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PARTICIPATORY EVALUATION AND DEMONSTRATION OF FINGER MILLET (*Eleusine coracana*) TECHNOLOGIES AND THEIR CHARACTERISTICS IN SOUTH GONDAR ZONE OF NORTH WESTERN ETHIOPIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author MA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author EM managed the analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Participatory demonstration and evaluation of finger millet technologies was conducted at South Gondar Zone of North Western Ethiopia. Besides, recently released variety was used under this demonstration to evaluate its performance with old varieties. It was particularly conducted with in two districts which have differences to some extent in terms of agro ecological and farming system. Four varieties were demonstrated and evaluated at twelve locations and/or sites and evaluated relying on varietal characteristics, farmers' preferences and feedbacks. Farmers' variety or local variety which is a variety available at farmers' hand and cultivated for long time was used as standard check for comparison. Six demonstrations were conducted at the site of Farmers Training Center (FTC) and others were at farmers' own fields. Quadrant system of yield estimation was employed to estimate average and relative yields of each variety. Regarding yield estimation, in general *tesema* variety performed highest comparing with others including the local variety. There were no statistically significant mean yield differences among demonstrated varieties between two districts in which demonstrations taken place. However, the average yield of *tesema* variety was statistically significant from the national average yield recorded by Ethiopian Central Statistical Agency (CSA). All demonstrated and improved varieties had relative yield advantages over local variety. There were also relative yield advantages between improved varieties themselves. Grain color, size, cooking quality, animal feed (palatability), biomass, marketability and disease resistance were identified as the main determinants of variety selection for farmers and different key stakeholders. Relying on this work and preference of varieties, further large scale demonstration need to be conducted to each of the site where demonstrations were undertaken. Variety releasing and development by respective breeders shall to take those variety selection criteria and farmers' preferences in to account so as scale up and out reach the technology.

Keywords: *Biomass; cooking quality; disease resistance; finger millet; grain color; marketability; preference; variety evaluation; yield.*

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1. BACKGROUND AND JUSTIFICATION

Finger millet (*Eleusine coracana)* is a small seeded cereal grown in low rain fall areas of the semi-arid tropics of the world (. It is hardy crop capable of providing reasonable grain yield under circumstances where most crops give negligible yield. Finger millet is staple food crop in drought prone areas of the world and often considered as component of food security strategies. Its annual world production was about 33 million tons: 18.5 million tons (40%) were produced in Africa mainly Eastern and Southern African [1]. Finger millet is one of the neglected and underutilized crops of Africa. It is extensively cultivated in the tropical and sub-tropical regions of Africa and India and is known to save the lives of poor farmers from starvation at times of extreme drought [2].

Millets are extremely important in the African SAT (semi-arid tropics), produced in 18.50 million ha by 28 countries covering 30% of the continent [3]. This is a significant 49% of the global millet area, with a production of 11.36 million tons by 1994. There are nine species which form major sources of energy and protein for about 130 million people in SSA (Sub-Saharan Africa). Among these, only four are produced significantly in Africa; including pearl millet (the most widely grown in 76% area), finger millet (19% area), tef (9%) and fonio (4%). Millet production is distributed differentially among a large number of African countries; largest producers being in West Africa led by Nigeria (41%), Niger (16%), Burkina Faso (7%), Mali (6.4%), Senegal and Sudan (4.8% each). Finger millet is produced mainly in East and Southern Africa [4,5].

Ethiopia is one of the major producers of finger millet in addition to Uganda, India, Nepal and China and it is also native to the highlands of the country [6]. Finger millet is the sixth important cereal crop in Ethiopia both in area coverage and production after maize, tef, sorghum, wheat and barley and its productivity is 22.6 quintals per hectare at the national level. Similarly it is the sixth important crop in Amhara region in terms of area coverage and production, its average productivity is 22.73 quintals per hectare. Finger millet productivity in Amhara region is lower than Oromia Region (23.4 quintals per hectare) but better than SNNP region (16.06 quintals per hectare) [7].

Finger millet plays an important role in both the dietary needs and incomes of many rural households like other African countries due to its richness in fiber, iron and calcium [8]. The yields of finger millet are low in Ethiopia due to different production problems including: shortage of improved varieties, little research emphasis given to the crop, non-adoption of improved technologies, poor attitude to the crop, disease like blast which is the most serious disease, lodging and moisture stress in dry areas, threshing and milling problem are some of most serious production constraints in finger millet production in Ethiopia (Tsehaye and Kebebew, 2002; Degu et al., 2009; Andualem, 2009), [9,10].

In 2019 a new finger millet variety was released namely *Jabi* which is relatively lodging resistant and blast tolerant, and also has a yielding potential of 25-30 and 20-25 qt/ha at research and farmers field respectively. Therefore, demonstration and evaluation of the varieties including the newly release variety is found to be crucial before large scale promotion of the technology in potential areas.

2. OBJECTIVES

- To demonstrate and evaluate improved finger millet technologies to farmers and extension workers
- To assess reactions, feedbacks and preferences of farmers and extension workers
- To create demand on the technology

3. MATERIALS AND METHODS

Two districts were selected and a total of 12 demonstration sites were targeted under this research intervention. A Plot size of 10m x 10m was used for each variety with spacing between rows, 40cm was applied. Four treatments were considered and three of them were improved varieties with improved agronomic practices. The local variety was practiced by farmers' own indigenous knowledge and experiences. Seed rate of 15kg/ha, fertilizer rate of 121kg NPS and 50kg urea per hectare were applied. And full amount of Nitrogen fertilizer was applied by splitting, at tillering stage. Training was given for host farmers, extension workers and agricultural experts to enhance technical capability on production of finger millet technologies. Monitoring and evaluation was carried out jointly with farmers and relevant stake holders. Field day was organized to popularize the technology for different key stack holders.

3.1 Data Collocation and Analysis

Yield and yield related data, farmers and extension workers perceptions on attributes of improved finger millet technologies were collected and analyzed by employing descriptive statistics using a software of Statistical Package for Social Science (SPSS-23).

3.2 General Diagrammatic Description of Methodology

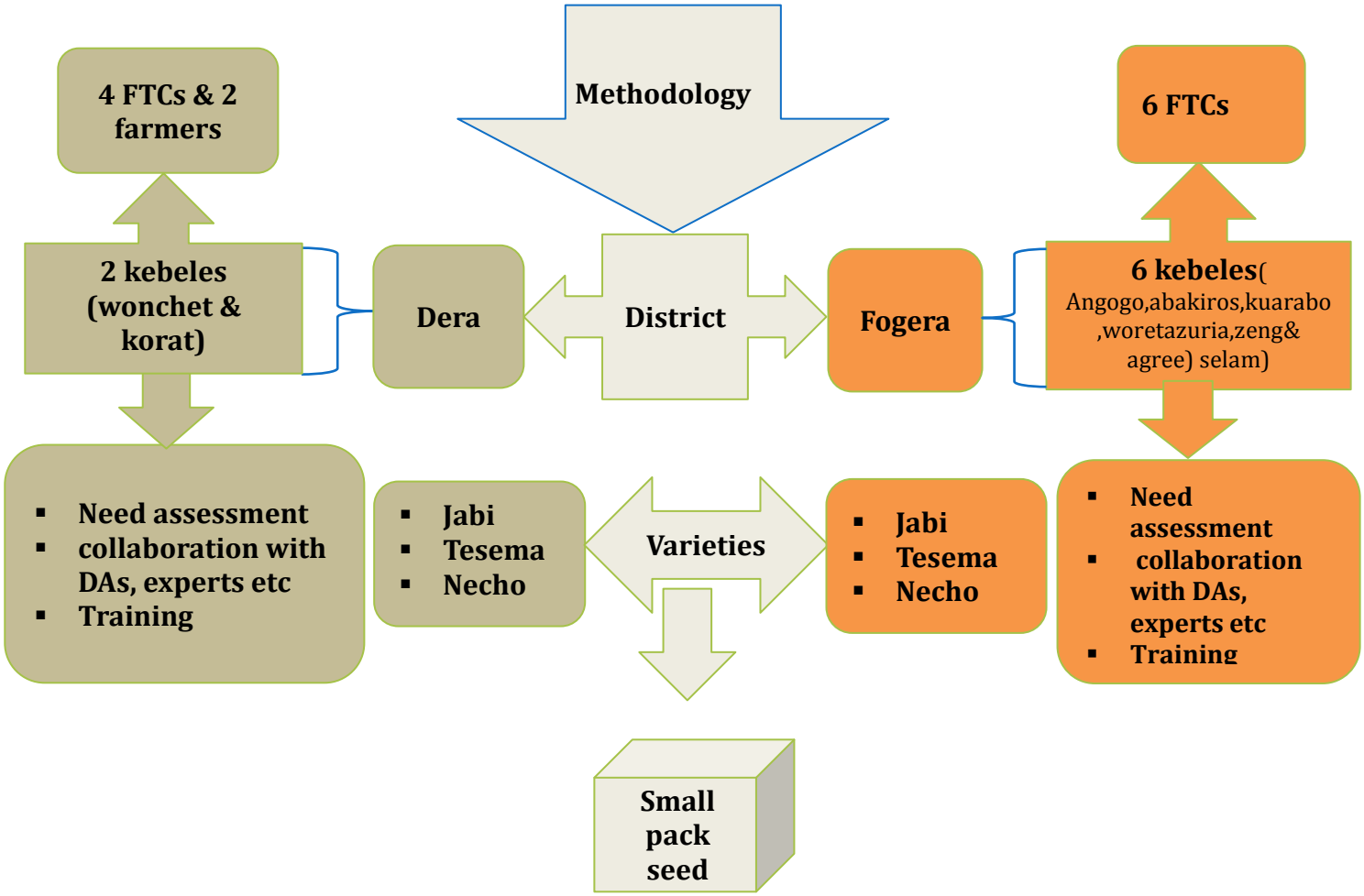

Fig. 1. General diagrammatic description

3. RESULTS AND DISCUSSION

3.1 Characterization of Productivity Performance of Demonstrated Varieties

Productivity performance of demonstrated finger millet varieties were evaluated and characterized across locations by quadrant estimation using randomized techniques. The findings shows that *Tesema* variety was ranked first pertaining to average performance of productivity and followed by *jabi* variety. *Necho* variety was ranked thirdly followed by local variety in the last.

The average productivity of *tesema* variety was recorded higher than the rest of demonstrated varieties including standard check or local variety at two districts. Nevertheless, there were no statically significant yield differences among varieties between the two districts. The average productivity of *jabi* variety was recorded as 23.75 quintals per hectare which is approximately equivalent with 2.4 tons/ha in Dera district. On the other hand, the same variety performed 23.25 quintals per hectare or 2.3 tons/ha in Fogera district. There was no statistically significant mean yield difference on this variety between two districts ($p= 0.934 >\alpha$) at 5% level of significance. The mean yield was 25.6 quintals/ha or close to 2.6 tons/ha for *tesema* variety in Dera district and 27.95 quintals/ha was recorded in Fogera district. However there was no statistically significant mean yield difference between the two locations/districts ($p=0.172 >\alpha$). Average productivities of necho variety were 22.55 quintals per hectare or 2.3 tons/ha and 24.2 quintals per hectare or 2.4 tons/ha in Dera and Fogera districts, respectively. Neverthless, there was no significant mean yield difference between two districts at 5% level of significance ($p=0.624 >\alpha$).

Mean yield of demonstrated varieties were compared with the mean yield recorded nationally. The mean productivity of *tesema* variety was significantly different from the yield recorded by Ethiopian Central Statistical Agency (CSA) almost at 1% level of significance ($p=0.015 <\alpha$). There was also significant mean yield difference between the yield recorded from local variety and the national mean yield documented by CSA approximately at 1% level of significance ($p=0.018<\alpha$). However there were no statistically significant mean yield difference of *jabi* and *necho* with national yield estimation ($p_1=0.709$ and $p_2=584$), respectively.

Table 1. Descriptive statistical values of demonstrated varieties

Productivity of varieties	Range	Min	Max	Mean	S.E	S.D
Productivity of *jabi* variety	8.50	19.50	28.00	23.500	2.188	4.377
Productivity of *tesema* variety	3.90	25.00	28.90	26.775	0.818	1.637
Productivity of *necho* variety	5.70	20.70	26.40	23.375	1.266	2.532
Productivity of local variety	4.50	15.90	20.40	18.125	0.950	1.901

Table 2. T-test for equality of means of productivities among demonstrated varieties

Productivity of varieties	Dera district		Fogera district		T-test	
	Mean	S.D	Mean	S.D	t-value	p-value
Poduc_*jabi* variety (qt)	23.75	6.01	23.25	4.59	0.093	0.934
Produc_*tesema* variety(qt)	25.6	0.84	27.95	1.34	-2.091	0.172
Produc_*necho* variety(qt)	22.55	2.61	24.2	3.11	-0.574	0.624
Produc_local variety (qt)	18.1	0.84	18.15	3.18	-0.021	0.985

****,**, and * statistically significantat 1%,5% and 10%*

Table 3. Analysis of one sample statistics among demonstrated varieties in comparison with the mean productivity recorded by Central Statistical Agency (CSA)

Test value = 22.6					
Description of variables	t	p-value	Mean Difference	95% confidence interval of the difference	
				Lower	Upper
Productivity of *jabi* variety	0.411	0.709	0.90000	-6.066	7.866
Productivity of *tesema* variety	5.098	0.015	4.17500	1.568	6.781
Productivity of *necho* variety	0.612	0.584	0.77500	-3.255	4.805
Productivity of local variety	-4.707	0.018	-4.47500	-7.500	-1.449

3.2 Relative Yield Advantage

The productivity performance of demonstrated or improved varieties was by far higher than those farmers' or local varieties entirely in all demonstration locations. The newly released variety (*Jabi*) was evaluated against with old and improved varieties (*Tesema* and *Necho*) including the local variety. *Jabi* variety performed better than *tesema*, *necho* and local varieties only in one location. Hence,*tesema* and *necho* are best performing varieties in most of the demonstration locations (*kebeles*).

Regarding to the relative yield advantage of demonstrated varieties, it was estimated using the following simplified formula.

Relative yield advantage (%) =

$$\frac{\text{yield of new variety} - \text{yield of standard check}}{\text{Yield of standard check}} \times 100$$

The relative yield advantage of *jabi* variety was estimated to be 14.75% and 12% over *necho* and *tesema*, respectively at Dera (korata site). It had also 60% relative yield advantage over the local variety. All improved varieties had greater yield advantages over farmers' variety or standard check. *Tesema* variety had 69.8%, 42.9 %, 41.7% and 40.1 % yield advantages over local variety at Woreta zuria, korata, hager selam and wonchet *kebeles*, respectively. Necho variety had relative yield advantages of 39.4%, 38.4%29.4 and 10.7% over local variety at Korata, woreta zuria, hager selam and wonchet kebeles, respectively.

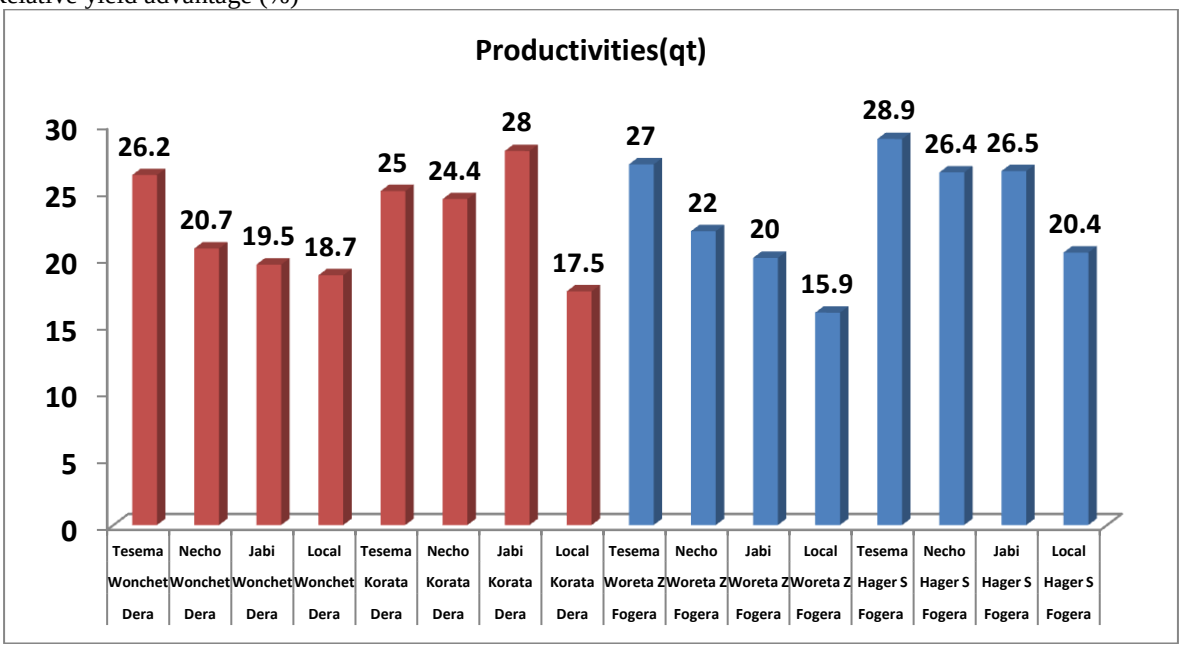

Fig. 2. Productivities across locations within two districts

Table 4. Relative yield advantages among improved varieties and between improved and local varieties

Varieties and their relative yield advantage	Locations (*kebeles*)	*Tesema*	*Necho*	*Jabi*	Local
Tesema>	*Wonchet*	-	26.5	34.36	40.1
(%)	*Korata*	-	2.46	<	42.9
	Woretazuria	-	22.7	35	69.8
	Hager-selam	-	9.5	9.1	41.7
Necho>	*Wonchet*	<	-	6.1	10.7
(%)	*korata*	<	-	<	39.4
	Woretazuria	<	-	10	38.4
	Hager-selam	<	-	<	29.4
Jabi>	*Wonchet*	<	<	-	4.3
(%)	*Korata*	12	14.8	-	60
	Woretazuria	<	<	-	25.8
	Hager selam	<	0.38	-	29.9

***Note**: >denotes greater yield advantage over others, while < less yield advantage over others*

Fig. 3. Grain color and size matters, *tesema* variety at the left and *jabi* variety at the right side

Table 5. Preference and characteristics of varieties at Fogera district

District	Criteria for (1st rank)	Demonstrated varieties			Sites/*kebeles*
		Tesema	***Necho***	***Jabi***	
Fogera	Long finger (yield), high tillering capacity, disease resistant	1st	2nd	3rd	Angogo
	Long finger (yield), high tillering capacity, disease resistant	1st	2nd	3rd	Hager Selam
	Long finger (yield), high tillering capacity, disease resistant	1st	2nd	3rd	Zeng
	Market acceptability, food quality	2nd	1st	3rd	W. Zuria
	Long finger (yield), high tillering capacity, disease resistant	1st	2nd	3rd	Aba kiros
	Not effective due to soil characteristics (black soil), high rain fall				Kuar abo

Table 6. Preference and characteristics of varieties at Dera district

District	Criteria for (1st rank)	Demonstrated varieties			Sites/*Kebeles*
		Tesema	*Necho*	*Jabi*	
Dera	Yield, disease resistant (rust)	3rd	2nd	1st	Korata
	Grain color, food quality, animal feed	2nd	1st	3rd	Wonchet

3.2 Preference, Feed Backs and Perceptions of Farmers and Stakeholders

Farmers, development agents and agricultural experts participated in variety evaluation and selection process. More than 200 farmers, 8 development agents, 2 agricultural experts from districts and 3 agricultural experts from Zonal agricultural offices were participated. Grain color and size, cooking quality, yields, disease resistant (rust) and animal feed

(palatability) and biomass were identified as the matters for farmers and stack holders to evaluate demonstrated varieties along with local variety.

4. CONCLUSION AND RECOMMENDATIONS

All demonstrated improved finger millet technologies along with improved agronomic practices are better than farmers' variety or local check with farmers' practices. Hence, further large scale demonstration need to be conducted and strengthened based on their preferences of the varieties and other characteristics. Breeders need to take in to consideration of farmers' preferences and choices to release and /or improve finger millet technologies or varieties. Research institutions shall to give due emphasis to the crop since it was neglected though it has several benefits and contributing to human nutrition and food security.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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