are a crucial commercial vegetable crop in Ganjam district, but farmers in the region are facing several challenges due to climate change. These issues include drought-like conditions and a scarcity of labor during the summer months. Additionally, a lack of knowledge about the use of biocontrol agents and other basic intercultural practices has led to an increase in production costs and a reduction in tomato yields. Market price fluctuations also affect farmers in the area. All of these factors increase the risk of tomato cultivation, which is why frontline demonstrations have been conducted to boost farmers' confidence and increase profitability through enhanced productivity.

Krishi Vigyan Kendra Gnjam-I, under Odisha University of Agriculture and Technology, Bhubaneswar, conducted a study for three consecutive years (2019-20 to 2021-22) in the farmers' fields

Table 1. Level of use and gap in adoption extent of tomato technologies in study area

Crop operations	Improved package of practices	Farmers practices	Gap
Variety	*Hybrid (Swarna Sampad)* Naveen.		
Soil testing	Have done in all locations	Not in practice	Full gap
Seed rate	100 gm/ha	200 gm/ha	Partial gap
Seed priming	Seed priming was performed for better germination. Seeds were soaked during night for 8-10 hours with natural water,drained out excess water and dried in shade before sowing.	Not in practice	Full gap
Seed treatment	Seed was treated by carbendazim @ 1 gm/ kg seeds	Not in practice	Full gap
Transplanting method	Transplanting in raised bed distance Row to Row 90 cm & Plant to Plant 60 cm	Flat bed transplanting Row to Row 60cm & Plant to Plant 30 cm	Partial gap
Nursery time	September	Last week of September	Partial gap
Transplanting time	October	November	Partial gap
Fertilizer dose	Fertilizer @ 150 Kg N, 115 Kg P_2O_5 and 150 Kg K_2O/ha	Without recommendation	Partial gap
Weed dose	Pendimethalin @ 1.0 kg/ha was applied immediately after transplanting.	Hand weeding/rarely used	Partial gap
Multiplex nutrient spry	@ 2.5 gm/ litter water and spray on both surface of leaves. First spray just before flowering, second spray during flowering or 25 days after first spray and third spray whenfruits are bean size.	No application	Full gap
Plant protection Measures	Need based in case of severe infestations of TLCV imidaclroprid 17.8 % SL. or dimethoate 30 EC @ 2ml/lt and other systematic chemicals	Use chemicals with recommendations	Partial gap

at various locations in Ganjam district through front line demonstrations. Front line demonstrations are a powerful tool for technology transfer, showcasing the benefits of new technologies in increasing yields and profits. The study consisted of 30 demonstrations conducted on 3.0 hectares of land across three years, with each demonstration covering 0.2 hectares, and an adjacent 0.2 hectares considered as a control (farmer's practice) for comparison. The farmers were selected based on a survey by KVK, and special training was provided to them on tomato cultivation.

The difference between the demonstration package and the existing farmer's practice is provided in Table 2. The demonstration plot followed all the recommended package of practices, including the use of biocontrol agents (*Trichoderma* and *Pseudomonas*), enriched FYM, recommended dose of fertilizers, mulching, integrated pest management practices, and quality seeds of improved variety. Traditional practices were considered as the control. Field days were organized in each cluster to showcase the results of the front line demonstration to farmers from the same and neighboring villages. The soils in the area were sandy to sandy loam with medium to low fertility status, and the average annual rainfall was 1200 mm. The temperature varied from 15 to 43 °C, with an average temperature of 24 °C.

KVK scientists collected data on yield, pest management, production cost, and returns from the front line demonstration plots and control plots (farmer's practice) during frequent field visits from 2019-20 to 2021-22. They calculated the extension gap, technology gap, and technology index using the formula suggested by Samui *et al.* (2000) and Dayanand *et al.* (2012). The formulas are given below.

Percent increase in yield = Demonstration yield - farmers practice yield X 100 /Farmers practice yield

Technology gap = Potential yield -Demonstration yield

Extension gap = Demonstration yield - Yield under existing practice

Technology index = Potential yield - Demonstration yield X 100 /Potential yield

The data of adoption and horizontal spread of technologies were collected from the farmers with the interaction them. Data were subjected to suitable statistical methods. The following formulae were used to assess the impact on different parameters of tomato crop.

Impact of yield = Yield of demonstration plot- yield of control plot/Yield of control plot X 100

Impact on adoption (% change) = No. of adopters after demonstration- No. of adopters before demonstration /No. of adopters before demonstration X 100

Impact on horizontal Spread (% change) = After area (ha)- Before area (ha)

Results and Discussion

Yield

According to Table 2, the examination of data reveals that the use of a complete package of practices, including bio fertilizer enriched FYM, recommended amounts of fertilizers, raised bed preparation, mulching, pheromone traps, and timely plant protection chemical application, resulted in a tomato yield increase ranging from 580.40 q/ha to 605.80 q/ha in demonstration plots and from 490.60 q/ha to 505.30 q/ha in farmer's practice plots over a period of three years. The average yield of tomato was 594.32 q/ha in demonstration plots compared to 493.22 q/ha in farmer's practice plots during the same years. This clearly demonstrates that the adoption of the complete package of practices led to higher average yields in demonstration plots over the years in contrast to farmer's practice, which

Table 2. Productivity, technology gap, technology index and extension gap in tomato under FLD

Year	Area (ha)	No. of farmers	Yield (q/ha)			%Increase in yield	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
			Potential	Demonstration	Control				
2019-20	1.0	10	650	580.40	490.60	18.31	89.6	69.60	11.99
2020-21	1.0	10	650	596.75	483.75	23.35	113.00	53.25	8.92
2021-22	1.0	10	650	605.80	505.30	19.88	100.50	44.20	7.29
Average	-	-	650	594.32	493.22	20.51	101.10	55.68	9.4

Control*= Farmers practice use as control lacked the knowledge and application of bio fertilizers, balanced fertilizers, and integrated pest management (IPM) practices.

The average tomato yield increased by 20.51% due to the complete package of practices, and the yield could be further increased beyond the yield obtained under farmer's practice, which lacks the knowledge of bio fertilizers, balanced fertilizer use, and IPM practices. Similar results were obtained in the studies conducted by Singh *et al.* (2011); Hiremath *et al.* (2007); Mishra *et al.* (2009), Kumar *et al.* (2010); Surywanshi and Prakash (1993), Dhaka *et al.* (2010); Mokidue *et al.* (2011) and Misra *et al.* (2014) for enhancing the yield of different crops in frontline demonstrations.

The increase in tomato yield varied between 18.31% to 23.35%, with the highest increase (23.35%) observed in 2020-21 compared to farmer's practice. However, variations in tomato yield across different years could be attributed to fluctuations in soil moisture availability, rainfall patterns, and changes in demonstration locations each year.

Extension gap

During 2019-20, 2020-21, and 2021-22, there was a significant extension gap of 89.60 q/ha, 113.0 q/ha, and 100.50 q/ha, respectively. The average extension gap over the three-year period of the front line demonstration (FLD) program was 101.10 q/ha. This highlights the necessity of educating farmers through various techniques to promote the adoption of improved agricultural production technologies and to reverse the trend of a wide extension gap. By utilizing the latest production technologies and high-yielding varieties, farmers can improve their yields and help reduce the extension gap.

Technology gap

In 2019-20, 2020-21, and 2021-22, the technology gap, which is the difference between potential yield and the yield obtained in demonstration plots, was 69.60 q/ha, 55.25 q/ha, and 44.20 q/ha, respectively. The average technology gap over the three-year period of the front line demonstration (FLD) program was 55.68 q/ha. The causes of the technology gap could be attributed to soil fertility, individual farmers' managerial skills, and climatic conditions in the area. Therefore, it is crucial to provide location-specific recommendations to bridge these gaps. These findings are consistent with those reported by Singh *et al.* (2011); Sharma and Prakash (1993); Misra *et al.* (2014); Poonia *et al.* (2011) and Gatahi (2020).

Technology Index

The technology index is an indicator of the practicality of the demonstrated technology in farmers' fields. The technology index ranged from 7.29 to 11.99, as shown in Table 2. The average technology index over the three years of the front line demonstration (FLD) program was 9.4%, demonstrating the efficacy of the technical interventions. This promotes the adoption of the demonstrated technical interventions to enhance the yield performance of tomato.

Economic returns

To determine the economic feasibility of the demonstrated technologies compared to the control, various economic indicators such as cost of cultivation, net return, and benefit-cost (B:C) ratio were calculated. The economic viability of the improved demonstrated technology over the farmers' practice was evaluated based on prevailing input and output costs and presented as B:C ratios (as shown in Table 3). The study revealed that the cost of tomato production under demonstration ranged from Rs. 56,900 to 62,500 per hectare, with an average cost of Rs. 59,666, compared to Rs. 51,300 to 56,500 with an average of Rs. 53,733 under control. The additional cost incurred in the demonstration was mainly due to higher expenses involved in using balanced fertilizers, procuring improved *hybrid (Swarna Sampad)* seeds, and implementing integrated pest management (IPM) practices.

Table 3. Comparative C:B analysis of tomato under FLD and farmers practice

Year	Cost of Cultivation		Gross return (Rs./ha)		Net Returns (Rs./ha)		B:C Ratio	
	Demo.	Control*	Demo.	Control*	Demo.	Control*	Demo.	Control*
2019-20	56900	51300	202500	159000	145600	107700	2.55	2.09
2020-21	59600	53400	217900	167500	158300	114100	2.65	2.13
2021-22	62500	56500	226000	173000	163500	116500	2.61	2.06
Average	59666.67	53733.33	215465.66	166500	155800	112766.67	2.60	2.09

Control*= Farmers practice use as control

Improved technologies for tomato cultivation resulted in significantly higher net returns of Rs. 1,45,600/ha, Rs. 1,58,300/ha, and Rs. 1,63,500/ha in the years 2015-16, 2016-17, and 2017-18, respectively, with an average net return of Rs. 1,55,800/ha. This was much higher than the average net return of Rs. 1,12,766.67/ha in farmer's practices. The benefit-cost ratio (BCR) of tomato cultivation ranged from 2.61 to 2.65 in demonstration plots and from 2.06 to 2.13 in farmer's practice plots during the three-year demonstration period, with an average BCR of 2.60 in demonstration plots and 2.09 in farmer's practice plots. The higher yield obtained and lower cost of cultivation under the improved technologies may have contributed to the higher net returns and BCR compared to local check (farmer's practice). These findings are consistent with the results of similar studies conducted by Singh *et al.* (2011); Misra *et al.* (2014); Tomar *et al.* (2003) and Chapke (2012) in the case of jute.

The study found that the B:C ratio was consistently higher in the demonstration plots compared to the control plots throughout the study period. The adoption of scientific methods of tomato cultivation can significantly reduce the technology gap and enhance tomato productivity in the district, which can improve the economic conditions of the farmers. It is essential for extension agencies in the district to provide appropriate technical support to the farmers using various educational and extension methods to decrease the extension gap and promote better tomato production in the different regions of Odisha.

The results of the improved technology intervention revealed that the adoption rate of the recommended *hybrid (Swarna Sampad)* tomato by farmers was negligible before the demonstration, but increased by 106.25% after the demonstration. The transplanting in raised bed technique also increased by 150% due to the intervention through FLD. The overall adoption level of *hybrid (Swarna Sampad)*, tomato production technology increased by about 209.52% due to FLD conducted by KVK, Ganjam-I (as shown in Table 4).

In the present study, efforts were made to investigate the impact of FLD on the horizontal spread of tomato *hybrid (Swarna Sampad) (Swarna Sampad)*.

The data presented in Table 5 demonstrated that the FLD organized on tomato crop significantly increased the area under the recommended *hybrid (Swarna Sampad)*. The area under the *hybrid (Swarna Sampad)* tomato increased significantly from 9.50 to 38.0 ha horizontally.

Conclusion

The study revealed that the FLD had a significant positive impact on the productivity and profitability of the latest technology intervention under real farming conditions. Consequently, it can be inferred that the FLDs conducted by KVK, Ganjam-I played

Table 4. Impact of Front Line Demonstration (FLDs) on adoption of Tomato production technology

Technology	Numbers of adopters		Change in No. of adopter	Impact (% Change)
	Before demonstration	After demonstration		
Land preparation and FYM applications	15	37	22	146.66
Recommended *hybrid (Swarna Sampad)*	16	33	17	106.25
Seed rate	05	23	24	360
Transplanting in raised bed	12	30	16	150
Balance fertilizer application	07	23	21	228.57
Weed management	15	25	14	66.66
Spacing and plant populations	08	23	15	187.50
Foliar nutrition	05	17	12	240
Recommended insect pest management	04	20	22	400
Overall impact				209.52

Table 5. Impact of Front Line Demonstration (FLDs) on horizontal spread of tomato *hybrid (Swarna Sampad)*

Variety	Area (ha)		Change in area (ha)	Impact (% Change)
	Before demonstration	After demonstration		
Swarna Sampad	9.50	38.0	22.50	300.00

a crucial role in spreading the technology horizontally. To further enhance the knowledge and skills of growers and facilitate the adoption of technology, it is recommended to implement target-oriented training programmes on improved vegetable production technology and multiple demonstrations. This approach could help overcome some of the constraints in the current technology transfer system in the Ganjam district of Odisha. The productivity gain achieved through FLD compared to existing tomato cultivation practices has raised awareness and motivated other farmers to adopt the demonstrated technologies, which can enhance the vegetable production, consumption, nutritional security, and overall livelihood security of the districts of Odisha.

Conflict of interest: Authors don't have any conflict of interest

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