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Yield Gap Analysis and Impact of Demonstration on Turmeric in Tirap District of Arunachal Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The north eastern region of India having good area under spices viz. turmeric, ginger etc. But the productivity is too low due to adoption of old varieties, as well as non-recommended practices followed by farmers. In this context, Megha Turmeric-1 variety of turmeric was demonstrated under front line demonstration programme during 2020-21 and 2021-22 respectively by Krishi Vigyan Kendra Tirap, Arunachal Pradesh. The average FLD yield was 218 and 224 q/ha was recorded as compared to 164 and 179 q/ha under farmers practices. The Technology gap was 32 and 26 q/ha, extension gap was 54 and 45 q/ha and technology index ere 13 and 10 respectively. The net income under FLD plot was higher over farmers practice during both years of study (Rs, 290000 &

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300000 vs. 210000 & 214000). Similarly, the B:C ratio was also better than farmers practice (2.45 & 2.02 vs. 1.77 & 1.76). Being a very low technology index, it assumes that turmeric production can be enhanced by dissemination of improved technologies at farmer's field.

Keywords: Demonstration; megha turmeric 1; yield gap.

1. INTRODUCTION

Turmeric (*Curcuma longa* L.) is popular as the king of spices grown by the farmers of Arunachal Pradesh in their kitchen garden. The crop has the good potentiality to enhance the farm income as well as farmer's livelihood ness in Arunachal state as well country.

It thrives in warm, humid climates with temperatures between 20 and 30 degrees Celsius with an ideal annual rainfall of 1500 mm Many soil types, including rich loamy soils with natural drainage and irrigation capabilities, red soils, light black loams, clay loams, and rich loamy soils, are suitable for growing turmeric [1].

Although the rhizomes are composed of 69.4% carbohydrates, 5.1% fat, 6.3% protein, 3.5% minerals, 5.0% volatile oil, and 7.9–10.4% oleoresin, curcumin or diferuloylmethane (2.5–6.0%), which is composed of curcumin I, or curcumin (94%), curcumin II, or dimethoxy curcumin (6%) and curcumin III, or bis-demethoxy curcumin (0.3%), is what gives the rhizomes their yellow color (Raghuraja, 2016).

Turmeric has a wide range of culinary, medicinal, and cosmetic applications. According to Kaur et al. [2], it has antibacterial, anti-inflammatory, blood-purifying, stomachic tonic, and anti-parasitic properties (Soibam et al. 2021). It is also utilized in the production of anti-cancer drugs and as an antiseptic. Rhizome juice in its raw form is anti-parasitic and used to treat a variety of skin conditions (Reddy, 2010).

The tribal farmers in the Tirap district of Arunachal Pradesh, who grow turmeric traditionally without access to improved scientific knowledge on the variety, agronomic practices, optimal nutrient management module, and quality planting material free of insect, pest, and disease infestation, could benefit greatly economically from this crop.

Turmeric's average production in this region is poor (160–170 q/ha, Table 1) due to a number of biotic and abiotic factors, two of which are the inadequate application of plant protection methods against pests and diseases and the cultivation of indigenous, inferior varieties. As a result, an effort was made to raise the region's low productivity by using site-specific technologies on turmeric, providing training, and holding demonstrations.

Through clonal selection, the high-yielding variety Megha Turmeric-1 was produced at the ICAR (Research Complex) for the NEH Region, Umiam, Meghalaya. It is also suitable to the conditions of Arunachal Pradesh, with a crop length of 300–315 and an average production potential of 268 q/ha. 16.37% dry matter, 6.8% curcumin, and 5.5% essential oil are present in this cultivar. According to Chandra et al. [3], it has a good tolerance to the diseases leaf spot (*Colletotrichum capsici)* and leaf blotch (*Taphrina maculans*).

Consequently, there is a lot of room to grow turmeric's productivity. According to Manan et al [4], farmers must apply 25% more phosphatic fertilizer than is recommended and employ mulching material at a rate of 6 t/ha in sandy soils with low NPK levels in order to maximize the rhizome yield of turmeric. Thus, Thus, a frontline demonstration on nutrient management in turmeric (Megha Turmeric-1 variety) was demonstrated in various pockets of Tirap's district of Arunachal Pradesh for the two years.

2. MATERIALS AND METHODS

Before conducting of demonstration, KVK Tirap conducted a field Krishi Vigyan Kendra (KVK), Tirap, Arunachal Pradesh, India conducted a field level survey to know the reality, farmer's practice's, local yield, insect- pest attack problems etc. in turmeric crop. As per the survey results, yield of farmer's practices was low due to non - adopting of scientific know-how.

The Frontline demonstrations (FLDs) were carried out on 2 ha & 3 ha during 2021 and 2022 respectively. The demonstration plot size of farmers was 0.20 ha. The total 10 & 15 numbers (during both years) of demonstration carried out during the study.

Table 1. Improved practices vs farmer's practices of Turmeric

Particular	Technological intervention	Existing practices	Gap
Variety	Megha Turmeric 1	Very Old variety	Full gap
Seed rate	2500 kg/ha	3500 kg /ha	Full gap
Rhizome treatment	Treated	Not treated	Full gap
Sowing method	Line sowing	Line sowing	Partial gap
Spacing	60 x 25 cm with 6 cm depth of sowing	45 x 20 cm with 8 cm depth of sowing	Partial gap
Application of recommended dose of manure	20 t/ha	Nil/without recommendation	Full gap
Application of Bio fertilizer	Soil application of *Azospirillum* & PSB @ 2 kg/ha mix with FYM	No application	Full gap
Drenching	drenching of *Trichoderma viride*at 5 g/liter	Not applied	Full gap
Weed management	Done at 30, 60 and 90 days after planting	Not common	Full gap
Spraying of Biopesticide	Neem oil @ 5ml/litre of water	Not sprayed	Full gap
Harvesting	Manual	Manual	No Gap

The Chasa, Noksa, Dadam, Noitang and Makat villages under different circles of Tirap district was selected under FLD programme.

For conducting FLDs, selection of farmers, layout of demonstration, farmers' participation was followed as suggested by Choudhary (1999). The required inputs were supplied and regular visits to the demonstration fields by the KVK scientists ensured with proper guidance to the farmers. The recommended practices included treatment of rhizomes with Ridomil (2.5 g/l) for40 min before sowing as prophylactic measure for rhizome rot disease, seed (rhizome) @2500 kg/ha were sown @ 60 cm x 25 cm. Application of FYM @ 20t, N: P: K @ 30:50:60 kg/ha [5], intercultural operations and application of 1% Bordeaux mixture at 15 days interval against leaf spot disease. Field days and group meetings were also conducted to provide the opportunities for other farmers of the same village as well as neighboring villages witness the benefits of demonstrated technologies. The data output was collected from both FLD plots as well as control plots and cost of cultivation, net income and benefit.

3. RESULTS AND DISCUSSION

It is clear from Table 2 that demonstration plots of Megha turmeric 1 was performed better than check. The average yield of demo. Plots was 218 q/ha and 224 q/ha as compared to 164 & 179 q/ha from farmer's practice. The demo yield was 32% & 25 & higher over farmers practices which proved that demonstrated technology was economic viable. The genetic viability of improved planting material as well as timely planting was the key factor behind this better result. Besides that, use of manure and fertilizers in appropriate dose, application of biofertilizers, biopesticides etc. also influenced the vegetative growth which converted into economic yield of turmeric. Chandra et al, [3], Kaur et al. [2]. Barua, [6] revealed that the balanced doses of fertilizers were induced maximum number of tillers, maximum number of leaves which converted good amount of biomass in turmeric. The additional amount of phosphorus influenced the better root development thus the good yield of rhizomes was recorded under demonstration as compared to farmers practices where fertilizer was not applied.

The gap between potential yield and demonstration yield is known as technology gap [7]. Here this gap was very minimum (32 q/ha & 25 q/ha respectively, Table 2). During the second-year technology gap was lesser than first year; which means the technology was impacted very positively at farmer's field. Though; there was full gap between variety used by farmers as well as FLD. This gap may be minimized after continuous efforts by the developmental agencies through adopting various extension approaches.

Table 2. Production and other extension parameters of Turmeric

Year	Area	Variety	No of Demos.	Potential Yield	Average Yield (q/ha)		% increase over Check	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
					D	C				
2021-22	2	Megha Turmeric 1	10	250	218	164	32	32	54	13
2022-23	3	Megha Turmeric 1	15	250	224	179	25	26	45	10

Where D stands for Demonstration and C stands for Check

Table 3. Economics of turmeric cultivation

Year	Yield(q/ha)		Cost of Cultivation (Rs/ha)		Gross Return (Rs/ha)		Net Return (Rs/ha)		Benefit Cost ratio B:C Ratio	
	D	F	D	F	D	F	D	F	D	F
2021-22	218	164	146000	118000	436000	328000	290000	210000	2.45	1.77
2022-23	224	179	148000	121000	448000	358000	300000	214000	2.02	1.76

Where D stands for Demonstration and C stands for Check

There was also full gap for seed treatment, weed management, nutrient management etc. which caused lower yield under farmers practices (Raghuraja,2016). The seed without treatment faces several fungal attacks in field which reduces their vitality as well as growth and developmental abilities. The weed is also a limiting factor in any crop production. They compete with main crop for solar energy, nutrients, water, space thus the main crop reduces their yield due to completion with weed. The variation in technology gap may be attributed to dissimilarity in the soil fertility status, agricultural practices and local climatic situation (Reddy,2010).

The gap between demonstration plot and farmers practices is called extension gap [7]. The first year's extension gap was 54 q/ha which was minimized during second's year of demonstration as 45 q/ha. Thid proved that Improved variety of turmeric- Megha turmeric-1 was viable at farmer's field [8].

It is the worth mentioning that targeted and precise extension methodologies can serve in better way for the welfare of farming community which can teach them, encourage them for better farm out. The new technologies will eventually lead to the farmers to discontinue the old technology and to adopt new technology [9,4].

The average technology index during first year was 13 while 10 during second's year of study. The lower technology index mean technology is more feasible at farmer's field. This was only due to application of improved variety with full package of practices. This finding is also in confirmation of Rao et al. [9] and Ahuja, [10].

The Cost of cultivation during the first year of study was Rs. 146,000 per ha and Rs. 148,000 per ha during second years of study under FLD while Rs. 118000 per & 121000 per ha under farmer's practice. The cost of cultivation includes cost of field preparation, seeds, labor, fertilizers, biopesticides [11]. The gross return was Rs. 436000 & 448000 per ha under FLD as compared Rs 328000 & 358000 under farmer's field. The net return was higher under FLD plots as compared farmers practices (Rs. 290000 & 300000 as compared 210000 & 214000). The benefit cost ratio is the pivotal point in any farming. The FLD proved its economic viability over farmers practices. The new variety with full package of practices again proved its superiority over check (2.45 & 2.02 as compared 1.77 & 1.76). Similar finding also reported by Mishra et al. [7] who reported better yield of tomato under demonstration plots as compared farmers practices in eastern Uttar Pradesh's conditions.

The increased grain production observed under better technology as compared to farmers' practices may be the cause of the higher B:C ratio in improved intervention technology. Similar financial gains from the use of better technological interventions were also noted by Thakur et al. (2019) and Kaur et al. [1],[12].

4. CONCLUSION

The improved variety of turmeric- Megha turmeric 1 performed well with full package of practices; under supervision of KVK experts as compared to farmer's practice. This technology can enhance the turmeric production in Tirap district of Arunachal Pradesh with wider adoption by farming community. The developmental agencies like- department of Horticulture, department of Agriculture and Krishi Vigyan Kendra can disseminate this one for penetrating the maximum area under this technology.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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