International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 4037-4040

Received: 22-04-2020
Accepted: 24-05-2020

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Demonstration of production potential, value addition and economic benefits of climate resilient crop-fox tail millet (*Setaria italica*) IN comparison with ragi (*Eleusine coracona*)

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4ay.10281

Abstract
Small millets are more nutritious and feature a lower glycaemic index than rice and wheat. However, factors like lack of improved varieties, agronomical practices and value addition in minor millets are constraining the production, productivity and the social economic conditions of farmers. Front line demonstrations on Production Potential and Value Addition of Foxtail Millet was carried out by Krishi Vigyan Kendra, Ramanagara in 30 hectares comprising 80 demos (farmers) in 15 villages of Ramanagara district of Karnataka, India from 2013 to 2017 with the objective of demonstrating the production potential of foxtail millet over finger millet and the importance of value addition in millets apart from analysing the yield gaps. The results of the front line demonstrations revealed that the locally grown finger millet Ragi recorded almost 90 per cent higher yield over demonstrated foxtail millet but the net returns realised at the farm gate level was high for fox tail millet (Rs.48511.3/ha) compared to Ragi (Rs. 42852/ha). It was found that the demonstration enhanced the farmer's income by increasing benefit: cost ratio to the tune of 5.7 in foxtail millet compared to ragi (2.3). An additional income of Rs.8943/- (42.7 per cent) was obtained in fox tail millet compared to widely grown ragi.

Keywords: Frontline demonstration, value addition, B:C Ratio, Ragi and fox tail millet

Introduction
The environmental, social and economic challenges of 21st century like climate changes, water scarcity, increasing world population and other socio-economic impacts are expected to generate a great threat to agriculture and food security worldwide, especially for the marginal and small farmers (Saleh *et al*., 2013) [6]. Consequently, there is a need of alternative crops that can resist changing environmental conditions and provide nutritive food source. Ushakumari *et al*., 2004 [7], stated that the millets are considered as crop of food security because of their sustainability in adverse agro-climatic conditions. Small millets are small sized grains and are grown in different regions of the world because they share a set of characteristics which make them unique amongst cereals due to their productivity and short growing season under dry, high-temperature conditions and can also survive in areas with as little as 300 mm or less of seasonal rainfall. Upadhyaya *et al*, 2015 [8], stated that the small millets are continued to be neglected in terms of production, value addition, research, promotion and development. Their presence in the food basket has been declining over the years. One of the main reasons for this decline is the increased availability of other staple and commercial crops such as rice, wheat, maize, *etc*. Millets contain much higher amounts of fibre and essential minerals than wheat, rice and other cereal grains. Despite an increasing demand for millets from health-conscious urban dwellers, the area under millet cultivation in Karnataka has declined by around 2.5 lakh hectares in the last decade. In India, the acreage under millets cultivation has reduced to 0.2 % from 0.4 % of the total cultivable land of 142 million hectares. There was a dramatic decrease in the cultivated area of small millets from 1960 to 2009 (80% for small millets and 46% for finger millet) and 76 per cent decrease in total production of small millets that caused significant reduction in per capita availability of all millets despite high productivity gains for some varieties. Apart from this, there is a steep fall in overall millets consumption. The other reason is the lack of awareness about improved machineries for processing the small millets.

Frontline demonstration (FLD) is a unique approach to provide a direct interface between researcher and farmers as the scientists are directly involved in planning, execution and monitoring of the demonstrations for the technologies developed by them and get direct feedback from the farmers' about the crops. While demonstrating the technologies in the farmer's field, the scientists are required to study the various factors contributing for higher crop yield, constraints in field production & value addition and thereby required to generate production data apart from feedback information. Keeping these in view, Frontline Demonstration of improved high yielding varieties with the thematic area to replace local seeds with high yielding improved variety of foxtail millet were conducted to enhance the productivity, economic returns and impart knowledge on value addition of millets and also to convince the farmers for adoption of newly developed high yielding varieties in small millets.

Ragi and fox tail millet are the most commonly grown millet crops in Ramanagara district of Karnataka. Ragi is milled as flour and consumed either as ragi ball or rotis. While fox tail millet grain is consumed after removing outer bran through decortication or dehulling process at house hold level by hand pounding. This process is a time consuming and tiresome which is an attributing factor of declined area under cultivation. Of late, in the advent of technology, millet milling machinery is available. In recent times due to nutritional value, value added products of millets are seen in the consumer markets which are in huge demand (Shanthkumar *et al.*, 2010). Hence, it is the right time to demonstrate and educate farmers on millet production and processing along with improved machineries. In the present study, an attempt was made to analyse the details of the technological interventions made though FLD, to work out the performance of plant parameters and its effect on yield & income in foxtail millet as well as Ragi and to work out the economics of value addition in foxtail millet.

Material and Methods

Front line demonstrations (FLD) in fox millet were conducted by KVK, Ramanagara for four years from *kharif* 2013 to 2017 at Gangainadoddi, Hosadoddi villages of Kanakapura Taluk; Annigeri, Mallur Patna, H. Mugenally & hamlet villages of Channapattana Taluk and Solur and Kuduru of Magadi taluk. FLD was carried out in an area of 30 hectares covering 15 villages comprising 80 demonstrations. For the purpose of the study at District level, primary data available at data bank of KVK, Ramanagara was used to begin with and the supplementary data was collected from the farmers who participated in the FLD conducted by KVK. Further, for the purpose of the study under micro level situation (FLD), the secondary data available at data bank of KVK was also used as a starting point. With the aid of resulting secondary data, additional information on input and output data from the beneficiaries of the FLD was also collected. Per cent increase in income and additional income generated over value addition to foxtail millet was also calculated.

Results and Discussion

The major driving forces in achieving higher productivity in any crop are high yielding variety (HYV), chemical fertilizers, intensive irrigation, improved pest and disease management practices, input subsidization and incentives to farmers through remunerative pricing policies, public investment in agricultural research and education and institutional reforms. In the present study, considering these aspects improved technologies in fox tail millet were demonstrated to farmers and were compared with farmers practice (Ragi). These practices are presented in Table 1. There was cent per cent gap in adoption of variety, seed treatment, method of sowing, fertilizer application, weed management and value addition. The productivity of crops in rainfed area is very low because of low and erratic rainfall and poor adoption of improved technologies. To bridge yield gap, crop diversification is required for increasing the productivity and profitability per unit area and hence growing of Foxtail millet in place of Ragi was demonstrated.

Krishi Vigyan Kendra bridges the extension gap between the technologies developed at the Research Institutions or State Agriculture & Horticulture Universities and its adoption at the field level by the farmers through various extension approaches as indicated in Table 2. Krishi Vigyan Kendra, Ramanagara adopted cognizance approach where 5 group discussion meetings regarding foxtail millet cultivation were conducted covering 128 farmers. The other cognizance approaches includes 8 news coverage and 4 different types of extension literature which were distributed to 612 foxtail millet growers. As a tool of ICT, KVK has implemented Agriculture Short Message Service (ASMS). From 2013 to 2017, as many as 33 SMSs related to foxtail millet cultivation were sent covering 6666 farmers. Apart from the cognizance approach and ICT tool, methodological approaches were the mainstay of KVK to up-scale technologies among the farmers. Four front line demonstrations (80 demos), 42 training programmes (On & Off trainings) covering 1056 farmers and four field days covering 256 farmers were conducted. All the various extension methods mainly focused on introduction of foxtail millet in the district.

An effort to work out the performance of plant parameters and its effect on yield and income in foxtail millet as well as Ragi was made and the details are tabulated in Table 3. The average yield obtained over four years in ragi was 1047 kg/ha while it was 547.5 kg/ha in foxtail millet. The yield potential of medium duration ragi variety is 800 to 1000 kg/ha under rainfed condition, while it is 700-800 kg/ha in fox tail millet. It is vibrant that both the crops were incomparable with respect to yield and it is evident from the results that the yield of Ragi was far higher than the Fox tail millet. As per the agreement and findings of Anil kumar *et al.*, 2010 [1], Farmers are concerned about the cost-returns of crop or an enterprises than the yield levels, which enable them to take decisions regarding selection of crops with low cost of cultivation and high net returns. The present finding supports this view.

When economics was worked out, it was found that at farm gate level, the cost of cultivation of fox tail millet was low (Rs.10,427/ha.) and high for Ragi (Rs. 33,889/ha.). The higher cost of cultivation in ragi is due to more labour involvement to carry out cultural operations like hand weeding. While in fox tail millet, through minimum human interference weeds were managed through passing of Cycle weeder. Average Gross returns obtained over the years in ragi was Rs.76,741 per ha whereas it was Rs.58, 939 per ha in fox tail millet (Table 3). However, the net returns in fox tail millet was higher with Rs.48,511 compared to Ragi which was Rs. 42,852. The rationale behind this is that the market price of ragi varied from Rs.17 to Rs.20 per kg, while the market price for fox tail millet was Rs. 27 per kg. Therefore, the B:C ratio was higher in Fox tail millet (5.7) than Ragi (2.3). These results are in agreement with the findings of Naveen, 2017.

As part of the FLD, farmers were exposed to the mechanized millet processing wherein during the process, the husk from

the grain was removed and millet rice was collected. The processing fee for per kg of grain was Rs.5 which was also added to the cost of cultivation. Hence, the average gross cost including processing grain to millet rice was Rs.13, 165 (Rs. 10427 + 2657 per hectare) (Table 4). Ragi is directly milled to flour and no processing charges were added for the gross cost. Gross returns of the processed millet rice was higher (Rs.29, 893) than ragi (Rs. 20,950 per ha.). Similar results also have been reported by Khan *et al.*, (2009) [2]. Small millets are more nutritious and has large amount of vitamins, minerals, and have a lower glycaemic index than rice and wheat and hence it is considered as the best food for diabetic. The market price of processed Foxtail millet rice was Rs.70 per kg, while it varied from Rs.17 to 20 per kg for Ragi. Due to this market price difference and reduced cost of cultivation, there was 42.7 per cent increase in income to the farmers by growing Fox tail millet over farmers practice (Ragi). The average additional income the farmers gained by processing the foxtail millet was Rs 8,943 per annum. The results from the current study clearly brought out the potential of adopting improved production technologies and value addition in rainfed condition crops to reap higher profit for the crop grown. Similar results also have been reported by Rudrasen singh *et al*., (2014) [3]

Front Line demonstration played an important role in demonstrating new technologies to the farmers like use of high yielding varieties, Line sowing through seed drill, seed treatment, application of soil test based balanced doses of the fertilizers and post-harvest processing & value addition. The productivity gain under demonstrations over conventional practices created awareness and motivated fellow farmers to adopt appropriate recent production technologies of fox tail millet. Farmers expressed that cultivating fox tail millet along with conventional crop (Ragi) would fetches more price and that foxtail millet is not prone for serious pest & diseases, can withstood long moisture stress and is easy to cultivate. Further, Value addition in foxtail millet through processing redefined the role of creating and capturing value for the produce. However, concerned departments, agencies and NGOs must work on the lines of creating millet processing units at gross root level.

Table 1: Details of the technological interventions under Frontline Demonstration against farmers practice in fox tail millet

No.	Practice	Farmers practice (Ragi)	Technological Intervention in Demonstration
1	Farming situation	Rainfed	Rainfed
2	Variety	Ragi	Fox tail millet (DHFT 109-3, HMT 100-1)
3	Time of sowing	June -July	June -July
4	Seed treatment	Not followed	Seed treatment with *Azatobacter* and *Phospho solubilising bacteria* @ 25g/kg seed
5	Method of sowing	Broadcasting	Line sowing through seed drill
6	Fertilizer application	Non authentic method of basal application of fertilizers and no addition of micronutrient mixtures	Recommended INM practices, Soil application of FYM @ 12 t/ha and recommended dose of NPK based on soil test results
7	Weed management	One intercultivation at 20-25 days after sowing	One intercultivation at 20 days after sowing followed by passing of Cycle weeder at 35 DAS
8	Value addition	Not followed	Payasa, Bisibelabath, Puliyogare, Fox tail millet snacks (Chakali, Millet snack bar, Millet pop up- mixture)

Table 2: Extension Approaches Adopted by KVK to Educate Foxtail Millet Growers of Ramanagara District from 2013-14 to 2016-17

Sl. No	Extension Approaches	Number / Programs	No. of farmers reached
1	Group discussions	5	128
2	Front Line Demonstrations (FLD's)	4	80
3	Training programmes (On & Off campus)	42	1056
4	Field days conducted	4	256
5	Farmers personal visit to KVK for advisory services about foxtail millet (since 2013)	72	-
6	Advisory services through Whats App (since 2013)	51	308
7	Advisory services through phone calls	83	-
8	Method demonstrations conducted (soil sampling, seed treatment, Line sowing and Value addition)	39	667
9	News coverage about foxtail millet	6	612
10	Literature distributed (Folders/Leaflets)	36	-
11	Agriculture Short Message Service (SMS sent)	33	6666
12	Cell phone calls	41	-
13	Exposure visits	6	208

Table 3: Plant and Yield Parameters of fox tail millet under Demonstration Plot and Farmers Practice from 2013-2017

Particulars	2013-14		2014-15		2015-16		2016-17		Average over years	
	Demo	Check (Ragi)	Demo	Check (Ragi)	Demo	Check (Ragi)	Demo	Check (Ragi)	Demo	Check (Ragi)
Plant height (cm)	96.4	120.8	94.6	120	95.2	121.4	92.8	115.9	94.8	119.5
No. of productive tillers	5	6	5	6	5	6	5	6	5.0	6.0
No. of panicles or fingers / plant	4	5	3	5	4	5	3	5	4.0	5.0
Panicle or ear head length (cm)	12.2	10.6	12	10.1	12.5	10.4	12.3	10.2	12.3	10.3
Seed Yield (kg/ha)	530	980	550	1050	540	1070	570	1090	547.5	1047
Straw Yield (t/ha)	3	3.1	3	3.1	3.1	3.2	3.2	3.2	3.1	3.2
Gross cost (Rs./ha)	10420	33845	10335	33705	10500	33905	10456	34102	10427	33889
Gross return (Rs./ha)	57841	75841	58962	76032	59241	78042	59714	77052	58939	76741
Net income (Rs./ha)	47421	41996	48625	42325	48741	44137	49258	42950	48511	42852
B:C ratio	5.6	2.2	5.7	2.2	5.6	2.3	5.7	2.3	5.7	2.3

Table 4: Economics of Value addition in Foxtail millet and its comparison with Ragi

Particulars	2013-14		2014-15		2015-16		2016-17		Average over years	
	Demo	Check (Ragi)	Demo	Check (Ragi)	Demo	Check (Ragi)	Demo	Check (Ragi)	Demo	Check (Ragi)
Grain yield(kg/ha)	530	980	550	1050	540	1070	570	1090	547	1047
Processing efficiency (78%)	413.4	980	429	1050	421.2	1070	444.6	1090	427	1047
Gross cost + processing fee (Rs 5/kg for fox tail millet)	13070	0	13085	0	13200	0	13306	0	13165	0
Gross return @ 70/kg	28938	19600	30030	21000	29484	21400	31122	21800	29893	20950
% increase over Control	47.6	0.0	43.0	0.0	37.8	0.0	42.8	0.0	42.7	0
Additional income (Rs/ha)	9338	0	9030	0	8084	0	9322	0	8943	0

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