Quantifying the Effect of Frontline Demonstrations on Post-Rainy Sorghum Production Technology and Livelihood Perspectives of the Farmers

Rajendra R. Chapke[1] and Vilas A. Tonapi[2]

1. Principal Scientist (Agricultural Extension)
2. Director, ICAR-Indian Institute of Millets Research, Hyderabad 500 030, India

Corresponding author's email: chapke@millets.res.in

ABSTRACT

The problem of low remunerations and low adoption of sorghum production technologies resulted into drastic decline in area. Therefore, evaluation of production potential, adoption, economic and other benefits of the technologies in social perspectives of the farmers was undertaken. The study was conducted with 200 adopted farmers under frontline demonstration(FLDs) organized during five years from 2009-10 to 2013-14 in five districts in two prominent sorghum growing regions in Maharashtra state, India. The yield potential and merits was measured by following before and after method, and data were collected through semi-structured interview schedule conducting personal interviews, group meetings, facilitated discussion, from recorded data and empirical observations. The effect of the demonstrated technologies was resulted into increased in adoption (27%), higher net returns (170%), followed by grain yield (58%) with better quality (78%) and fodder yield (26%), found to be significantly positive over the pre-FLD. It enabled to motivate farmers and increase in area under sorghum by 29 per cent. Furthermore, the additional returns helped them in spending significantly higher towards purchase of household items (111%) followed by, on attending more social functions (109%), purchase of animals (91%), in start of new business (86%), deposit in bank (77%) and investment for farm development (62%). This study ultimately will enable to motivate farmers using appropriate production technology(s) and extension strategy, and also to bridge gap between potential and realized yield in farmers' fields in order to support farmers' livelihood. The effect of sorghum technologies in terms of yield potential and adoption comprising its practical, economical and socio-cultural significance would have substantial implications in motivating the farmers towards sustainable cultivation. The study represents a unique attempt inmotivating farmers' with the effect of post-rainy sorghum production technologies on farmers' livelihood.

Key words: *Post-rainy sorghum, Effect of production technologies, Adoption, Yield, Net returns, Income utilization pattern, Farmers' motivation*

INTRODUCTION

Sorghum (*Sorghum bicolor* [L] Moench) is one of the most important cereal crops in the world grown in 108 countries covering 35.7 m ha with a total production of 63.56 m tones during 2014. India has largest sorghum area, comprising 16.30 per cent of global area and 8.48 per cent of production. Whereas, U.S.A. was the largest producer with 17.29 percent of production in the world. The other major sorghum producing countries were Mexico (13.21 percent), Nigeria (10.61 %), India (8.48 %), Ethiopia (6.83 %), Argentina (5.45 %), China including China mainland (9.31 %), Brazil (3.59 %), Burkina Faso (2.69 %), Niger (2.24 %), Australia (2.02 %), and Mali (2.00 %), during the same period (FAOST AT, 2016).

Sorghumis a staple food for millions of poorest and most food-insecure people in the semi-aridtropics (SAT) of Africa, Asia and Latin America. More than 300 million people in more than 30 countries depend on sorghum as the main source of energy and protein (Oku the *et al*. 2013).India is the main producer of sorghum in Asia. It is one of the cheapest sources of energy, higher content of digestive fibres, protein, vitamins and minerals (Ashok Kumar *et al*. 2012 and 2013). In terms of nutrient intake, sorghum accounts for about 35% of the total intake of calories, protein, iron and zinc in the dominant production/consumption areas (Parthasarathy Rao *et al*. 2006). Besides, being a major source of staple food for human beings, it also serves as an important source of fodder, feed and industrial raw material. It is grown in semi-arid climate where other cereal crops don't stand well (Paterson *et al*. 2009). Sorghum is the third cereal crop after rice and wheat in India, mostly grown under marginal and stress-prone areas of SAT. With the threat of climate change looming large on the crop productivity, sorghum has an important role in food, feed and fodder security in dry land agriculture.

Among all the sorghum growing states in India, Maharashtra State ranked first in harvested area and production with 2.86 million hectares and 2.51 million tone, respectively during 2013-14. It is cultivated by all type of farmers in different types of soils mostly during rainy (June-October) and post-rainy (September-January) seasons. National average yield of sorghum has doubled since 1980 due to adoption of both improved varieties and management practices by the farmers (Pray and Nagarajan, 2009). The Maharashtra (62.43%) and the Karnataka (27.82%) were major states followed by Tamilnadu (4.85%), Andhra Pradesh (3.39%) and Gujrat (1.50%). The post-rainy (*rabi*) sorghum produce is used both for human consumption and fodder for cattle. Thus, it is the key for the sustenance of human and livestock population. However, the productivity of post-rainy sorghum is lesser (840 kg/ha) than rainy sorghum (1033 kg/ha) during 2013-14. Because, it was mostly grown on residual moisture of rainy season under rain-fed condition with low fertilizers and inadequate technologies use(Deb *et al.* 2005). Low remuneration coupled with lack of policy and market support were major de-motivating factors. Almost 31 per cent area of post-rainy sorghum has reduced from 4.63 m ha during 2008-09 to 3.51 m ha during 2013-14 (ASG 2015).

Several extension programmes and efforts were made in transfer and refinement of recommended improved production technologies on the farmers' fields through institute village linkage programme, operational research programme, lab to land programme and frontline demonstrations (FLDs) since 1996 by the government of India. More than 2200 FLDs on only *rabi* sorghum production technologies were conducted in major sorghum growing regions of the country (Chari *et al.* 2008). The several reports indicated that there was significant impact of the demonstrated sorghum production technologies mainly on yields. But, not all released varieties and cultivation practices result in impact, of course; adoption by farmers depends on the varieties' suitability to their needs and conditions, the availability of seed and other inputs, the availability of information about the varieties, and other factors. Impact has been especially strong in the regions/states of the Marathwada and the western Maharashtra in the Maharashtra state, and in the northern Karnataka state; this area is known as 'Sorghum Bowl' of India (Deb and Bantilan, 2003). However, neither the effect of the technologies were ascertained adequately on different parameters not managed effectively.

Therefore, this study was conducted to ascertain effect of the demonstrated technologies on agro-economic, farming and farmers' livelihood aspects, so that they can be motivated and built-up confidence for sustainable sorghum cultivation. The extend of adoption of these recommended the production technologies were also assessed in order to replicate successful results. This study ultimately will direct to develop effective extension strategies based-onrealized advantages of the sorghum which would be motivating incentives for the farmers.

METHODOLOGY

Conceptual framework

Though, sorghum has potential to grow well in harsh climatic conditions unlike other fine cereals (wheat, rice and maize) and provide livelihood and nutritional security to resource-poor farmers in dryland areas, its cultivation area has declined (>60%) drastically. With latest advancement of research outputs of sorghum, extension and development systems have been promoting and disseminating the technologies since the very inception. However, the major problems like, low remuneration, low adoption, lack of awareness and skill, low consumption and market support were persists. Enhancing productivity, employment generation coupled with reducing cost of cultivation along with market support can raise remuneration and motivation provided adoption of improved production technologies and timely management. In this context, effect of the production technologies in terms impact comprising, adoption, yield, employment generation and socio-economic benefits as a whole needs to be ascertained. Therefore, this study was conducted to evaluate extend of adoption, yield advantage and other benefits in terms of economic and social perspectives. It can provide future direction to the researchers and strategy for further development.

Study area, research design and selection of the respondents

The study was conducted in major post-rainy sorghum (September-January) growing regions namely, western Maharashtra and Marathwada in Maharashtra State, India where the FLDs were conducted on the farmers' fields continuously during five years from 2009 to 2013. The study mainly attempted to describe the institutional, social and agro-economic factors in relation to adoption and impact of the demonstrated technologies in retrospect (*after the-fact*). An ex-post-facto survey design was employed which involves data collection after a naturalistically occurring event (Fraenkel and Wallen, 2000; Casely and Kumar, 1992).

Purposive random sampling method was followed for selection of respondents out of the participatory farmers of FLDs. Thus, total 100 respondents from the each region those who were well responsive, cooperative and maintained records of the cultivation, were selected randomly, making sample size of200.

Development of interview schedule and data collection

Initially, benchmark data on socio-personal and agro-economic profile of the trial farmers were collected before initiating the FLD trials (pre-FLDs) with the help of semi-structured interview schedule prepared including experts suggestions. Subsequently, the trial data of the selected farmers during adoption period were recorded on various parameters like, performance of the demonstrated technologies, acreage under crop, attitude, yield difference, seed exchange, if any, level of adoption, labour use pattern, economics and utilization of additional income. The adoption period of individual farmers was varying from two to five years as they were changing. Finally, data were collected after withdrawal from the trials (post-FLDs) for the purpose of evaluating impact of demonstrated technologies was collected from the same set of farmers conducting personal interviews, group discussions, empirical observations, memory data and field records of the FLD trials.

Measurement of adoption and impact of the latest sorghum technologies

Extend of adoption and impact was measured using suitable methods as mentioned earlier. The data were categorized in three stages *viz*., pre-FLDs, during FLDs and post-FLDsin order to evaluate impact of the latest demonstrated technologies using pre- and post-evaluation test. The adoption of the demonstrated technologies was ascertained on three-point continuum i.e. full, partial and no with assigning two, one and zero score, respectively. The extend of adoption was computed with adoption index using formula: {(Difference between post- and pre-FLDs) / (Adoption level at pre-FLDs) x 100}. Similarly, other parameters like, change in grain yield, fodder yield, net returns and benefit-cost ratio were measured using formula: {(Difference between post- and pre-FLDs) / (pre-FLDs) x 100}. Impact index was worked out by calculating average score of the four parameters *viz*., grain yield, fodder yield, net returns and benefit-cost ratio (B:C) of the demonstrated technologies obtained under pre- and post-FLDs.The data were analyzed with descriptive statistics; mean, correlation and 't' test analysis. For the non-descriptive questions, the respondents were requested to indicate their level of rating on one to five-point Likert-type scales where one indicated the lowest rating and five indicated the highest rating. The qualitative data were summarized through content analysis to facilitate interpretation.

RESULTS AND DISCUSSION

Adoption of demonstrated technologies by the farmers

Between 2009 and 2013, front line demonstrations of improved post-rainy sorghum production technologies were organized in farmers' fields in highest sorghum growing state, Maharashtra in the county. Practice-wiseadoption of the demonstrated production technologies followed by the trial farmers in Western Maharashtra region were found significantly higher than the pre-FLD stage (Table 1). More than 48 percent adoption was found in practicing seed treatment (85%),use of high yielding varieties (70%),use of nitrogen fertilizer (57%), following time of sowing (49%) and maintaining plant spacing (48%). Whereas, below 30 per cent adoption was found in use of phosphorous, potassium fertilizer, pest control measures, land preparation in time, irrigation application, harvesting at proper time and maintaining seed rate. It may be due to getting low remuneration out of this crop and scarcity of laboures in peak season. Overall, significant increase in adoption of the demonstrated practices was observed than the pre-FLD stage. However, use of farm yard manure (FYM) was found to be decreasing significantly over the period of five years. It may be due to obvious reason of its scarcity and high cost than chemical fertilizers. The above findings elicited that the sorghum farmers of Western Maharashtra region were comfortable with adopting five major practices namely, seed treatment, use of high yielding variety, use of nitrogen fertilizer, following time of sowing and maintaining plant spacing. The similar findings were also supported by Chapke, 2014.

In Marathwada region, an adoption level was also found significantly higher than the pre-FLD stage (Table 1). Majority of the farmers were adopted practices such as, weed control (70%), maintaining plant spacing (63%), use of high yielding varieties (48%) and maintaining seed rate (48%). Whereas, adoption of pest control measures (29%), practicing seed treatment (24%),use of nitrogen, phosphate and potassium (N:P:K) fertilizers, following time of sowing, irrigation application, land preparation in time, irrigation application, and harvesting at proper time were found below 30 per cent, but was highly significant than the pre-FLD stage. Similarly, use of FYM was found decreasing significantly over the period of five years. The reason for this was the same as mentioned earlier. The above findings explicated that the sorghum farmers of Marathwada region were preferred to continue with four major practices namely, weed control, maintaining plant spacing, use of high yielding varieties and maintaining seed rate. The lower adoption of recommended fertilizer dose was associated with less irrigation facilities and poor soil status of the Marathwada region compared to the Western Maharashtra region.

Overall, adoption pattern in both the regions indicates that more than 50 per cent adoption of three crop cultivation practices like, use of high yielding variety, maintaining plant spacing and use of treated seeds or seed treatment was found highly significant over pre-FLD stage. Further more, more than 25 per cent adoption of weed control measures, nitrogen fertilizer application, following sowing time and use of proper seed rate was found highly significant. While, below 25 per cent adoption was found in pest control, phosphorous and potassium fertilizers use, following time of land preparation, application of irrigation and following time of harvesting. The use of FYM was going down significantly may be due to the known fact of its scarcity and high cost. It reveals that out of fifteen demonstrated practices, five practices namely, use of high yielding variety, maintaining plant spacing, use of treated seeds or seed treatment, use weed control measures and nitrogen fertilizer application were found suitable by the farmers which can be easily practiced and gave significant results. On discussion with farmers also revealed that the other groups of non-adopted farmers from nearby villages within 45 km radius and relatives of the adopted farmers and non-trial farmers were motivated seeing yield performance of the demonstrated cultivars and requesting for seeds.

Adoption of the farm technology should not be regarded as an end in itself, but rather as a continuous decision-making process (Sombatpanit *et al.* 1996). Individuals pass through various learning and experimenting stages from awareness of the problem, its potential solutions and finally deciding whether to adopt or reject the given technology. Adoption of new technology normally passes through four different stages, which include awareness, interest, evaluation, and finally adoption (Rogers and Shoemaker 1971). At each stage there are various constraints (social, economic, physical, or logistical)for different groups of farmers. Therefore, scientist community should not be rest on their achievements as the adoption process is highly dynamic. Whereas, the provision of support services, such as credit, access to inputs, training and extension services, also increased adoption (Gafsi and Brossier 1997; Paudel and Thapa 2004).

Table 1
Adoption of demonstrated technologies by the farmers after FLD (%)

Practices / item	Western Maharashtra		Marathwada		Pooled	
	Increased adoption over pre-demo stage (%)	't' value	Increased adoption over pre-demo stage (%)	't' value	Increased adoption over pre-demo stage (%)	't' value
Land preparation in time	12	3.08*	9	3.93**	10.5	4.65**
Use of high yielding variety	70	14.28**	48	43.37**	58.5	22.44**
Seed treatment	85	23.69**	24	9.56**	54.5	17.73**
Seed rate	5	2.07*	48	48.74**	26.5	13.24**
Time of sowing	49	9.51**	15	5.74**	31.75	10.26**
Spacing	48	10.65**	63	20.54**	55.25	20.06**
• Nitrogen (Urea)	57	15.72**	19	6.8**	37.75	14.3**
• P_2O_5 (S. S.P.)	29	6.75**	3	2.28*	15.5	6.56**
• K_2O (MoP)	24	6.12**	17	5.62**	20.25	8.24**
• FYM	-11	1.52 NS	-6	2.93*	-5.75	2.77NS
Insecticide used	18	5.59**	29	10.47**	23.5	10.91**
Disease control	03	2.28*	5	3.32*	3.75	4.02**
Weed control	12	3.73**	70	18.29**	40.75	12.69**
Irrigations applied	15	5.2**	5	3**	10	5.88**
Time of harvesting	08	2.36*	4	2.73**	5.75	3.17**

**Significant at 1% level,; *Significant at 5% level; NS = Non significant

Yield and economic benefits obtained from the demonstrated technologies

The higher adoption of the demonstrated technologies (103%) by the farmers in Western Maharashtra led to produce higher grains (78%) with better quality (42%) and fodder yield by 30 per cent over pre-FLD stage. The increased yields were not only enabled them to obtain higher net returns (168%) and incremental increase of benefit-cost ratio (15%) but also motivated to increase in area under sorghum significantly than the pre-FLD stage. Whereas, very low increased in cost of production (11%) over the pre-FLD stage was observed which, may be due to increase in price of inputs over the years (Table 2). Nevertheless, effect of the FLD technologies in terms of benefit-cost ratio was not found significant. It is elicited that only increasing in productivity can't support farmers to get maximum benefit. Therefore, judicious use of inputs as per the recommendations coupled with adopting timely management practices were also play vital role in achieving maximum profits per unit cost.

In the Marathwada region, the farmers obtained higher net returns (170%), higher grain yield (28%) with better quality (136%) and fodder yield by 23 per cent due to adoption of the demonstrated practices (24%). The increased yields were also enabled them to obtain incremental increase of benefit-cost ratio (28%) and increase in area under sorghum (36%) which was significantly higher than the pre-FLD stage. As mentioned earlier, little increase in cost of production (11%) than the pre-FLD stage was observed. It is indicated that adoption of the demonstrated production technologies helped farmers to get maximum benefit with quality production.

In sum, effect of the demonstrated technologies after FLD period in Maharashtra in terms of increase in adoption level (27%) resulted into higher net returns (170%), followed by grain yield (58%) with better quality (78%) and fodder yield by 26 per cent. This effect motivated the farmers to extend area under sorghum by 29 per cent (Table 2). Only 11 per cent increased in cost of production were found over the period of five years. It indicates that the demonstrated sorghum technologies were found convenient and beneficial to the farmers and therefore, they were continuing with them after withdrawal from the FLDs. In support of these findings, Deb and Bantilan, 2003 also stated that for any crop, it can be difficult to interpret yield levels and changes in yield as measures of research impacts. This is particularly true for crops such as sorghum that are customarily grown with few inputs under dry and conditions. Even small changes in the quantities of inputs used or the quality of the land planted to sorghum can have large effects on yields.

Table 2
Indicators of impact assessment of rabi Sorghum FLDs

Sl. No.	Indicators	Western Maharashtra		Marathwada		Pooled	
		Change over pre-demo stage (%)	't' value	Change over pre-demo stage (%)	't' value	Change over pre-demo stage (%)	't' value
1	Area of sorghum (ha)	27	3.97**	36	4.63**	29	5.24**
2	Adoption level	103	31.94**	24	41.12**	27	45.4**
3	Cost of production (Rs./ha)	11	2.68**	11	38.30**	11	5.63**
4	Grain yield (q/ha)	78	13.58**	28	3.36**	58	10.63**
5	Fodder yield (q/ha)	30	6.60**	23	7.76**	26	9.36**
6	Net returns (Rs./ha)	168	2.24**	170	9.95**	170	5.46**
7	Benefit-cost ratio	15	1.15NS	28	7.96**	22	3.2**
8	Quality of grain	42	10.09**	136	26.53**	78	20.92**
9	Labourer used	133	10.56**	43	13.35**	19	7.87**
10	Hired labourer	122	7.49**	64	12.82**	39	11.08**
11	Family labourer	167	5.53**	20	7.03**	-25	7.86**

**Significant at 1% level,; *Significant at 5% level; NS = Non significant

Employment generation

Notably, most of the farmers engaged their family and hired labourer as their own resources in cultivation of sorghum. It was recorded that five years before ratio of hired and family labour used in the sorghum cultivation was 18:08, which became 25:06 (Table 3). It was shifting towards more on hired labourer by 39%. It may be due to the fact that young family members were not interested to do farm work; rather preferred to do work in non-agricultural sectors. Sorghum is a labour intensive crop, which consumed 52 per cent cost for human labour alone out of total cost of cultivation. While, sorghum cultivation could provide small employment in the form of family labour and depended more on hired labourer up to 81 per cent. This draws attention to the need of introduction of mechanization, wherever possible, for sustainable sorghum cultivation.

Table 3
Labour used pattern in sorghum cultivation

Labourer	Pre-demo	Post-demo	Change over pre-demo stage (%)
Total	26 (100)	31 (100)	19
Hired	18 (69)	25 (81)	39
Family	08 (31)	06 (19)	-25

Figures in parentheses indicates percentage

Income utilization pattern of sorghum farmers

Utilization of additional returns obtained from the improved sorghum cultivation by the FLD farmers in Western Maharashtra revealed (Table 4) that farmers could spend double on attending more social functions like, marriage, birthday functions, etc. (100%) than earlier followed by on purchase of household items like television, mobile set, etc. (62%), health of all family members (54%), for next crop cultivation (53%), education of their children (49%) and food for their family (39%) which was significantly higher than the pre-FLD period. A little increased in investment in farm development (13%) was also found. Whereas, it could not help them much in high investment items like, start of business, purchase of costly dairy animals and making bank deposit.

The income utilization pattern of the farmers after FLD period in Marathwada region was indicated that the additional returns only helped them in spending significantly higher on attending more social functions (116%) than before demonstration period, followed by, on purchase of household items (111%), purchase of animals (90%), education of their children (57%), health of all family members (49%) and for next crop cultivation (45%). Whereas, increased expenditure on investment in farm development (63%) e.g. field leveling, pond construction, well repair work, etc., food for their family (39%) and making bank deposit (77%) was not significant. Due to scanty rainfall coupled with poor soil status, they tend to start subsidiary occupations like dairy and other small enterprise.

Overall, the additional returns only helped them in spending significantly higher on purchase of household items (111%), on attending more social functions (109%), purchase of animals (91%), in start of new business (86%) and making bank deposit (77%) exclusively in the Marathwada region, increased expenditure on investment in farm development (62%), same for next crop cultivation, health and education (52%) and food for their family (39%) which was significantly higher than the pre-FLD period. Whereas, increased expenditure on start of new business and making bank deposit was not significant. It is elicited that sorghum being low income crop could not support in big investments items. However, it is one of the major livelihood supports to the farmers where there was no other alternative crop can be grown. The findings aptly indicated that effect of the production technologies was key element of their motivation and had been playing vital role to meet out their social, educational, health and financial needs apart from food and fodder.

Table 4
Utilization of additional returns obtained from sorghum cultivation

Sl. No.	Items (Human needs)	Western Maharashtra		Marathwada		Pooled	
		Change over pre-demo stage (%)	**'t' value**	**Change over pre-demo stage** (%)	**'t' value**	**Change over pre-demo stage** (%)	**'t' value**
1	Education	49	13.6**	57	9.98**	52	16.26**
2	Health	54	18.22**	49	6.75**	52	15.31**
3	Food	39	10.58**	39	1.89NS	39	3.76**
4	Purchase of animals	01	1.00NS	90	2.35*	91	2.32*
5	Next crop cultivation	53	6.11**	45	4.63**	52	6.81**
6	New business	02	1.42NS	86	3.86**	86	3.73**
7	Bank deposit	00	00NS	77	1.84NS	77	1.83 NS
8	Purchase of household items	62	12.04**	111	3.65**	111	10.44**
9	Investment in farm development	13	19.32**	63	1.89NS	62	1.93 NS
10	Attending social functions	100	16.62**	116	3.50**	109	11.7**

**Significant at 1% level,; *Significant at 5% level; NS = Non significant

Association between socio-economic traits of the farmers and impact of demonstrated technologies

Correlation between different variables with impact of the demonstrated technologies was analyzed. Since, sorghum is labour intensive, family size refer to the total number of family members involved in the farming activities which was found to be positive and significantly correlated with impact of improved production technologies (Table 5). This implies that size of family with more members had more contribution in farm work and therefore, had influence on the effect. It was also supported by the findings of Tiwari *et al.* 2008. Furthermore, adoption period of the farmers under FLDs was impacted as highly significant and positive. It was hypothesized too. And, increased in grain and fodder yield, net returns and benefit-cost (B:C) ratio had high correlation with impact. Thus, out of thirteen different socio-economic and yield related variables namely, family size, duration adoption period of the farmers under FLD programme, increased grain yield, net returns and B:C ratio were found highly correlated at 1% level of probability with impact of the FLDs, while the adoption level was found correlated at 5% level of probability. Where as, variables *viz*.,increased in cost of production was found negatively correlated. It implies that more number of family members and number of years of adoption under FLD had high correlation with effect in terms of impact of the technologies in terms of additional grain yield, net returns and B:C ratio.

In this study, social factors like the caste classification of the farmer and dominated community had no relevance as significant impact was observed among the farmers who had the adequate working members in the family and the dependency on farming occupation only. The same observations were also recorded by Tiwari *et al.* 2008.

Table 5
Definition, correlation of socio-economic variables and impact of the demonstrations

Code	Variable	Definition and measurement	Mean	S. D.	Correlation (r)
X_1	Age	Age of the farmers, measured in years	45.03	9.85	0.016
X_2	Education	Formal education acquired by the farmers (if illiterate = 0, otherwise = increasing numbers of schooling years)	9.49	4.79	0.063
X_3	Occupation	Occupation of farmers as Farming only=1 and Farming plus other business = 2	1.05	0.22	0.190
X_4	Family size	Members of farmer's family living together in numbers	6.00	2.93	0.326**
X_5	Land holding	Land holdings of farmers measured in hectare	3.51	3.93	0.017
X_6	Adoption p eriod under FLDs	Period during which farmers were adopted for frontline demonstration programme in years	1.92	1.45	0.389**
X_7	Percentage changed inarea under sorghum	The percentage change in area of sorghum was calculated as a ratio of the increase inthe area apportioned by the farmer for sorghum in post-FLD over the area in the pre-FLD period.	44.23	76.68	0.115
X_8	Percentage increasedin adoption level	The percentage change in adoption level of demonstrated technologies was calculated as a ratio of the increase inthe adoption level at post- FLD period over the adoption levelatpre-FLD stage.	68.34	65.51	0.169*
X_9	Percentage changed incost of production	The percentagechange in operational cost of production incurred was calculated as a ratio of the increase in operational cost of production in post- FLD period over th e operational cost of production incurred in the pre-FLD period.	16.36	32.61	-0.096
X_{10}	Percentage changed ingrain yield	The percentagechange in grain yield of sorghum was calculated as a ratio of the increase inthe grain yield in post- FLDover the grain yield obtained in the pre-FLD period.	57.74	48.32	0.279**
X_{11}	Percentage changedinfodder yield	The percentage change in fodder yield of sorghum was calculated as a ratio of the increase inthe fodder yield in post-FLD over the fodder yield obtained in the pre-FLD period.	23.11	34.59	0.177*
X_{12}	Percentage changeinnet returns	The percentage change in net returns obtained from sorghum was calculated as a ratio of the increase in net returns in post-FLDover the net returns obtained in the pre-FLD period.	-23.90	2066.30	0.833**
X_{13}	Percentage changedinbenefit-cost ratio	The percentage change in benefit-cost ratio obtained from sorghum was calculated as a ratio of the increase innet returns in post- FLDover th e benefit -cost ratio obtained in the pre-FLD period.	97.99	275.34	0.471**

CONCLUSION

Out of fifteen demonstrated practices, only five practices namely, use of high yielding variety, maintaining plant spacing, use of treated seeds or seed treatment, use weed control measures and nitrogen fertilizer application were found suitable by the farmers which can be easily practiced and gave significant results. Effect in terms of impact of the demonstrated technologies was increased in adoption level which was resulted into higher grain yield with better quality and fodder yield, and ultimately net returns. This impact enabled to motivate the farmers to extend area under sorghum. It indicates that the demonstrated sorghum technologies were found to be effective tool to motivate and build-up confidence among the farmers. They were continuing with them after FLD period too. The improved sorghum cultivation could provide small employment in the form of family labour. However, number of family laborer were reducing. The shifting trend towards more hired labourer use prompted to introduce mechanization in sorghum cultivation, wherever possible. It is also concluded that more number of family members and number of years of adoption under FLD programme resulted into high impact. The findings aptly indicated that effect of the production technologies was very vital in motivating farmers to adopt demonstrated technologies to meeting out their social, educational, health and financial needs apart from food and fodder. Moreover, even small changes in use of low-cost recommended practices and timely management can have large effects on yields and monetary benefits, which supports their livelihood.

The farmers' socio-economic condition was complex and resource-poor where several factors were at interplay. Farmers have diversified needs and worked under several socio-economic and farming constraints which had become their primary concern in motivational perspectives before they decided for any changes and adoption of the new practices. The new technologies should be less input intensive, low cost, and less labour intensive. The role of the farmers in the whole system is more on the receiving end as 'passive subjects' rather than 'active stake holders' despite the fact that sorghum crop constitutes one of their main sources of livelihood.

ACKNOWLEDGMENTS

The financial support received from the Directorate of Agriculture, Cooperation and Farmer Welfare, Ministry of Agriculture and Farmer Welfare, Government of India for organization of the FLDs is acknowledged. We are sincerely grateful to the participating farmers of the regions, who have co-operated and actively participated in conducting the field trials, and sharing the data and their views. The support of the Director, IIMR is also acknowledged. The authors are acknowledged the inputs and constructive suggestions of the unknown reviewers for improvement of the manuscript.

Paper received on 04.09.20
Accepted on 13.09.20

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