OPEN ACCES

Middle East Research Journal of Agriculture and Food Science
ISSN: 2789-7729 (Print) & ISSN: 2958-2105 (Online)
Frequency: Bi-Monthly
DOI: 10.36348/merjafs.2023.v03i02.002

KUWAIT SCHOLARS PUBLISHER
Website: http://www.kspublisher.com/
Email: office@kspublisher.com

Pre-Extension Demonstration and Popularization of Improved Sorghum Technologies in Selected Districts of Assosa Zone, Benishangul Gumuz Regional State, Western Ethiopia

Habtamu Alemu[1*], Fekadu Begna[1], Woldegebriel Tesfa Mariam[2]
[1]Ethiopian Institute of Agricultural Research, Assosa Agricultural Research Center,Assosa
[2]Pastoral & Agro-pastoral Research Directorate (PAP), Ethiopian Institute of Agricultural Research, Addis Ababa

Abstract: The activity was carried out in Assosa, Homosha and Bambasi districts of Assosa zone of Benishangul Gumuz regional state as Large-scale demonstration activity in 2019/2020 cropping season. The demonstration was done in eight kebeles by involving 158 male headed and7 Female headed households. The average age of participant farmers in sorghum technology large-scale production and promotion was 30to 45 years with mean farming experience 30- 40 years, which show that they are active age for agricultural production, enabling them to understand new technologies. All participant farmers share between 0.125 and 1 hectares of land to establish cluster form. Totally, 126 hectares of land established for cluster based large-scale demonstration purpose. Then training were given for 165 farmers, 24 Regional, Woreda experts, and DA's involve on all agronomic practice like ploughing, sowing, fertilizer application, weeding, harvesting, threshing and storing were given in an interdisciplinary team from agricultural extension, communication and sorghum breeder. The selected farmers were supported with 61 quintals of urea and 12.6 quintals of improved seed. Thus, field day organized at physiological maturity stage of the crop. Totally, 713 (farmers 630, DA, experts and other stakeholders 83,) were participated on the field day events. Mean grain yield of improved Assosa-1 sorghum variety at demonstrated areas were 26.8 qt.ha^{-1}at Assosa, 29qtha^{-1}at Bambasi, and32qt.ha^{-1}at Homosha(Table 7) respectively. The technological gap in the study area ranges from 6 to 11.2 qt.ha^{-1}, with an average technological yield gap of 8.73qtha^{-1}. The highest technological yield gap 11.2 q.ha^{-1} was observed in Assosa district and the lowest technological gap 6 q.ha^{-1} was observed in Homosha district. Similarly, the extension yield gaps were ranged from 12.8 to 20qt.ha^{-1} with an average yield of 15.6qtha^{-1}. The result further showed that the highest extension gap of 20 q.ha^{-1}was observed at Homosha district and the lowest extension gap was observed at Assosa districts with 12.8qt.ha^{-1}.

Keywords: Large-Scale, Cluster Based, Demonstration, Benishangul Gumuze, Extension Gap, Technology Gap.

Research Paper

***Corresponding Author:**
Habtamu Alemu
Ethiopian Institute of Agricultural Research, Assosa Agricultural Research Center,Assosa

How to cite this paper:
Habtamu Alemu, Fekadu Begna, Woldegebriel TesfaMariam (2023). Pre-Extension Demonstration and Popularization of Improved Sorghum Technologies in Selected Districts of Assosa Zone, Benishangul Gumuz Regional State, Western Ethiopia. *Middle East Res J. Agri Food Sci.*, *3*(2): 19-26.

Article History:
| Submit: 16.07.2023 |
| Accepted: 24.08.2023 |
| Published: 25.08.2023 |

1. INTRODUCTION

Sorghum is an important cereal crop used by humans as stable food grain in many semi-arid and tropical areas of the world (Belay, 2017). According to Gudu, *et al.*, 2013, a major food and nutritional security crop to more than 100 million people in Eastern Horn of Africa. Sorghum in Ethiopia is grown in different agro-ecologies. As it is grown in diverse environment, the productivity of sorghum is constrained by several biotic and abiotic factors. The major constraints in the dry land are drought, striga, low yield and insect (Birhanu. G., 2012).In Africa, Sorghum is processed in to a very wide variety of attractive and nutritious traditional food such as bread, porridges, fermented and none-fermented and forming the foundation of successful food and beverage industries, the leaves and stalks for animal's feeds and as a fuel woods and even as a cash source by selling it for fuel in towns. The average national productivity of the crop is 28.8 quintals per hectare while the average regional productivity of Benishangul Gumuz region is 29.63quintals per hectare (CSA, 2020).

In Ethiopia, Sorghum grain consumed at the house level estimated about 74% from the total of production the remaining being used for sale and seed purposes at local level(Taffesse *et al.*, 2012). The grain is used for preparation of different local staple food products such as leavened bread (*injera*), porridge and local beverages that require specific grain quality characters additionally the Stover, which has uses for animal feed, fuel and construction of fences and shelters, is often valued as highly as grain yield, hence taller varieties are highly favored by farmers (Taye *et al.*, 2016). More than 50 sorghum varieties have been released since the establishment of the sorghum program so far in Ethiopia while the number of farmers growing improved lowland varieties reached 28 percent (Tadesse, T. (n.d.). The limited availability of farmers preferred improved sorghum varieties generation and dissemination resulted in low adoption rates for the improved sorghum technologies (Beshir, B. and Sime, M. (2013).

Even though, sorghum is dominantly grown in the zone, most smallholder farmers produce for long period of time individually on the piece small of lands with low agricultural inputs and use local variety of sorghum that results in low yield, high susceptible to disease and insects, practical problem and shortage of improved variety of sorghum. To improves the economy of smallholder farmers and enhance the adoption of improved sorghum variety, large scale demonstration of improved sorghum technologies has been conducted with collaboration of agricultural extension and communication research process and Sorghum team researcher and selected woreda's agricultural offices.

1.2. Objectives

- To demonstrate the improved sorghum variety with full package technologies in the economically marginalized smallholder farmers,
- To share experience and awareness creation among different stakeholders of cluster based large-scale demonstration approaches of improved sorghum technologies in the region.
- To collect farmers and stakeholders perception on cluster based large-scale demonstration approaches in the study areas.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

Assosa Zone is one of the zones found in Benishangul Gumuze regional state. The zone consists of eight districts which include Ura, Abrahamo, Bambasi, Homosha, Menge, Kurmuk, Sherkole, Oda Bildigilu, Mao and Komo especial districts. Assosa is the capital city of Benishangul Gumuze regional state located in Western part of the Ethiopia around Sudan border. Assosa town is 670 km far from capital city of the country, Addis Ababa. It is located on altitude and longitude of $10^{0}04'N34^{0}31'E/10.067^{0}N34.517^{0}E$, with an elevation of 1570 meters above sea level. Major crops produced in the area include Sorghum, Maize, Finger millet, Teff, Soya bean, Sesame, Groundnut, Rice and horticultural crops. In addition, livestock reared include cattle, goat, sheep, donkey and poultry.

The mean annual rainfall is 1300 ml. The main rainy season of the zone starts in May and lasts until October. The soil type of the district is silt and sandy soil.

2.2. Description of Assosa-1 Sorghum Variety

Assosa-1 sorghum variety is an improved variety released by Assosa Agricultural Research center in 2015 G.C. The variety is released through collection, characterization and purification of land races from western Ethiopia. It is well adapted to wet lowland and intermediate agro-ecologies of the country including Benishangul gumuz, Western Oromia, Southwestern Oromia, and Gambella and newly formed Southwestern Ethiopia regional states. The variety can also adapt to other areas with similar agro-ecologies with the above-mentioned areas. The variety has well identified features with white colored seed, manageable plant height of 2.06m. Assosa-1 variety takes 139 days to flower and 180 days to reach physiological maturity. The variety can give as high as38quintal per hector on research field while it can yield up to 34.5 quintals of produce on farmers' field with farmers practice. The recommended fertilizer rate for the variety is 100kg/ha of NPS and 50 kg/ha of Urea. The variety is adapted to well-drained clay loam soil.

2.3. Site and Farmer's Selection

Now days, cluster based or group approach is more efficient than dealing with individuals, especially in our context where the majority of farmers are smallholders and clear socio-economic differences are existing. It enhances development, popularization, dissemination and adoption of improved agricultural technologies meant for our farmers and it is better to supervise large number of lands and users. Based on this, Assosa, Homosha and Bambasi districts from Assosa zone was purposively selected with the collaboration of district experts and kebele development agents in cluster based approaches for the implementation of the activity based on the potential for sorghum production in2019/2020 cropping season.

Representative kebele's were selected based on their willingness, interest and accessibility for field inspection and evaluation, and ability to implement the activity. Based on these criteria 165 (Male 158, Female 7) farmers were selected to implement the demonstration on 126 hectares of land. In selected kebeles or areas, each farmer contribute 0.25 to 1 hectare of land for demonstration in cluster approaches. Totally, 126 hectares of land established for large-scale demonstration purpose in a cluster form. The training were given for 165 farmers, 24 Regional, Woreda experts, and DA's involve on all agronomic practice like ploughing, sowing, fertilizer application, weeding, harvesting, threshing and storing were given in an interdisciplinary team from agricultural extension, communication and sorghum breeder.

The center provide improved seed of recently released sorghum variety called "Assosa-1"which was given for the target farmers and sown in large-scale demonstration approaches. The selected farmers were support with 61 quintals of inorganic fertilizer called urea and 12.6 quintals of improved Assosa-1 variety seed. The farmers prepared DAP fertilizer by themselves for their allocated land based on recommended fertilizer rate for sorghum production in the area. To keep the optimum plant population per hectare the row to row spacing was 75 cm and between plants was 15 cm respectively.

Table 1: Pre-extension demonstration participants

Woreda /districts	Kebele	Participants	
		Male	**Female**
Assosa	Amba-13	73	-
	Nebar-komoshiga	4	-
	Amba-12	11	-
	Enzi-Shedriya	5	-
	Agusha	4	-
Bambasi	Mender-48	35	2
	Nebar-Keshmando	7	-
Homosha	Shula	19	5
Total		**158**	**7**

Source: field data, 2019/2020

Table 2: Duties and Responsibilities of Stakeholders in sorghum large scale demonstration implementation

• Site and farmer selection with experts and DAs • Prepare manuals and provide training for farmers and DAs Researchers • Establish clustered farms and provide seed on time • Provide technical support to farmers and experts • Organized field days and experience sharing with districts office
Agricultural Experts • Site selection with researcher and arrange cluster and development agents• Participate in training and provide technical support for farmers
• Provide information (number of farmers, land size)
• supervise different weed, disease and insects in the cluster
• collect different preferences in cluster
• Prepare farm land and fertilizer Farmers
• Ploughing the land and sowing on time
• Managing weed, disease, insect and harvest on time
• Threshing and storing on time based on training provides

2.4. Data Collection and Analysis

Both qualitative and quantitative data were collected through field observation and focus group discussion with experts and farmers. The collected data includes amount of input distributed, total farmers, experts participant on training ,and field day, participants in cluster by gender, field day, area coverage in hectares, yield data, income, farmers feedback were collected. Finally, the collected data were analysis by descriptive statistics.

3. RESULT AND DISCUSSION

3.1. Characteristics of Participants

Among participant farmers, 158 male headed and, 7 women headed households are participate. The average age of participant farmers in sorghum technology large-scale production and promotion in both districts was 30to 45 years with mean farming experience 30- 40 years, which show that they were in active age for agricultural production, enabling them to understand new technology. All participants' farmers share between 0.125 and 1 hectares of land to establish cluster form.

3.2. Training for Participant Farmers and Stakeholders

Assosa Agricultural Research Center (AsARC) multidisciplinary team gave participatory training from Agricultural Extension Communication and sorghum breeder researcher for selected participants. The training were given for different stakeholders and farmers on agronomic practice of improved sorghum production techniques and managements, concepts of cluster based large scale demonstrations approach, site clearing, ploughing, sowing, weeding, disease and insect control, harvesting, threshing and storing. Stakeholder's participant on the training was regional, zonal, district experts, development agents (DAs) and farmers. Totally 158 Male and 7Female farmers, 24 Regional, Woreda experts, and Development agents (DA's) attend the practical training.

Table 3: Trainingfor participants and stakeholders

Woreda	Participanta					
	Farmers		Experts		DA's	
	Male	Female	Male	Female	Male	Female
Assosa	97	-	3	-	5	3
Bamabasi	42	2	2	-	4	2
Homosha	19	5	2	-	3	-

Source: field data, 2019/2020

Practical training was given for the participated farmers on the improved sorghum production technologies like site selection, land preparation, planting sorghum seeds by maintaining the spacing between plant and rows, how to add fertilizers, drilling the seeds. After the sorghum plant emergency, the farmers also had orientations of how to thin the seedlings maintain 15cm spacing between plants, when to conduct first weeding, second weeding, when and how to apply second urea fertilizer and how to manage the field overall.

Photo taken during the practical training on the field at Shula Kebele, HomoshaWoreda. June, 2020.

Table 4: Area coverage and input distributed

Woreda /districts	Kebele	Hectare	Min.	Max.	Seed distributed (qt.)
Assosa	Amba-13	18	0.25	0.5	1.8
	Nebar-komoshiga	12	0.5	1	1.2
	Amba-12	5	0.25	0.5	0.5
	Enzi-Shederiya	5	0.25	0.5	0.5
	Agusha	5	0.5	0.75	0.5
Bambasi	Mender-48	50	0.25	0.5	5
	Nebar-Keshmando	7	0.25	0.5	0.7
Homosha	Shula	24	0.5	1	2.4
Total		**126**			**12.6**

Source: field data, 2019/2020

3.3. Field Day Organized

Field day is a method of motivating people to adopt new practices by showing what has already achieved under field condition. In other words, it is to show the performance and profitability of new practices innovation and to convince about the applicability. Thus, field day organized at physiological maturity stage of the crop. Totally, 713 (farmers 630, DA, experts and other stakeholders 83,) were participant on the field day events. During field day participants were sharing their best experience, on the production of sorghum how to implement the demonstration in cluster based approach, how to organized with other farmers to produce sorghum in large scale demonstration, application of fertilizer, how to sowing in row, time of weeding managements and others participant farmers share their experiences to invited farmers and stakeholders. During events, invited experts and farmers expressed an interest to use the technologies by next cropping year to their kebele's and share the experiences to extend this demonstration to their districts. Similarly, the events covered by regional media such as BG TV and Radio, which disseminated knowledge and experience on sorghum technology production for other undressed area.

Table 5: Number of participants on field day events

Woreda	Farmers		Expert, DA's & other stakeholders	
	Male	Female	Male	Female
Assosa	220	85	14	10
Bambasi	120	30	16	12
Homosha	130	45	22	9
Total	470	160	52	31

Source: field data, 2019/2020

Photo taken at the farmers field day. December, 2020.

3.4. Yield Potential and Yield Gap Analysis

Mean grain yield of improved Assosa-1 sorghum variety at demonstrated area Assosa 26.8 q.ha^{-1},Bambasi 29 q.ha^{-1}, Homosha 32 q.ha^{-1}(Table 7) respectively. Due to the use of recommended agronomic practices, with appropriate packages, training and field management, the potential mean yield was higher than farmers' practice. The result indicated that the performance of the Assosa-1 variety better than the farmers' practice. This study clearly demonstrated that farmers' methods of grain yield performance were significantly lower than grain yield obtained through large-scale demonstration. As a result, large-scale demonstrations of enhanced sorghum variety prioritized in the targeted environment of potential sorghum growing area. This, in turn, means that the technologies demonstrated in the individual districts are promising in terms of enhancing production and productivity, and hence contribute to farmers' food security in the area.

Table 6: Yield performance at each demonstrated kebele's 2019/2020 crop year

Name of woreds	Name of kebeles	Area (ha)	Mean yield per- hectare(Qt.)	Yield gain from total hectare(Qt.)
Assosa	Amba-13	18	26	468
	Nebar-komoshiga	12	33	396
	Amba-12	5	22	110
	Enzi-Shederiya	5	24	120
	Agusha	5	29	145
Bambasi	Mender-48	50	33	1650
	Nebar-Keshmando	7	32	224
Homosha	Shula	24	32	768

Source: field data, 2019/2020


Field performance Sorghum crop on Large Scale Demonstration at vegetative and maturity stages respectively.

The grain yield of the large-scale demonstration cluster based across each district was also compared with the potential yields of the variety to estimate the technological and extension yield gap of the technology. The technological gap was found ranges from 6 to 11.2 $qt.ha^{-1}$, with an average technology yield gap of 8.73 $qt.ha^{-1}$. The highest technological yield gap 11.2 $qt.ha^{-1}$was observed in Assosa district and the lowest technological gap 6 $q.ha^{-1}$ was observed in Homosha district. The yield difference may be observed, due to the environment difference, dissimilarity of soil fertility and due to management problem.

Similarly, the extension yield gap was observed from 12.8 to 20 $q.ha^{-1}$ with an average yield of 15.6 $qt.ha^{-1}$ was observed. The result further show that the highest extension gap 20 $q.ha^{-1}$was observed at Homosha district and the lowest extension gap was observed at Assosa districts with 12.8 $qt.ha^{-1}$. The extension gap vary may be due to difference soil fertility, extension service, weather condition, management problem was observed. Therefore, the highest extension gap indicates that there is a strong need to motivate the farmers for adoption of improved technologies over their local practices. Moreover, the use of the latest production technologies with high yielding varieties will subsequently improve the extension gap.

Table 7: Sorghum grain yield gap analysis of Assosa-1 variety

Woreda	Area (ha)	potential yield ($q.ha^{-1}$)	Demonstration yield ($q.ha^{-1}$)	Farmers practice yield ($q.ha^{-1}$)	Technology gap yield ($q.ha^{-1}$)	Extension gap ($q.ha^{-1}$)
Assosa	45	38	26.8	14	11.2	12.8
Bambasi	57	38	29	15	9	14
Homosha	24	38	32	12	6	20
Mean	42	38	29.26	13.66	8.73	15.6

Source: Field data, 2019/2020

After the sorghum crop reaches the physiological maturity, the farmers have harvested the crop and store on the field where the harvested heads can get sun light for few days or weeks. This enables the crop to dry to the required level or to avoided unwanted moisture which can highly affect the quality of the harvested sorghum seed. The farmers prepare the storage from locally available materials which enables sufficient aeration and avoid the contact with soil and other inert materials.

The stored sorghum heads after harvest until threshing

3.5. Farmers Feedback during Field Day Events

Farmer's suggestion combine issues concerned to the technology specific to the merits of the demonstrated of sorghum "Assosa-1" variety. The feedback was collected from men and women headed households from the participants. In the demonstration, area due to the unknown nature of local variety and factor of agro-ecology and lack of improved technology for long time the communities are use traditional practice and each farmers produce sorghum individually

On the piece of land in different area. This resulted in low product and productivity of sorghum for long time. All participant farmers were very interested on this improved Assosa-1 variety and organized in cluster based approach. Crop technology on cluster based on approach has given a good impact over the farming community as they were encouraged by recommended technology applied in the demonstration fields. Generally farmers describes that Assosa -1 sorghum variety stem strength high resistant to lodging, seed size and white in color good for making "injera", disease resistant, stalk is used as fuel, has ecologically and economic importance and used for food and income source and attractive for market price food security. The other point's farmers discussed during events, the problem of sustainability of cluster based approaches for the future and unavailability of improved seed and due to large-scale production in the area is lack of machinery technologies that ease to the burden and difficulty to harvest and threshing (labor intensive).Beside, clustering and group approach were enhanced the working culture of farmers. Good awareness and confidence were created among different stakeholders about Assosa-1 variety.

4. CONCLUSIONS AND RECOMMENDATIONS

This study was conducted as large-scale demonstration in cluster based approaches of sorghum Assosa-1 variety to improve sorghum technology in selected districts of Assosa Zone of Benishangul gumuz region to create more demand on sorghum technology, strengthening linkage between stakeholders, capacity building and enhancing technology diffusion in the production and productivity system in the area. Thus, the demonstration result confirmed that improved sorghum variety with its technology packages provided better advantage in both product and productivity. The researcher strongly recommends that Assosa-1 sorghum variety with its full technology packages should further scale out to other similar agro ecologies. Seed producing and marketing cooperatives need to established and play great role to make technology diffusion and exchange system viable to satisfy emerging technology demands. From the demonstration interventions, it can be concluded that, there are wider possibilities to greatly support the government efforts toward enhancing food security and livelihood of poor households. At the end cluster based large- scale demonstration is a successful tool in enhancing the productivity through improving and change the knowledge and attitude of farmer's in- group approaches at the same time and environment of the participants. Therefore, based on this result the researchers recommend farmers and other development practitioner to focus more on large-scale demonstration (LSD) approaches.

5. ACKNOWLEDGMENT

The Authors want to extend their gratitude toward all selected farmers for the demonstration activity, Woreda agricultural office staffs, development agents, farmers, administration bodies, Assosa agricultural research center, (crop research process and agricultural extension and communication research process) and pastoral and agro-pastoral research directorate for financial support for the implementation of activity.

REFERENCE

- Beshir, B., & Sime, M. (2013) Understanding Farmers' Improved Sorghum Variety Selection Criteria: The Case of Farmer Research Group Approach in Habro District, West Hararghe. *Research Report 102*. http://www.eiar.gov.et

- Central Statistical Agency (CSA) (2020) The Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural Sample Survey. Report on Area and Production of Crops. Statistical Bulletin. Addis Abeba, Ethiopia.
- Gebreyes, B. G. (2017). Determining the physicochemical compositions of recently improved and released sorghum varieties of Ethiopia. *Journal of Food and Nutrition Sciences*, *5*(5-1), 1-5.
- Gudu, S., Ouma, E. O., Onkware, A. O., Too, E. J., Were, B. A., Ochuodho, J. O., ... & Maina, S. M. (2013, February). Preliminary participatory on-farm sorghum variety selection for tolerance to drought, soil acidity and striga in Western Kenya. In *Maina Moi University, Kenya First Bio-Innovate Regional Scientific Conference United Nations Conference Centre (UNCC-ECA) Addis Ababa, Ethiopia. DOI* (Vol. 10).
- Mindaye, T. T., Mace, E. S., Godwin, I. D., & Jordan, D. R. (2016). Heterosis in locally adapted sorghum genotypes and potential of hybrids for increased productivity in contrasting environments in Ethiopia. *The Crop Journal*, *4*(6), 479-489. ISSN 2214-5141.
- Tadesse, T. (n.d.). Sorghum Research. http://www.eiar.gov.et/marc/index.php/anrl-research/crop-research
- Taffesse, A. S., Dorosh, P., & Asrat, S. (2012). Crop production in Ethiopia: Regional patterns and trends. International Food Policy Research Institute (IFPRI).
- Tesfahunegn, G. B. (2012). Effect of tillage and fertilizer practices on sorghum production in Abergelle area, Northern Ethiopia. *Momona Ethiopian Journal of Science*, *4*(2), 52-69. *https://doi.org/10.4314/mejs.v4i2.80116*