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Ashoka P
Senior Scientist and Head, ICAR-Krishi Vigyan Kendra, Ranebennur taluk, Haveri, Karnataka, India

Priya P
Assistant Professor, Department of Agronomy, College of Agriculture, Hanumanamatti, Ranebennur taluk, Haveri, Karnataka, India

Sarojani J Karakkannavar
Professor and Head, Department of Food Science and Nutrition, College of Community Sciences, Dharwad, Karnataka, India

Corresponding Author:
Ashoka P
Senior Scientist and Head, ICAR-Krishi Vigyan Kendra, Ranebennur taluk, Haveri, Karnataka, India

Yield gap analysis of *Rabi* sorghum through frontline demonstrations in Haveri region of Northern Karnataka

Ashoka P, Priya P and Sarojani J Karakkannavar

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Abstract
The study was carried out during *rabi* season of 2016-17 to 2018-19. All the front line demonstrations were carried out in an area of 12 hectares with 30 demonstrations. The results of FLD's showed that improved technologies consisting of use of improved variety, seed treatment with *Azospirillium*, balanced fertilizer application and integrated pest management recorded higher yield as compared to farmer's local practice. The results indicated that on an average 20.52 per cent higher grain yield was recorded in demonstration plots than the local check. The extension gap, technology gap and technology index were 2.45 q/ha, 4.41 q/ha and 3.71 per cent, respectively. Average of three years data revealed that SPV-2217 variety under improved practices recorded higher grain yield of 20.64, 15.19 and 25.29 kg/ha during 2016-17, 2017-18 and 2018-19 and the recommended practice gave higher net returns of Rs 50,788, 15,468 and 51, 000 ha^{-1} and B:C ratio of 4.14, 2.44 and 4.06, respectively as compared to farmers practice.

Keywords: Demonstration, farmers' practice, yield gap, improved variety, *rabi* sorghum

Introduction

Jowar (Sorghum) is traditionally grown for food and fodder purposes [1]. It is an important staple food for more than 300 million people in Asia and Africa. Among the cereals, sorghum ranks fifth in terms of area and production in the world after wheat, maize, rice and barley. Sorghum has the potential for grain production even under low rainfall and they sustain adverse agro-climatic conditions. In India it is a staple food in the states of Maharashtra and parts of Karnataka, Madhya Pradesh, Tamil Nadu, Gujarat and Andhra Pradesh. Sorghum is cultivated in India during *kharif* (rainy) and *rabi* (post rainy) seasons. Sorghum is an excellent source of energy, contains 349 k cal, 10.4 g of protein, 1.9 g of fat and 72.6 g of carbohydrate and also has good amount of minerals particularly iron (4.1 mg/100g) and zinc (1.6 mg/100g) [2]. Modern genetic alterations are being used to modify cereals to increase their nutrient content. These approaches have the potential to have a major impact on the malnutrition of population groups who derive their dietary energy from a single staple cereal. Sorghum being a good source of nutrient and a common food grain for most of the population; it can be well exploited for combating the deficiency of nutrients. Hence, better nutrient composition promotes nutritional empowerment of people dependent on sorghum as a staple food in rainfed condition.

In addition, sorghum is cultivated in nutrient poor soils in frequently drought-prone areas, it offers food and fodder security through risk aversion on sustainable basis. Despite of its multiple uses, the area under sorghum in India has declined from 18.61 m. ha in 1969-70 to 4.96 m. ha in 2017-18. However, its productivity has increased from 522 kg/ha to 998 kg/ha due to significant improvements made in research and development. There is wide gap between national productivity and yield potential of the improved sorghum technologies developed from the research institutes. Productivity of the crop can be enhanced by adopting the improved practices as recommended by the Agricultural Universities, Department of Agriculture and ICAR Research Institutes. Keeping above points in view Front line demonstration was conducted on popularization of SPV2217 *rabi* sorghum by ICAR- Krishi Vigyan Kendra, Haveri (University of Agriculture Sciences, Dharwad). Front line demonstration is a long term educational activity conducted in a systematic manner at farmers' fields to prove the worth of a new practice/technology. Farmers in India are still producing crops based on the knowledge transmitted to them by their forefathers leading to a grossly unscientific agronomic, nutrient management and pest management practices. As a result of these, they often fail to achieve the desired potential yield of various crops and new varieties. The productivity of *rabi* sorghum is low due to several reasons *viz*., non-availability of quality seeds of improved varieties and poor crop management practices due to unawareness and non-adoption of recommended production practices. Therefore, it is very essential to demonstrate the high yielding varieties resistant to biotic and abiotic stresses and other improved production technologies which the framers generally do not adopt. In Haveri district, *rabi* sorghum is mainly grown under rainfed condition. The main objective of the study was to exhibit the performance of recommended high yielding *rabi* sorghum varieties with recommended practices for harvesting higher crop yields.

Material and Methods

Front Line Demonstration (FLD) was conducted to assess the impact of adopting improved package of practices over farmers' practice on the yield and economics of *rabi* sorghum. An attempt to study the impact of this transfer of technology through participatory approach on the economics of the district was made. The study was conducted in Haveri district of Karnataka, which comes under Agro-climatic Zone – 8 *i.e.* Northern Transitional Zone. All the seven block of the Haveri district were considered for the study. The sample for the study was 30 randomly selected respondents, which comprised of growers of *rabi* sorghum. The list of all the beneficiaries was organised village wise and block wise and then the respondent was randomly selected for the study. This FLD was conducted by Krishi Vigyan Kendra, Haveri during *rabi* season from 2016-17 to 2018-19 (three years) in thirty receptive progressive farmers field from all the villages which were selected for conducting the trial to ensure their active participation. The demonstration of improved technology was taken in an area of 0.4 ha in each farmer field. The improved variety and production practices were compared with farmers practice *i.e*. treated as a control. Each demonstration was of 0.4 ha area and the critical inputs were applied as per the package of practices. The quality seed of *rabi* sorghum variety during all the years of the study was used for conducting FLD. The result was compared with the full package of practice. The primary data on output of sorghum yield were collected from the selected farmers in FLD plots besides this, data on local practices commonly adopted by the farmers of this region were also collected with the help of interview schedule and presented in terms of per centage and expressed as per cent increase in yield. The average yield of each FLD and farmers practice, cost of cultivation, gross return, net return and benefit cost (B: C) ratio was taken for interpretation of the results. The extension gap, technology gap and technology index were calculated using the following formula as suggested by Samui *et al*. [3].

Extension gap = Demonstration yield - Local check yield

Technology gap = Potential yield - Demonstration yield

Technology index = Potential yield - Demonstration yield x 100/Potential Yield

$$\%\ \text{Increase over farmers practice} = \frac{\text{Improved practice - Farmers practice}}{\text{Farmers practice}} \text{X100}$$

The yield data were collected from the treated plot and one control plot (farmer practice). Their feasibility and economic variability of the trial was also envisaged with the following four fundamental assumptions,

1. When the technology is not acceptable by the farmer in its recommended form it needs minor modification, refinement or change.
2. It needs the integration of related indigenous knowledge of the farmers with the scientific recommendation in the process of refinement or modification, moreover the refinement or modification is a continuous process in the lack of available technological option specific to each microenvironments.
3. The collaboration of farmers who has been experimenting on their own to evolve solutions to the constraints in their farm and of the extension system which is vital in the process of technology development.
4. The technology or practices generation through Front Line Demonstrations become farmer's recommendation comprising a basket of after natures and as the most appropriate to solve problem. Keeping above points in view the Front Line Demonstrations were executed in the selected villages of Haveri district.

Results and Discussion

Frontline demonstrations are effective educational tools in introducing various new technologies to the farmers and its adoption by building confidence on the basis of results obtained on their fields. The demonstrations could convince the farmers of the respective localities that high crop yield is within their reach by adopting feasible package of practices. A comparison between the farmers practice and suggested scientific practices would indicate the technology gap in yield adoption (Table-1). The Grain yield and yield gap analysis of *rabi* sorghum presented in Table-2 reveals that production of sorghum yield was found to be substantially higher than that of farmer's practices. Higher grain yield of 20.64, 15.19 and 25.29 q/ha were observed during the study period in comparison with the local check.

Table 1: Comparison between demonstration package and farmers existing practice in sorghum production

Particulars	Demonstration Package	Farmers Practice
Farming situation	*Rabi*	*Rabi*
Variety	SPV-2217	Local
Seed rate (kg/ha)	8	5
Seed treatment	Imidachloprid 60 WP @ 5.0 gm/kg Seed	Nil
Azosphillum and Trichoderma	Seed treatment with *Azosphillum* @ 4 gram/kg seed and Trichoderma @12 gram/kg Seed.	Nil
Method of sowing	Line sowing	Broadcasting
Sowing time	Early *rabi*	Late *rabi*
Nutrient Management (NPK kg/ha)	Application of RDF (50:25:0/ha) + $ZnSO_4$ @ 15 kg/ha	30:20:0 NPKkg/ha
Pest management	Whorl application of Carbofuran at the time of shootfly incidence	Nil

Table 2: Grain yield and yield gap analysis of frontline demonstration on *rabi* sorghum

Year	No. of Demo.	Area (ha)	Yield (q/ha)		% increase over control	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
			Demo	Local check				
2016-17	10	4.0	20.64	20.97	20.97	3.60	1.73	6.60
2017-18	10	4.0	15.19	12.75	20.80	2.44	10.81	1.81
2018-19	10	4.0	25.29	21.11	19.80	1.31	0.71	2.73
Average			20.37	18.28	20.52	2.45	4.41	3.71

An extension gap between demonstrated technology and farmers practice range from 3.6 to 1.31 q/ha during three years and on an average the extension gap was 2.45 q/ha (Table 2). This gap might be attributed to adoption of improved technology in demonstrations which resulted in higher grain yield than the traditional farmer's practices. Similarly wide technology gap was observed during different years and this was lowest (1.81 q/ha) during 2017-18 and was highest during (2.73 q/ha) during 2018-19. The average technology gap was 2.45 q/ha. The difference in technology gap during different years could be due to more feasibility of recommended technologies during different years. Similarly, the technology index during study period were in accordance with technology gap.

Table 3: Economics of *rabi* sorghum cultivation under demonstration package and existing farmers practice

Year	Yield (q/ha)			Net returns (Rs./ha)		B:C Ratio	
	Demo	Control	% increase over control	Demo	Control	Demo	Control
2016-17	20.64	20.97	20.97	50788	39163	3.99	3.01
2017-18	15.19	12.75	20.80	15468	10494	2.44	1.91
2018-19	25.29	21.11	19.80	51000	40369	4.06	3.42
Average	20.37	18.28	20.52	39085	30008	3.50	2.78

Various economic indicators like net returns and Benefit: Cost ratios of frontline demonstrations are presented in Table-3. The economic indicators clearly showed that the net returns from the recommended practices were substantially higher than the control plot *i.e.,* farmers practice during the demonstration period. The average net returns from the recommended practice were higher (Rs. 39, 085 /-) in comparison to farmers practice/control plot (Rs. 30,008/-). Additional income was received through the innovative technological interventions that is correct date of sowing, seed treatment, plant protection measures and balanced cultural practices. Economic analysis of the yield concluded that the benefit: cost ratios of demonstration plots (3.50) were significantly higher over control (2.78). The results are in conformity with the findings of Hiremath *et al.* [4] in onion, Kumar *et al.* [5] in bajra, Mishra *et al.* [6] in potato, Sharma [7] in moth bean, Gurumukhi and Mishra [8] in sorghum, Yadav *et al.,* [9] in oilseeds, Lathwal [10] in pulses and Singh *et al.* [11]. The benefit: cost ratio of the system proved the economic viability of the interventions made under demonstration and convinced the farmers on the utility of the interventions. The results of frontline demonstrations showed that the yield of sorghum could be increased with the help of innovative technological intervention.

Conclusion
Frontline demonstration programme was effective in changing the attitude of farmers towards sorghum cultivation. Cultivation of demonstrated plots of *rabi* sorghum with improved technologies has increased the skill and knowledge of the farmers. FLD also helped in replacement of local non recommended varieties with improved recommended varieties. This also improved the relationship between farmers and scientist and built good rapport between them. The farmers where improved technology was demonstrated also acted as primary source of information for other farmers on the improved practices of sorghum cultivation. The concept of Front line demonstration may be applied to all categories of farmers including progressive farmers for speedy and wider dissemination of the recommended practices to other members of the farming community.

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