MAXMIZATION OF PRODUCTIVITY FOR BLACKGRAM (*Vigna mungo* L.) THROUGH IMPROVED TECHNOLOGIES IN FARMER'S FIELD UNDER TNIAMP ALIYAR SUB-BASIN OF TAMILNADU

ABSTRACT

Large scale pulse seed production demonstrations on black gram under the TN IAMP scheme were conducted by Agricultural College and Research Institute, Tamil Nadu Agricultural University, Vazhavachanur, Tiruvannamalai district, Tamil Nadu, India in 2 cluster villages at 50 farmer's holdings during 2019-2020 and 2020-2021, respectively. The result and data analysis show an extension gap of 0.09 q/ha over farmers' traditional practices. The results revealed that TNIAMP intervention demonstrated registered higher growth and yield parameters viz., no. of clusters per plant, no. of pods per plant, grain yield and benefit-cost ratio compared to farmer's practice grain yield and benefit cost ratio. TNIAMP pulse seed production intervention has had a good impact on pulse growing farmers of the Aliyar sub-basin, as they were motivated by good agricultural practices in the TNIAMP intervention plots and yielded an increase of 15.8 % higher than farmer's practices.

Key words: Pulse Seed Production; Good Agricultural Practices (GAP); Farmer's Practice (FP); Economics Analysis

INTRODUCTION

Pulses are the most important food crops after cereals, referred to as "grain legumes" and it is one of the important ingredients in a global vegetarian diet (Ray *et al.*, 2023), commonly known as "poor man's protein source," as they contain 20-25% of protein (Singh, 2011; Sunilkumar *et al.*, 2018; Marwein and Ray, 2019; Yadav *et al.*, 2019) and are known to reduce several non-communicable diseases like colon cancer and cardiovascular diseases (Curron, 2012). In India, pulses are an integral part of the diet as a source of protein and are also rich in calcium and phosphorous. They provide a perfect mix of vegetarian protein components of high biological value when supplemented with cereals (Andrews and Hodge, 2010; Ali and Gupta, 2012; Tomar *et al.*, 2021). The results from household consumption surveys indicate a decline in protein intake (Shalendra *et al.*, 2013; Tomar *et al.*, 2021). India is still home to about 24% of undernourished people in the world (Sharma *et al*., 2016). About 15.2% of people in India are undernourished (Tomar *et al*., 2021). This signifies the importance of pulses in food and nutrition security for the Indian population. It is the second major source of dietary protein (27%) after cereals (55%). Food legumes are commonly known as “poor man’s meat” and “rich men's vegetable” because of their high protein content, low price, and widespread access to the poor. Pulses can fix atmospheric nitrogen (Sunilkumar *et al*., 2018) 40 percent per year (Burns and Hardy, 1975) and their deep penetrating root system enables the plants to utilize limited available moisture more efficiently. It improve the physical condition of the soil like soil aeration, water holding capacity, improving microbial population, breaking of hard pans and moisture retention. Pulses can be used as a catch crop, cover crop, intercrop and crop rotation. Pulses are also an excellent feed and fodder for livestock (Ali and Gupta, 2012). The per capita requirement of pulses according to ICMR is 150gm/capita/day and according to FAO, 140gm/capita/day. In India, pulse productivity is much lower than other pulse producing countries. But the production of pulses has not been able to keep pace with their domestic demand, resulting in imports of 2-3 million tonnes of pulses per annum. For the two decades, post1991, pulses production is almost stagnated at around 14 million tonnes, leading to a significant decline in their per-capita availability, from 61g/day in 1951 to 54.5 g/day in 2018 one-third less than the recommended intake of 65 g/day (ICMR, 2018). Therefore to elevate protein energy malnutrition, a minimum of 50g pulses /capita/day should be available in addition to other source of protein such as cereals, milk meat and egg. At present, the per capita availability of pulses in India is only 47gm/capita/day.

India is the largest producer and consumer of pulses in the world accounting for about 25 per cent of global production, 27 per cent of global consumption and about 33 per cent of the world’s area under pulses (Pramanik *et al*., 2009; Deshmanya *et al*., 2015 and Raju, 2019). Among the different pulses, blackgram (*Vigna mungo* L. Hepper.) is one among highly prized vegetarian diets in India (Ayyadurai *et al*., 2017 and Raju, 2019). It is also called as ‘poor man’s meat’ particularly for the vegetarian population of the Indian subcontinent (Chubatemsu and Malini, 2017). It can be boiled or eaten whole and they are ground into flour and used to make porridge or baked into bread and biscuits. The green pods are also edible. Black lentil is nothing but the split black gram and after removing black skin it is sold as white lentil (Raju, 2019). Dried blackgram contains about 9.7% water, 26.2% protein, 350 cal./100g 1.2% fat, 56.6%

carbohydrate and 3.8% fibre along with 185 mg calcium, 8.7 mg iron, 345 mg phosphorus, 0.37g riboflavin, 0.42 g thiamin and substantial amount of minerals, amino acids, calcium, magnesium, potassium, 2 mg niacin, 0.42 mg vitamin B_1 and 0.37 mg vitamin B_2 in each gram of blackgram (Verma *et al*., 2011; Ayyadurai *et al*., 2017; Raju, 2019, Ramesh *et al*., 2020 and Amuthaselvi *et al*., 2023) which are necessary for our body It has two types of fibers: soluble and insoluble. Insoluble fiber helps to prevent constipation and soluble fiber helps in our digestion system. It also helps to reduce cholesterol which ultimately improves cardiovascular health. High amount of magnesium and folate of black gram supports blood circulation. Black gram has medical properties which help to Rheumatic pains, stiff shoulder and contracted knees (Raju, 2019). In South India, the most popular food preparations *viz*., idly and dosa are prepared by mixing rice and blackgram flour. Being leguminous crop, it has beneficial effect on improving soil fertility through fixation of atmospheric nitrogen (22 kg/ha) (Sunilkumar *et al*., 2018, Sangeetha *et al*., 2022) 50 percent (Anon, 1972) which has been estimated to be supplement of 59 thosand tons of urea annually (Senaratne and Ratnasinghe, 1993) and in soil through symbiotic association (Islam *et al*., 2011). Also, it is used as nutritive green fodder for dairy animals (Sathe, 1996). It is a good green manure crop also acts as a intercrop, catch crop (Amuthaselvi *et al*., 2023) cover crop and thereby prevents soil erosion.

In India, blackgram is popularly known as "Urd bean" or "Urad dal" or "Urid" and "mash" and it is highly prized pulse among all the pulses and reported being originated in India. Its references have also been found in Vedic texts such as "*Kautilya's Arthasasthra*" and in "Charak Samhita" lends support to the presumption of its origin in India. It is also cultivated in many tropical and subtropical countries of Asia *viz*., India, Pakistan, Bangladesh, Afghanistan, Burma, Myanmar and Sri Lanka are the principal countries contributing to the world production Africa and Central America. Most suitable climate is 27- 30º C with heavy rainfall. This annual crop prefers loamy soil which has high water preservation capability. Black gram grows normally in 90-120 days and it also enriches the soil with nitrogen (Raju, 2019). It is extensively grown under varying climatic conditions and soil types in India.

In India, blackgram is being cultivated in about 46.3 lakh ha with the production of 27.8 lakh tonnes and productivity of 599 kg per hectare. The major blackgram growing area is Madhya Pradesh, Uttar Pradesh, Bihar, Punjab, Maharashtra, West Bengal and Tamil Nadu and it is mostly grown as a rainfed crop during summers in Northern India and in winters in Peninsular and Southern India.

In Tamil Nadu, it is cultivated in 4.07 lakh ha with the production of 2.68 lakh tonnes productivity of 660 kg per hectare. In Tiruvannamalai district, it is cultivated in an area of about 6000 ha with average yield of 721 kg ha^{-1}. About 90 per cent of the area under blackgram is being cultivated under rainfed condition during *kharif* season. Prevailing weather parameters such as rainfall, temperature, soil moisture and solar radiation during the different crop growth stages play an important role in deciding the yield of blackgram. The productivity of blackgram under rainfed condition is low due to occurrence of moisture stress, continuous cultivation of older varieties and incidence of yellow mosaic virus disease. Due to the uncertainty in rainfall, occurrence of moisture stress at critical crop growth stages leads to reduction in yield. Apart from moisture stress, lack of knowledge on the availability of suitable high yielding varieties, non-availability of good quality seeds, poor filling of pods, incidence of yellow mosaic virus and leaf crinkle disease also affect the blackgram productivity. Hence, large scale demonstration was conducted to assess the performance of Good Agricultural Practices (GAPs) in farmers' holdings with Farmer's practice (FP).

MATERIALS AND METHODS

Study area

To overcome the problems, the large-scale demonstration was conducted in fifty locations spread over in Thandrampet and Chengam blocks to improve productivity through Good Agricultural Practices (GAPs) followed in the Tiruvannamalai district (Fig 1).

Fig 1. Components of Good Agricultural Practices

The technological options include Blackgram varieties *viz.*, TO 1 - Farmers Practice (local), TO 2 - CO 8 were taken for the study. The characteristics of the varieties taken up for the study are given in Table 1.

Experimental design

The Blackgram crop was raised during *the kharif* season of 2017 coinciding with southwest monsoon. During that season, the district received 395 mm rainfall which was 9.4 per cent higher than the normal rainfall.

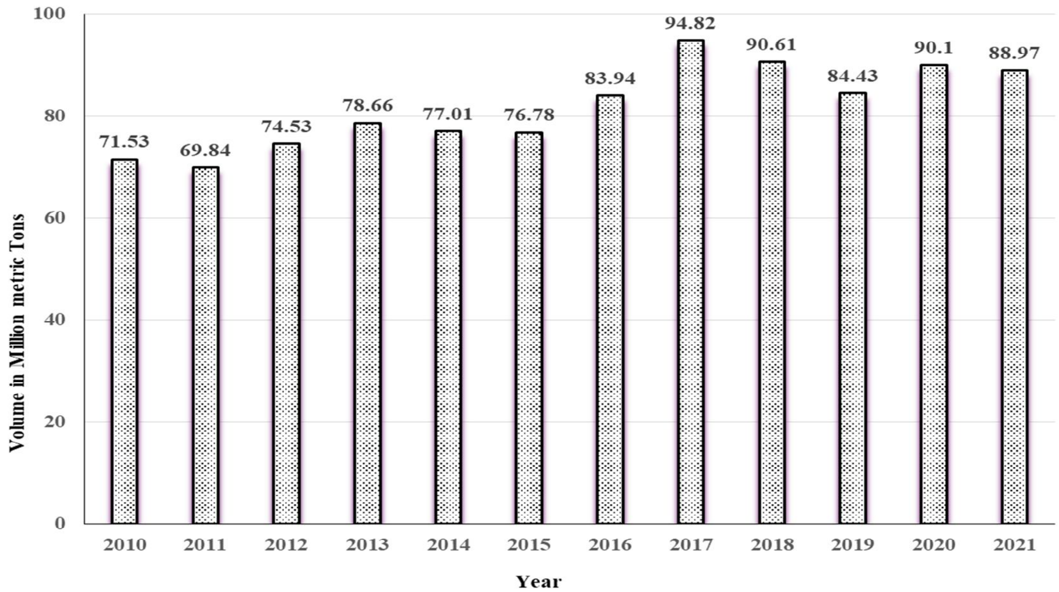

Fig 2. Volume of pulses produced worldwide 2010-2021

The soil of the trial plots was sandy loam in texture, nonsaline, slightly alkaline in soil reaction, low in available nitrogen (<280 kg/ha), and medium in available phosphorus (11-22 kg/ha) and potassium (118-280 kg/ha). The seeds were treated with Rhizobium @ 20 g/kg seed and *Trichoderma viride* @ 4 g/kg seed at the time of sowing and the seeds were sown at 30 x 10 cm spacing. Integrated nutrient management practices including basal application of FYM @ 12.5t/ha, recommended dose of NPKS @ 25:50:25:20 kg/ha, and soil application of TNAU pulses micronutrient mixture @ 7.5 kg/ha were followed. Foliar spraying of pulse wonder @ 5 kg/ha at the peak flowering stage was done. As pulse wonder contains nutrients and growth regulators spraying of it decreases the flower shedding and enhances the yield. Integrated pest and disease management practices were followed as per the TNAU crop production guide 2020. The incidence of yellow mosaic virus and leaf crinkling disease was observed during the crop growth stages. At the time of harvest, the growth and yield characteristics such as the number of pods per plant, number of seeds per pod, 100 seed weight (g), and grain yield (q/ha) were recorded both under demonstration and farmers' practice. Economic analysis was done by calculating the cost of cultivation, gross income, net income, and benefit-cost ratio.

Field measurement

Before conducting a large-scale demonstration, the farmer's list was prepared to form groups and skill training was imparted to the selected farmers on good agricultural practices, benefits of drought-tolerant varieties during dry spells, the need for balanced application of fertilizers, and integrated pest and disease management practices. All other procedures like site selection, farmer selection, layout of demonstration, farmer's participation, etc. were followed as suggested by Choudhary (1999) and Dubey *et al*. (2017). The sucking pest population was counted on three leaves per plant from the randomly selected ten plants by visual count method at fortnight intervals. The leaf miner and tikka leaf disease were recorded by counting the total number of plants and the number of plants infested from randomly selected quadrants (1x1m size) at four places in each field. The collected data were converted into percentages for mean comparison (Reddy, 2001). The yield data were collected from the demonstration and farmer's practice plots. The large-scale demonstration was conducted to study the technology gap between the potential yield and demonstrated yield, and the extension gap between demonstrated yield and yield under existing practice and technology index. The yield data were collected from both the demonstration and the farmer's practice by the random crop-cutting method. Qualitative data was converted into quantitative form and expressed in terms of percent increase in yield (Narasimha Rao *et al*., 2007).

Data analysis

The data was further analyzed by using simple statistical tools. The technology gap, extension gap, and technological index were calculated (Kadian *et al*., 1997; Samui *et al*., 2000) as given below.

$$\text{Technology gap} = \text{Potential yield - Demonstrated yield}$$

$$\text{Extension gap} = \text{Demonstrated yield - Yield under existing practice}$$

$$\text{Technology index} = \frac{\text{Potential yield - Demonstrated yield}}{\text{Potential yield}} \times 100$$

RESULTS

The analysis of the overall adoption level of black gram growers about recommended cultivation practices revealed that the majority of the respondents had a medium level of adoption of the cultivation practices (46%) while 30 and 24% adopted recommended cultivation practices in low and high-level adoption respectively (Table 2).

Adoption of recommended cultivation practices of black gram growers by individual

It is evident from Table 3 that 100 percent of the respondents adopted the good sowing time which was followed by 96 percent of land preparation, and disease management. The same level of respondents was recorded in water management by 90 percent. The level of respondents other recommended practices such as pest management (74%), recommended NPK (60%), seed treatment practices (58%), foliar application of nutrients (56%), and high-yielding varieties (52%).

Constraints faced by farmers

Table 4. revealed that the majority of the respondent constraints faced by not existing in the market (100%), it was also followed by lack of technical guidance (96%), complexity (92%), lack of marketing facilities (90%), non-availability of skilled labor (82%), monopoly of merchant in the market (64%) and lack of financial support (52%).

Grain Yield

The supervision of the Agricultural College and Research Institute, Vazhavachanur, Tiruvannamalai TNIAMP Phase II Aliyar sub-basin scientist crop yield was harvested accordingly. The grain yield from both the plots i.e., demonstration and farmers' practices were compared and it was evident that the average yield of demonstrated plots was 15.8 percent higher than that of farmer's practices (Table 5). The grain yield under demonstrated plots was 0.63 and 0.64 q ha-1 with an average of 0.64 q ha-1 from the years 2019-20 and 2020-21, respectively. However, it was 0.52 and 0.58 q ha-1 with an average of 0.55 q ha-1 under farmer's practice.

Extension Gap

An extension gap between demonstrated technology and farmers practices was calculated and on an average basis, the extension gap of 0.11 q ha-1 during 2019-20 and 0.06 q ha-1 during 2020-21 was calculated (Table 5).

Technology Gap

The technology gap was calculated by deducting the demonstrated plot yield from the potential yield of the black gram crop. The recorded technology gap was 0.22 and 0.21 q ha-1 during 2019-20 and 2020-21, respectively. The average technology gap was found 0.22 q ha-1 (Table 5.

Economic Analysis

The demonstrated technology observed higher gross return (Rs. 54,970 ha-1), higher net return (Rs. 30,490 ha-1), and higher benefit-cost ratio (2.27) on overage of both the years as compared to farmers practices (Table 6).

Discussion

The individual adoption level was assessed with packages of practices for enhancing the higher seed production in black gram under the Aliyar sub-basin of Tamil Nadu such as Good Agricultural Practices (GAPs) such as high-yielding varieties, land preparation, seed treatment, spacing, sowing time, manuring, recommended NPK, cultural practices, Integrated Weed Management, Integrated Water Management, Integrated Disease Management, Integrated Pest Management. Further, the level of individual respondents in the adoption of recommended practices showed that all the black gram growers knew the technologies with a level of more than 50 percent and they were motivated to adopt technologies through training and demonstration to achieve maximum adoption level. The reasons behind the increase of yield under demonstrated plots might be due to good agricultural practices followed which ultimately increased the yield. This technology gap might be attributed to the adoption of good agricultural practices in demonstrated plots which resulted in higher grain yield than the farmer's practices. Based on the extension gap, the farmers were motivated to follow good agricultural practices to reduce the extension gap and increase their grain yield. The higher technology index reflected the inadequate proven technology for transferring to farmers and insufficient extension services for the transfer of technology. Higher net returns which might be due to proper management practices resulted in higher yield and ultimately higher returns. Similar results were reported by Raju *et al* (2012), Daniela *et al*., (2017), Shani Kumar Sing *et al*, (2017), Raju, (2019), and Ayyadurai *et al*., (2024).

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Table 1. Difference between Good Agricultural Practices (GAPs) and existing farmer's practices under blackgram.

Crop operation	Good Agricultural Practices (GAPs)	Farmer's Practice (FP)	Gap
Variety	CO 8	Local	Full gap
Land preparation	One deep ploughing with chisel plough and inter cross ploughing	One cultivation ploughing and two inter cross ploughing	Partial gap
Seed rate (kg/ha)	20	40	Full gap
Seed treatment	*Trichoderma viride* @ 4 g/kg seed + *Pseudomonas fluorescens* @ 10 g/kg seed	No seed treatment	Full gap
Fertilizer dose (kg/ha)	25:50:75 kg NPK/ha + 80 kg S as gypsum on 45 DAS	10:30:0 NPK kg/ha	Partial gap
Sowing method	Seed drill 30 cm row to row and 10 cm plant to plant	Hand dibbling, no spacing	Full gap
Foliar spray	Pulse wonder @ 5 kg/ha at peg formation and pod formation stage	No foliar spray	Full gap
Plant protection	IPM module	One spray insecticide	Partial gap

Table 2. Over all adoption of blackgram seed grower about Good Agricultural Practices (GAPs) (N=50).

S. No.	Categories	Frequency	Percentage
1.	Low	15	30
2.	Medium	23	46
3.	High	12	24

Table 3. Adoption of individual recommended cultivation practices of blackgram seed grower

S. No.	Particulars	Frequency	Percentage
1.	High yield varieties	26	52.0
2.	Land preparation	48	96.0
3.	Seed treatment practices	29	58.0
4.	Spacing	23	46.0
5.	Sowing time	50	100.0
6.	Manuring	24	48.0
7.	Recommended dose of NPK	30	60.0
8.	Cultural Practices	43	86.0
9.	Water Management	45	90.0
10.	Disease Management	48	96.0
11.	Pest Management	37	74.0
12.	Foliar application of nutrients	28	56.0

Table 4. Constraints faced by farmer's

.S. No.	Constraints	Frequency	Percentage
1.	Lack of technical guidance	48	96.0
2.	Complexity	46	92.0
3.	Lack of financial support	26	52.0
4.	Not existing of the potential market	50	100.0
5.	Monopoly of Merchant in the market	32	64.0
6.	Non-avaliability of skilled labour	41	82.0
7.	Lack of marketing facilities	45	90.0

Table 5. Productivity, Extension gap, Technology gap and Technology index of blackgram as grown under large scale cluster demonstration and existing package of practices.

Year	Area (ha)	No. of farmer's	Potential yield (q ha^{-1})	Average Yield (q ha^{-1})		% increase over FP	Extension gap (q ha^{-1})	Technology gap (q ha^{-1})	Technology index (%)
				GAPs	FP				
2019-20	15	22	0.85	0.63	0.52	21.2	0.11	0.22	25.9
2020-21	25	28	0.85	0.64	0.58	10.3	0.06	0.21	24.7
Average	20	25	0.85	0.635	0.55	15.75	0.085	0.215	25.3

Table 6. Economic analysis of Good Agricultural Practices and farmer practices of blackgram as grown under large scale cluster demonstration under TN IAMP-II Aliyar sub basin of Tiruvannamalai District

Year	Cost of cultivation (Rs./ha)		Gross Return (Rs./ha)		Net Return (Rs./ha)		Benefit Cost Ratio	
	GAPs	FP	GAPs	FP	GAPs	FP	GAPs	FP
2019-20	22545	26523	51532	42810	28986	16288	2.31	1.61
2020-21	26414	32607	58407	50593	31993	17986	2.23	1.56
Average	24479.50	29565.00	54969.50	46701.50	30489.50	17137.00	2.27	1.59