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Ch. Sowmya
Subject Matter Specialist (Agronomy), Krishi Vigyan Kendra, PVNRTVU, Mamnoor, Telangana, India

M Shyam Prasad
Subject Matter Specialist (Fisheries), Krishi Vigyan Kendra, PVNRTVU, Mamnoor, Telangana, India

R Arunjyothi
Subject Matter Specialist (Home Science), Krishi Vigyan Kendra, PVNRTVU, Mamnoor, Telangana, India

J Narasimha
Programme Coordinator and Head, Krishi Vigyan Kendra, PVNRTVU, Mamnoor, Telangana, India

Corresponding Author
Ch. Sowmya
Subject Matter Specialist (Agronomy), Krishi Vigyan Kendra, PVNRTVU, Mamnoor, Telangana, India

Production, economics and yield gap analysis of groundnut influenced by cluster front line demonstrations in Warangal district of Telangana

Ch. Sowmya, M Shyam Prasad, R Arunjyothi and J Narasimha

Abstract
The Cluster frontline demonstrations (CFLDs) on groundnut were conducted by Krishi Vigyan Kendra, Mamnoor, Warangal during *Rabi* season of 2018-19 and 2019-2020 across an area of 97.2 ha with 157 demonstrations. Results revealed that per cent increase in demonstration yield over farmers practice was 18.7 and 24.24 during 2018-19 and 2019-20 respectively. Highest B: C ratio (2.61 and 3.16) was realized from demonstration during the study period against B: C ratio of 2.20 and 2.53 in farmers practice. During investigation, average technology gap (3.9 q/ha), average extension gap (3.7 q/ha) and technology index of 13.2% and 18.0% in respective years was recorded. Increased production and economic returns improved livelihood of farmers. The present study signifies that location specific recommendations must be formulated to narrow down technology gap and encourage beneficiary farmers to adopt full demonstrated technology to lessen extension gap. The technology index warrants horizontal spread.

Keywords: Groundnut, cluster frontline demonstrations (CFLD), yield, yield gap, gross returns

1. Introduction
Groundnut is called the 'King' of oilseeds. India ranks first in groundnut acreage and is the second-largest producer of groundnut in the world with 101 lakh tonnes with a productivity of 1816 kg/ha in 2020-21 (Groundnut outlook report 2021). In India, groundnut is cultivated during *Kharif*, *rabi* and summer seasons under various cropping systems. The major groundnut-producing states are Andhra Pradesh, Tamil Nadu, Gujarat, Karnataka and Maharashtra. Groundnut is not only an important oilseed crop of India but also an important agricultural export commodity. In vegetable oil production, mustard, soybean and groundnut contribute 27%, 34% and 30%, respectively (Cooperation and Farmers' Welfare Annual report 2020-21, Department of Agriculture,). According to IOPEPC, groundnut oil exports increased by 142% and stood at 2, 13, 448 tons in (Apr-Feb) 2021 against 35,629 tons in 2020 (Agricultural Market Intelligence Centre, PJTSAU 2021). Groundnut is also called wonder nut and poor men's cashew nut as they are rich sources of protein, fat, and various healthy nutrients. Groundnut kernel contains 44-56% oil and 22-30% protein on a dry mass basis. It is a rich source of minerals (Phosphorus, Calcium, Magnesium, and Potassium) and vitamins (E, K, and B group) (Ingale and Shrivastava 2011) [2]. Thus, groundnut accounts for nearly half of the 13 essential vitamins and 7 of 20 essential minerals necessary for human growth and development, besides being a high quality fodder for livestock. Groundnut is cultivated in 2.0 lakh hectares across Telangana region, making it one of the state's major crops. It is widely grown in Mahbubnagar, Warangal, Nalgonda and Karimnagar Districts. However, there is a wide gap between the potential yields and the actual production realized by the farmers.

The major constraints in groundnut production is maintaining low plant population thereby lower yields due to the application of lower seed rate in view of high cost towards purchase of seed constituting about 25% of the total cost of cultivation; use of local, age-old, low yielding varieties which are susceptible to drought and non-adoption of seed treatment which favors seed-borne diseases resulting in lower plant population ultimately less yields. Groundnut is the most neglected crop and is cultivated in all types of soils, including marginal lands; hence nutrient management is of prime importance. Though a legume crop, groundnut requires nitrogen during the initial stages. But most farmers do not resort to nitrogen application. Farmers apply less than the recommended dose of P_2O_5 and K2O, which affects the root growth resulting in lower yields. Besides, they use complex fertilizer for top dressing, which leads to nutrient deficiencies of Ca & S, which are essential for preventing pops and enhancing

oil content in pods. Farmers on a large scale fail to apply gypsum, which is necessary at pegging due to lack of availability on time. Weeds account for 24 to 70% of yield losses in groundnut as they compete with the crop for sunlight, water, nutrients and space. In addition, they harbour pests and disease organisms. The optimum time of sowing during *Rabi* season *i.e.*, September 2nd fortnight to October, is one of the significant factors that is deviated and sowing is carried out till January, which decreases yields considerably. Pest and diseases also cause significant yield reduction. In India, about 115 insect pest species cause damage. Only 9 species (leafminer, white grub, jassid, thrips, aphid, tobacco caterpillar, gram caterpillar, red hairy caterpillar and termites) are important. Out of these, white grub, thrips, tobacco caterpillar and hairy caterpillar are responsible for considerable yield losses. Among 55 pathogens, including viruses and early and late leaf spots, stem rot is a major disease in groundnut that leads to yield loss. The actual groundnut yield at the farm level depends on the management aspect associated with socioeconomic and biophysical factors (Bindraban *et al*. 2020) [1]. The higher crop productivity can be achieved by adopting improved production technology and using the latest high yielding variety through cluster frontline demonstrations (CFLDs) in farmer's fields under different agro-climatic regions and farming situations under close supervision of the KVK staff. ICAR-KVKs are organizing cluster demonstrations on oilseeds with the financial support of the National Food Security Mission (Oilseeds & Oilpalm) – NFSM (OS&OP).

CFLDs offer a scope to identify the constraints and provide solutions, thereby attaining potential yields thus improving the economic status of farmers. Besides, there is a horizontal spread of the technology with the concept of seeing by doing. In view of the above-notified issues, the present study was carried out to enhance groundnut productivity and find out the impact of FLDs on bridging the yield gap in terms of technology gap, extension gap and technology index.

2. Materials and Methods

The cluster front line demonstration was organized on farmers fields to demonstrate improved groundnut production technology at Errabelli village, Velair mandal, Warangal district, Telangana during Rabi season over two consecutive years of 2018-19 and 2019-2020. This village was selected as it was a groundnut growing belt and farmers were aware of cultivation practices. During the year 2018-19, demonstrations were conducted in 65 farmers' fields covering an area of 30 ha, whereas in 2019-2020, about 92 demonstrations were spread across an area of 67.2 ha. Each frontline demonstration was laid out on a 0.4 ha or 0.8 ha area and farmers allotted some area for carrying out their traditional practice for comparison. The soils were sandy loams with low nitrogen and medium-fertility of phosphorus and potassium. The crop under demonstration was raised under irrigated conditions during *Rabi* season with improved groundnut production technology *i.e.*, suitable groundnut variety ICGV-351 which was tolerant to foliar disease viz., late leaf spot and rust besides gaining higher yields; optimum seed rate, seed treatment, weed management, nutrient and pest management. In farmers practice, the crop was raised by traditional methods (Table 1). The yield data were collected from both frontline demonstrations and farmers plots at harvest. The extension gap, technology gap and technology index were worked out (Samui *et al.*, 2000) [4] as given below

Technology gap = Potential yield – Demonstration yield
Extension gap = Demonstration yield – Farmers yield
Technology index = [(Potential yield – Demonstration yield)/Potential yield] X 100

2.1 KVK intervention: The methodology adopted for demonstration started with identifying and selecting beneficiaries from all sections of society.

A household survey was conducted and major constraints leading to low yields mentioned by farmers were lack of viable seed, application of less seed rate, weed infestation, pest and disease attack and nutrient deficiencies. An awareness programme was organized for the beneficiary farmers wherein the entire package of practices in groundnut was explained in detail (Table 1). Seed treatment with fungicide mancozeb @ 3 g/kg seed to prevent soil-borne pathogenic disease was demonstrated to them. Advised the farmers to apply SSP instead of DAP, which contributes essential secondary nutrients like sulfur, calcium and magnesium in traces necessary for pod filling, kernel size and oil content, besides decreasing the input cost. To overcome the weed problem, pre-emergence application of pendimethalin @ 3.25 L/ha followed by post-emergence application of Imazethapyr @750 ml/ha was recommended. Applying the correct seed rate @ 200 kg/ha to maintain optimum plant stand towards realizing potential yields was advocated. Emphasized gypsum application @ 500 kg/ha at the time of pegging in the podding zone for pod development and prevention and pops. Created awareness and motivated farmers to follow IPM practices with low-cost, eco-friendly methods like pheromone traps, bird perches, poison bait, and trap crops like marigold to keep the pest population under control. A flexi board on package of practices was displayed at the gram panchayat office for reference. Frequent follow-up visits were conducted during the entire crop period delivering timely agro advisories and farmer's feedback was also collected regularly. The weather was congenial for the growth of the crop and no serious pest or disease attack was observed in the demonstrated plots.

Table 1: Detailed package of practices of groundnut

S. No.	Particulars	Demonstration	Farmers practice
1	Seed	ICGV - 351	Local variety
2	Seed rate	200 kg/ha	150 kg/ha
3	Time of sowing	2nd fortnight of September	1st fortnight of October to January
4	Method of sowing	Dibbling	Dibbling
5	Seed treatment	Mancozeb @ 750 g/ha	No seed treatment
6	Fertilizers	250 kg of SSP as basal, 82.5 kg of MOP and 45 kg of Urea as basal	50 kg DAP and 50 kg MOP as basal
		Application of Gypsum @ 500 kg/ha at pegging stage near podding zone	Lack of gypsum application
7	Weed management	Pendimethalin 30 EC @ 3.3 L/ha as pre-emergence herbicide followed by	Hand weeding during the initial

		post-emergence application of Imazethapyr @ 750 ml/ha at 20 to 25 days after sowing	stage and neglecting at 20-25 days after sowing
8	Pest management	Spray with neem oil @ 5 ml/l, bird perches @ 20/ha and marigold as trap crop	No neem oil and only chemicals
		Poison bait (25 kg rice bran + 1.25 kg jiggery + 1250 ml mono crotophos) per ha at base of the crop during evening time for spodoptera control	Control with application of Novaluron @ 500 ml/ha

3. Results and Discussion

3.1 Pod yield

The pod yield of groundnut realized during two consecutive years of 2018-19 and 2019-20 under demonstration and farmers practice are presented in Table 2. The pod yield of groundnut ranged from 20.5 q to 21.7 q with an average pod yield of 21.1 q/ha in demonstration compared to pod yields ranging from 16.5-18.3 q/ha with a mean pod yield of 17.4 q/ha under farmers practice. A close look at the data reveals that a yield increase of about 18.57% was recorded in the demonstration over farmers practice during 2018-19 and yield advantage of 24.24% was realized in subsequent year. The higher yields of groundnut under demonstration may be attributed to improved production technology aimed at yield maximization, which included improved variety i.e. ICGV-351, optimum seed rate of 200 kg/ha, seed treatment, timely weed control and balanced nutrient management and integrated pest management.

Similar results were observed by Raghava & Punna Rao (2013) [3]; Undhad *et al.,* (2019) [5]; Raghunatha Reddy *et al.,* (2019) [6]; Chongloi *et al.,* (2020); and Lakhani *et al.,* (2020) [9] and Dash *et al.,* (2021) [7].

Table 2: Pod yield of groundnut under Cluster Front Line Demonstration

Year	Area (ha)	No. of Farmers	Yield (q/ha)			
			Potential	Demonstration	Farmers practice	% increase in farmers practice
2018-19	30.0	65	25.0	21.7	18.3	18.57
2019-20	67.2	92	25.0	20.5	16.5	24.24
Mean			25.0	21.1	17.4	

3.2 Extension and technology gap

The extension gap indicated an increasing trend which ranged from 3.4 q/ha to 4.0 q/ha, with an average extension gap of 3.7 q/ha (Table 3). The gap advocates the necessity of convincing farmers to adopt demonstrated technology without any deviation. It can be accomplished only by conducting awareness programmes, training programmes on a package of practices in groundnut, frequent monitoring, and timely agro advisories KVK scientists.

The technology gap is the difference between potential yield and yield of demonstration. The technology gap during the study period ranged between 3.3 to 4.5 q/ha with an average of 3.9 q/ha. The technology gap observed might be due to differences in soil fertility status and local climatic conditions as varieties respond distinctly to diversified environments. Hence, location-specific high-yielding varieties with a specific package of practices addressing higher yields, weed population, fertility status, tolerance to drought, pests, and diseases have to be developed to narrow the technology gap. These findings are in accordance with Pawar *et al.,* (2018); Solanki & Nagar (2020) and Samir *et al.,* (2021).

3.3 Technology index

The technology index shows the feasibility of the demonstrated technology at the farmer's field, and the lower the value, the higher the technology's feasibility. The technology index ranged from 13.2 to 18.0% during the 2018-19 and 2019-20 years (Table 3). It implies that the technology is practically suitable for farmers' field situations and warrants widespread awareness among many non-beneficiary farmers. Awareness programmes, field days, group discussions, documentation of success stories, and farmers feedback help in the horizontal spread of the technology. The results are in agreement with Lakhani *et al.,* (2020) [9] and Samir *et al.,* (2021).

Table 3: Yield gap analysis of groundnut under Cluster Front Line Demonstration

Year	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
2018-19	3.4	3.3	13.2
2019-20	4.0	4.5	18.0
Mean	3.7	3.9	

3.4 Economics of groundnut under CFLD

For calculating the net return and benefit-cost ratio, the prices of commodities that existed during 2018-19 and 2019-20 were taken into consideration. A critical look at the data reveals that groundnut under demonstration realized higher gross returns of Rs. 97,903/ha and Rs.98, 900/ha over farmers practice of Rs.82, 350/ha and Rs.80, 500/ha during the years 2018-19 and 2019-20, respectively (Table 4).

Higher net returns of Rs.60, 403/ha and Rs.67, 700/ha were obtained in demonstration compared to Rs.45, 850/ha and 48,750/ha during the study period of 2018-19 and 2019-20 respectively. A superior benefit-cost ratio of 2.61 and 3.16 was recorded in demonstration compared to farmers' practice of 2.20 and 2.53 during 2018-19 and 2019-20.

Highest B: C ratio in demonstrations can be attributed to the realization of higher yields compared to farmers practice. The results corroborate with findings of Raghava & Punna rao (2013) [3]; Undhad *et al.,* (2019) [5]; Raghunatha *et al.,* (2019) [6]; Levish *et al.,* (2020) [8] and Lakhani *et al.,* (2020) [9].

Table 4: Economics of groundnut in demonstration and farmers practice

Year	Cost of cultivation (Rs/ha)		Gross returns (Rs/ha)		Net returns (Rs/ha)		B:C ratio	
	Demonstration	Farmers practice	Demonstration	Farmers practice	Demonstration	Farmers practice	Demonstration	Farmers practice
2018-19	37500	36500	97903	82350	60403	45850	2.61	2.20
2019-20	31200	31750	98900	80500	67700	48750	3.16	2.53
Mean	34350	34125	98402	81425	64052	47300		

4. Conclusion

The Cluster frontline demonstrations (CFLD) on groundnut conducted at Erabelli village in farmers fields recorded higher yields and registered higher economic returns, improving their livelihoods. The demonstrations created awareness on entire package of practices in groundnut, selection of high yielding variety, skill of seed treatment, importance of optimum seed rate, weed control, balanced fertilizers to reduce input cost besides providing secondary nutrients, role of gypsum for better pod yields and pest and disease management. Regarding yield gap analysis, total adoption of the demonstrated technology by beneficiary farmers lessens the extension gap besides increasing the groundnut yields. Formulation of location-specific recommendations addressing soil fertility status and local climate with high yielding variety tolerant to drought, pest and diseases is recommended to narrow down the technology gap. Learning the benefits accrued by the beneficiary farmers, other farmers were motivated. A horizontal spread of the demonstrated technology was in about 200 acres of maize growing farmers shifted to groundnut cultivation.

5. Future prospects of CFLD groundnut

The small and marginal holdings of farmers taken together (0.00-2.00 ha) constitute 86.08% of the total landholdings and the all- India average size of holding is 1.08 ha. (Source: Agriculture Census, 2015-16). In view of this, in addition to enhancing farmers' production, it is essential to increase the productivity per unit land area and provide a proper mechanization strategy to reduce the cost of cultivation. Five-row multi-crop planter and bullock drawn plough planter, Groundnut digger shaker, Tractor operated groundnut thresher, a self propelled groundnut combined harvester are some of farm machinery that could be taken up by forming farmers groups/ FPO's and they offer a solution by reducing the cost of cultivation in groundnut demonstrations further helping in area expansion of CFLD's.

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