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Demonstration on yield maximization in groundnut lead positive impact among farmers of Tamil Nadu, India

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Abstract
Groundnut is a significant oilseed crop in India, contributing 27% to the country's total oilseed production. In Tamil Nadu, it is cultivated on 3.51 lakh hectares with a production of 9,12,150 tonnes and a productivity of 2,598 kg/ha. Villupuram district is notable for its groundnut cultivation, covering 18,388 hectares during *kharif* and 10,507 hectares during *rabi* in 2022-23, producing 72,923 tonnes. This study evaluates the high-yielding groundnut variety Kadiri Lepakshi through front line demonstrations on 50 acres across three villages in Villupuram during the *rabi* seasons of 2021-22 and 2022-23. Kadiri Lepakshi, released in 2020, is notable for its high protein (28%) and oil content (51%), drought resistance, and stable yields even under stress. The demonstration involved high yielding variety, seed treatment, micronutrient and gypsum application, integrated pest and disease management. The study showed significant improvement in yield in demonstration plots compared to traditional farmer practices. Results indicated an average yield increase of 30.19%, with a higher economic return of 68.81% increase, showcasing the variety's potential for enhanced productivity and profitability with the adoption of improved cultivation practices. The study emphasizes the necessity of disseminating these improved practices through training and demonstrations to bridge the technology and extension gaps, thereby increasing groundnut yields and farmer income.

Keywords: Groundnut, Kadiri Lepakshi, yield, pests, economics

Introduction
Groundnut is the major oilseed crop of India, accounting 27% of the total oilseed production in the country (Annual Report 2022-23 of Department of Agriculture and Farmers Welfare). It occupies an area of 5.75 million ha with a production of 10.11 million tonnes and productivity of 1759 kg/ha (Agricultural Statistics at a Glance 2022) [1]. In Tamil Nadu, it was grown in an area of 3.51lakh ha with a production of 912150 tonnes and productivity of 2598 kg/ha. It is one of the major oilseeds crop grown in Villupuram district. The crop was cultivated in 18388 hectares during *kharif*, 2022-23 and 10507 ha during *rabi*, 2022-23 in Villupuram district with production of 72923 tonnes (Season and Crop Report, 2023). Groundnut is the 13thmost important food crop, 4thimportant source of vegetable oil and 3rdmain source of vegetable protein in the world (Shete *et al*., 2018) [27]. It is known as a self-fertilizing crop, nevertheless, it is very exhaustive crop compared to other legumes because a very little portion of the plant residue is left in the soil after harvest (Shete *et al*., 2018) [27]. It's cultivated in different agro-climatic surroundings characterized by soils of varying water holding capacity under rainfed as well as irrigated conditions (Priya *et al*., 2016) [21]. The genetic character of the variety, serious pests and diseases are major causes for low productivity of groundnut in India. The area and production under groundnut is decreasing over the years in Tamil Nadu. However, groundnut production could be increased by the selection of suitable varieties according to the season and usage of appropriate quantity of seeds, fertilizer and plant protection chemicals (Jagadesh, 2021) [8].
Stem and root rot is caused by *Macrophomina phaseolina*. Pande and Narayana Rao (2000) [18] reported that crown rot caused by *Aspergillus niger* is prevalent in warm and dry climatic conditions and its incidence ranges from 2% to 14% in groundnut. The pathogen is found to attack groundnut plants at all stages of plant growth and causes pre-emergence rotting in seeds,

soft rot in emerging seedlings and crown rot in mature plants. Biological control of plant diseases is cost effective and environmentally safe compared to fungicides. The advantage of biocontrol agent is that once established it persists in the soil for longer periods and offers disease protection even in the consecutive crop seasons (Mew and Rosales, 1986) [13]. *Trichoderma viride* induces pathogenesis related defence response against rot pathogen infection in groundnut (Gajera *et al*., 2015) [7]. *Trichoderma species* are antagonistic to a wide range of phytopathogenic fungi and are able to control economically in several crop plants (Papavizas, 1985) [19]. Hence this study was conducted to analyze the performance of high yield groundnut variety Kadiri Lepakshi in Villupuram district.

Materials and Methods

The present study was carried out at the Krishi Vigyan Kendra, Tindivanam, during *rabi* season in the farmers' field during 2021-22 and 2022-23. A total of 50 front line demonstrations in 50 acres were conducted in Nolambur, Peravur and Avanampattu villages of Villupuram district. Groundnut variety Kadiri Lepakshi was taken for study in the demonstration. The variety Kadiri Lepakshi duration in *kharif* season is 112 days (Table 1). It is resistant to pests, diseases and drought. The major advantage of the variety is that it contains 28 percent of proteins and 51 percent of oil. The average potential yield in rainfed region is 20-25 q/ha, whereas in irrigated conditions is 45-50 q/ha. The shelling percentage is 70%. The observed cons of this variety are a slight inferior taste for table-top consumption. It is very high yielding, profuse bearing Spanish variety with high oil and high protein. It is multiple resistant for drought, pests and diseases and produces stable yield (15-20 q/ha) even under severe drought.

Table 1: Salient features of Groundnut variety Kadiri Lepakshi

Year of Release	2020
Season	*Kharif* and *Rabi*
Duration (*kharif*)	112 days
Average yield (quintal/ha)	35
Shelling (%)	70
100 kernel weight (g)	40
Oil Content (%)	51
Salient features	Very high yielding, profuse bearing Spanish variety with high oil and high protein. Multiple resistant for drought, pests and diseases. Stable yield (15-20 q/ha) even under severe drought.

In general, soils of the area under study were loam soils with medium fertility status. Before sowing, seed treatment was done with biocontrol agent, *Trichoderma viridi* @ 4 g/kg of seed. Soil application of 2.5 kg/ha *Trichoderma viride* was followed. 75 kg of groundnut kernels were used for sowing in a hectare. Seed sowing was done in 3rd and 4th weeks of December in 2021-22 and 1st to 4th weeks of January in 2022-23. The spacing maintained was 30 cm between rows and 15 cm between plants in the rows. Weeding was done 30 - 35 days after sowing. During second weeding, gypsum was applied at the rate of 400 kg/ha followed by earthing up for better penetration and development of pegs. Two spraying of TNAU Groundnut rich @ 5 kg/ha in 500 litres of water for each spray was done at 35 (50% flowering) and 45 days (Pod development stage) to increase flower retention, pod filling and development. Other management practices were followed as per the recommendation for this region. Data with respect to pod yield from plots and from fields cultivated following local practices adopted by the farmers of the area were collected and evaluated. In case of local check plots, existing practices used by farmers were followed. Integrated pest and disease management practices were followed in the demonstration plot.

The details of different parameters and formula adopted for analysis are given below

Harvest index (%) = Pod yield/Biological yield × 100

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - Farmers' yield

Technology index (%) = (Technology gap/Potential yield) x 100

Additional cost = Demonstration cost - Farmers' practice cost

Effective gain = Additional return-Additional cost

Additional return = Demonstration return - Farmers practice return

Incremental Benefit cost ratio = Additional return/Additional cost

Results and Discussion

Impact of technological Interventions on Productivity of groundnut

The technological interventions comprising high yielding varieties, recommended seed rate, seed treatment, method of sowing, recommended dose of fertilizers, gypsum application, weed management, application of groundnut rich and integrated plant protection measures were used as per package of practice in groundnut.

Table 1: Growth and yield parameters of groundnut variety Kadiri Lepakshi

Used Practice	Plant height (cm)	No. of branches/plant	No. of pods/plant	Pod Yield (q/ha)	Kernel yield (q/ha)	Haulm Yield (q/ha)	Harvest index
Farmer practices	31.2	15.2	68	26.5	18.6	49.8	34.73
Demonstration	29.8	25.6	80	34.5	24.2	55.7	38.25
% Increase	- 4.69	6.8	17.64	30.19	5.6	11.84	10.13

The results in Table 1 indicated an average groundnut yield of 34.5 q/ha from demonstrated plot. The highest average groundnut yield of 41 q/ha was recorded during 2021-22 followed by 27.9 q/ha in 2022-23. Delayed sowing reduced crop growth and development due to moisture stress, thereby, decreasing the pod yield (Mohite *et al*., 2017) [14]. The higher yield of groundnut was due to use of the high yielding variety Kadiri Lepakshi (Sahaja *et al*., 2023) [25], integrated nutrient

management and integrated pest and disease management. Kadiri Lepakshi recorded the more number of branches/plant, higher pod yield, kernel yield and haulm yield. The pod yield and kernel yield varies with groundnut genotypes (Krishna *et al*., 2013; Borkar and Dharanguttikar, 2014; Kumar *et al*., 2014; Naik *et al*., 2018) [10, 3, 11, 15]. The highest pod yield (3607 kg/ha) and haulm yield (4647 kg/ha) were recorded in Kadiri Lepakshi by Chandini *et al*. in 2022. The results are in conformity with results reported by Deva *et al*., 2023 [6]; Jyothi *et al*., 2023 [9], Reddy and Debbarma, 2023 [24].

Paul and Dawson, 2022 reported that seed treatment with *Trichoderma* (5 g/kg) and sown at 30 cm x 15 cm spacing significantly increased number of nodules/plant (92.84), dry weight (27.56g/plant), Crop Growth Rate (60-90 DAS) (7.57 g/m2/day), Relative Growth Rate (60-90 DAS) (0.017g/g/day).

Boron increased significantly the uptake of N, P, K, Fe, Mn, Zn and B by straw and seeds of peanut in both seasons as compared with the corresponding treatments without biofertilizers. The growth, chlorophyll and pod yield were increased in groundnut by application of micronutrients containing Zn, Fe and B (Subrahmaniyan *et al*., 2001; Sonawane *et al*., 2010; Der *et al*., 2015) [31, 28, 5], Zn, B and Mo (Nayak *et al*., 2009) [17], ZnSO4 @ kg/ha in coastal region (Sowmya and Ganapathy, 2021) [30], Fe, Zn and Mn (Singh and Chaudhari, 1997) [29]. Nasef *et al*., 2006 reported that foliar spray of boron at 220 ppm and seed inoculation with rhizobium improved plant growth and yield parameters in groundnut.

Groundnut, Kadiri Lepakshi

Table 2: Economics of Groundnut variety Kadiri Lepakshi in Villupuram district of Tamil Nadu

Used Practice	Gross cost (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha	B:C ratio
Farmer practices	69450	129750	60300	1.86
Demonstration 2021-22	77247	256278	179030	3.32
2022-23	70890	95450	24560	1.35
Average	74068	175864	101795	2.37
% Increase		35.54	68.81	-

Incidence of pests and diseases

Table 3: Damage level of pests in Groundnut variety Kadiri Lepakshi

S. No	Stage of the crop	Used Practice	Tobacco caterpillar (Percent leaf damage)	Gram caterpillar (Percent leaf damage)	Leaf miner (Percent leaf damage)	Leaf hopper (No./leaf)	Thrips (No./leaf)
1.	Vegetative stage	Demonstration	5.60	3.20	4.82	0.90	0.84
		Farmers practice	9.50	8.50	10.40	1.40	1.30
2.	Pod formation stage	Demonstration	2.50	0	1.60	0	0
		Farmers practice	6.40	0	6.40	0	0
3.	Maturity stage	Demonstration	0	0	0	0	0
		Farmers practice	0	0	0	0	0

Tobacco caterpillar was comparatively higher at vegetative stage compared to pod formation stage. Sucking pests *viz*., leafhoppers and thrips were recorded to be higher during vegetative stage.

Stem and root rot is caused by *Macrophomina phaseolina*. Ramesh and Korikanthimath, 2006 [22] reported that seed treatment with biocontrol agents *viz.*, *Trichoderma viride* and *Pseudomonas fluorescens* significantly reduced disease incidence in groundnut compared to control (40-58 and 55-77 % during 2002 and 2003, respectively). The combined effect of *Trichoderma viride* and *Pseudomonas fluorescens* was good (Manjula *et al*., 2004) [12]. Rao *et al*., 2023 [23] reported that the lowest disease progression was observed in Lepakshi (0.04)

Table 4: Infection level of diseases in Groundnut variety Kadiri Lepakshi

S. No	Stage of the crop	Used Practice	Stem rot (Percent infected plant)	Root rot (Percent infected plant)	Leaf spot (Percent infected leaves)
1.	Vegetative stage	Demonstration	1.50	0.80	0
		Farmers practice	5.60	4.80	0
2.	Pod formation stage	Demonstration	0	0	2.74
		Farmers practice	0	0	9.48
3.	Maturity stage	Demonstration	0	0	1.48
		Farmers practice	0	0	6.56

Technology gap

The technology gap is the difference between the variety's potential yield and the yield of demonstration. The difference between potential yield and demonstration plots yield was 0.50 q/ha. It indicates that still there is gap in technology demonstration as a result of which the potential yield of the

improved technology could not be reaped by the participating farmers. The differences in soil fertility, climatic condition and cultivation practices might have contributed to the technology gap.

Extension gap

Extension gap is the difference between yield in the demonstration plot and farmers' field. The average extension gap recorded as 8 q/ha in this study and it should be filled by various extension methods. Training programmes may be conducted to disseminate information on improved varieties and technologies.

Technology index

Percentage of technology index is calculated as the ratio between technology gap and potential yield. It shows the viability of the improved technology at the farmers' field. The higher of technology index shows the insufficient extension services for transfer of technology. The lower value of technology index indicates the efficacy of technological interventions. The average technology index was recorded as 1.00 percent. This variation indicates that result differs due to soil fertility status, weather condition and mismanagement of crop. With adoption of improved practices, the technology gap can be reduced and as a result technology index will be reduced.

Economic performance

Under cluster front-line demonstrations, the economics of groundnut production were estimated.

Different variables like high yielding varieties, seeds, fertilizers, biofungicide, bio-insecticide and pesticide were considered as a technological intervention. On an average an additional investment of Rs.4618/ha were made under demonstration of groundnut. The study found an average additional returns of Rs.46114/ha from the demonstrated plot, which might be due to differences in cost of cultivation and higher market price. In consequence, average gross return of Rs. 175864/ha indicating the importance of improved technologies. The higher gross return realized by the farmers indicate the economic feasibility of the technology. The average effective gain received was Rs.41496/ha whereas, the average incremental benefit cost ratio was 9.98, indicating a good return of each additional rupee invested on improved technology in groundnut. Gross returns, net returns and B:C ratio was recorded maximum with the cultivar Kadiri Lepakshi (Akram *et al*., 2021) [2].

Conclusion

The adoption of technological interventions in the cultivation of the groundnut variety Kadiri Lepakshi significantly enhances productivity and economic returns for farmers. These interventions, which include high-yielding varieties, recommended seed rates, seed treatment, appropriate sowing methods, optimal fertilizer use, gypsum application, weed management, and integrated plant protection measures, collectively contribute to substantial improvements in plant growth and yield parameters. Economic analysis indicates that the demonstrated technological practices led to a higher average gross income of Rs. 175,864/ha and a net income increase of Rs. 101795/ha, indicating a benefit-cost ratio of 2.37. In conclusion, the implementation of advanced agricultural practices in groundnut farming, particularly for the Kadiri Lepakshi variety, not only enhances yield and economic gains but also offers sustainable solutions to pest and disease management.

The farmers should be encouraged to adopt the improved varieties and technologies to realize higher income. Continued efforts in bridging technology and extension gaps through comprehensive training and support for farmers can further optimize the benefits of these interventions, ensuring higher productivity and profitability in groundnut cultivation.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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