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A Cluster Farming of Sorghum Technologies in Benishangul-Gumuz Regional State: A Promising Approach

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Abstract
A large-scale demonstration of improved sorghum technologies was conducted using cluster farm approach to enhance commercialization and adoption of sorghum technologies. In 2020 and 2021 cropping seasons, 17 kebeles were selected from Assosa and Bambasi districts purposely based on the potential of sorghum cultivation and consent of the farmers. One thousand one hundred forty-three farm family participated among whom 15.5% were headed by female. Average yield of improved Assosa-1 sorghum variety was 2,876.0 kg/ha while that of the farmers' practice was 1,213 kg/ha. The benefit cost ratio accounted 1.03 birr for improved practice. The sensitivity analysis showed the profitability of sorghum production is more responsive to change in yield as well increase in variable cost other variables remain constant. Men and women farmers preferred Assosa-1 sorghum variety because of higher yield, white seed color, ability tolerant to striga and moderately resistance to leaf blight and anthracnose diseases. Baking quality was the trait preferred by women farmers. Women said Assosa-1 sorghum variety flour had better water holding capacity and it is better for injera making than the local one. Farmers' preferred local variety because of biomass for plant height used for fire wood, fencing and livestock feed. Large-scale cluster farm approach encourages production for market and strengthens habit of team work. The method enhances stakeholder integration a mechanism help for bringing pluralistic agricultural extension system. Low soil fertility, high fertilizer price, lack of tractor for ploughing, small plot of land allocation followed by lack of thresher were the major constraints to sorghum production. Assosa-1 sorghum variety production using cluster farm approach is profitable enterprise for small holder farmers in the area. Also, a cluster farming approach strengthens linkage between farmers and research, the regional state bureau of agriculture, university, non-government organization, projects and farmers-union. So focus on improvement of production constraints to augment production in the area is needed through finance on fertilizer, machinery and equipment; further scale-up of the approach and releasing of variety which meets farmers need for biomass, color, baking quality, striga and diseases resistance are recommended in the area.
Keywords: Large-scale demonstration, Sorghum, Cluster-farm, Variety, Traits, Benefit-cost ratio, Constraints
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1. Introduction

Sorghum is grown in highly diverse environments, which can be broadly classified into three major agro-ecologies; highland areas >1900 m, intermediate areas between 1600 and 1900 m and lowlands areas <1600 m above sea level, characterized by distinct edaphic and climatic conditions (Kumar et al., 2011). Sorghum is a staple crop in drought prone areas; -as it is drought tolerant worth promoting in view of effects of climate change and brings out large percentage of the people from poverty. Sorghum grows in a wide range ecology zone most importantly in the moisture stressed parts where other crops cannot survive and food insecurity is rampant (Asfaw, 2007).

According to (CSA, 2021), in Ethiopia sorghum was cultivated on 1,679,277.06-hectare land accounting for 13.22% (45,173,50.218 ton) of grain production with average productivity of 2.69 ton per hectare and it was ranked fourth next to teff, maize and wheat in area. People in Ethiopia use sorghum grain for food; the stalk for livestock feed, for simple construction as well as fire wood consumption.

Sorghum productivity in Ethiopia is constrained by different biotic and abiotic factors mainly drought and Striga (a parasitic weed) in the lowland and biotic stress in the highland and intermediate environments (Taye et al., 2016). With subsistence agriculture practiced by majority smallholder farmers, yield gaps are high and poor soils, amongst other constraints adding to the difficulties for sustainable farming and incomes (Macauley and Ramadjita, 2015).

Small and scattered land is a challenge for yield loss and gaps. Without yield gap assessment coupled with appropriate socio-economic analysis of constraints to improved productivity, policy makers and researchers will find it difficult to accurately assess future food security and land use change. This in turn may lead to policy development and research prioritization that are not well-informed, especially in developing regions such as Sub-Saharan Africa where current information is sparse (Van Ittersum et al., 2013). In order to achieve high productivity and to overcome constraints, cluster farming approach is appropriate tool to enhance sorghum productivity in the region.

Cluster farming consist of group of farm producers coming together to cultivate farmland, working together in farm activities, sell in bulk so as to reduce cost of transportation and other transaction costs (Montiflor et al., 2008). In cluster farming, many small-holder farmers usually referred to as satellites are attached to a hub farm to form a cluster and emerge as entrepreneurial, and revenues and the production costs are shared among members of the groups (Karki et al., 2021). Agro-clusters can stimulate technology adoption (Joffre et al., 2019, 2020) because they increase the use of improved production practices; they may also affect agricultural productivity (Wardhana et al., 2017). Cluster farming have shown to increase profits of smallholder farmers through bulk purchase of inputs and sales of output, as well as easy access to agricultural information and new agricultural techniques and innovations which is a hedge compared to non-cluster farming (Montiflor et al., 2008).

The absence of extension services, inadequate and bottlenecks in accessing credit, poor infrastructure, and access to markets among others are hindrances non-cluster farmers faced that can be overcome by providing extension agents, input providers and market access through cluster farming (Oakeshott, 2014). A growing variety of public and private rural advisory services are available today, leading to increasingly “pluralistic service systems” where advisory services are provided by different actors and funded from different sources (Wongtschowski et al., 2013). Pluralistic services systems have the potential to overcome constraints related to funding, staffing and expertise, and to make advisory services more demand-driven. This is generally regarded as an important step forwards, away from reliance on monolithic, mostly state-led service systems (Bitzer et al., 2016).

Therefore, in this practice cluster farming is the method used to enhance sorghum productivity, increase profitability, increase in inputs delivery, acquire information and services, share experience and enhance the social cohesion of working together. It is likely to address the limitations of efficiency and effectiveness of the agricultural extension and advisory services and to contribute for the rural development programs of Ethiopia through enhancing comprehensive and inclusive pluralistic agricultural extension and advisory services policy.

The overall purpose of this activity is to show cluster farming as a promising approach for demonstrating improved sorghum varieties, to assess the benefit of cluster farming approach for demonstrating improved sorghum varieties in large scale, to assess the yield performance of the demonstrated varieties using cluster based demonstration approach, to assess the profitability of demonstrated varieties using cluster based demonstration approach, to analyze the sorghum production constraints in the selected districts.

2. Material and Methods

2.1. The study area

The activity was conducted in Assosa zone (Bambasi and Assosa districts). Assosa zone is located in Benishangul-Gumuz regional state. It consists of seven districts (Assosa, Bambasi, Homosha, Menge, Sherkole, Kurmuk and Bildigilu). Assosa, the capital is 680 km west of Addis Ababa. The total population of Assosa zone estimated to be 479,567 (ESS, 2022). Farmers in the area practice mixed crop-livestock production system. Maize, sorghum, soybean, teff and groundnut are mainly produced by farmers. Cattle, sheep, goat and poultry are mostly reared in the area.

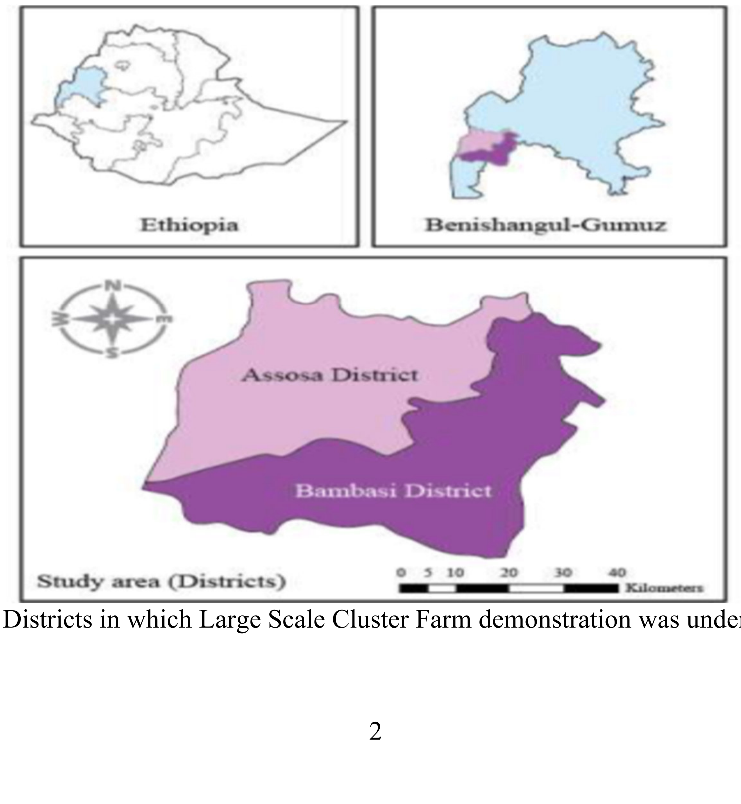

Fig1. Districts in which Large Scale Cluster Farm demonstration was under taken

2.2. Sample size and sampling techniques

In this study a multi-stage sampling technique was applied. At the first stage, Bambasi and Assosa districts were selected purposely based on the potential for sorghum production. At second stage, a total of 17 kebeles in the districts were selected purposely according to the proportion of sorghum cultivation within the same agro ecology. The host farmers were selected based on willingness to conduct the activity, accessibility for supervision and having minimum of 0.25 hectare (ha) land to be clustered in collaboration with researchers', development agents and agricultural experts. Female headed household were considered during selection.

2.3. Approach

2.3.1. Multi-disciplinary team approach

At the initial stage of the activity planning meeting was conducted with multi-disciplinary research team of Assosa Agricultural Research Centre and the Region Agricultural Bureau as well as with farmers Union to fill the research and extension gap in the area. These public organizations have been discussed on the demonstration of large-scale cluster farm approach and new sorghum technologies and practices, on the provision of training for farmers, development agents as well as for agricultural experts; the facilitation of agricultural input like improved seed and fertilizers, the seed quality assurance , facilitation of market for the produce, facilitating experience sharing for the farmers and agricultural experts to gain insight and knowledge about cluster farm approach and new technology of sorghum varieties and practices as well.

2.3.2. Training

For effective implementation of the demonstration, training was organized for farmers, development agents (DAs) and experts on agronomic practice, crop protection and post-harvest handling. The training was given by multidisciplinary team of researchers of Assosa Agricultural Research Center. The training was provided via lecture and practical aided by audio recording and video capturing through the region mass media to reach for the wider community and to alleviate the COVD-19 impact on production and productivity.

2.3.3. Field days

In the experiment conducted actors are engaged to strengthen the research and extension system through the implementation of farmers' field day and exchange visits to create awareness as well as demand on the technology and demonstration approach and for further scale up of the information transformation .The message was conveyed through Benesguangul-Gumuz mass media to size the information for the community. Also total of 200 brochures which explain sorghum production and management practices were distributed. The Stakeholder integration in the cluster farming has been identified as a mechanism for strengthening and bringing pluralistic agricultural extension system in which different actors are work together. Stakeholder (s) may be an individual or group influenced by and may have an ability to significantly impact directly or indirectly the topic of interest (Glicken, 2000).

2.4. Materials and Management

Required amount of Assosa-1 sorghum variety seed was supplied at a seed rate of 10 kilogram per hectare (kg/ha) and was planted at spacing of 75 centimeters between rows and 15 centimeters between plants. 100 kg/ha NPS fertilizer was applied at sowing time and 50 kilogram kg/ha urea fertilizer was applied at knee development stage.

2.5. Data collection

Quantitative and qualitative data were collected. Quantitative data such as volume of seed distributed, number farmers benefited, the number of site addressed, number of field day and training participants as well as yield data were measured. Qualitative data such as farmers variety and traits preference, constraints, farmers perception and stakeholders engagement were recorded using data collection sheet, focus group discussion, interview and observation.

2.6. Data analysis

2.6.1. Preference ranking

Through focus group discussion sorghum producer farmers were asked to list important traits of sorghum verities to be selected. Based on the farmers criteria pair wise matrix ranking was conducted to identify the most important traits. Based on the selected traits the verities were ranked across and weigh score was calculated. A ranking was done on a rating sheet indicating the criteria.

2.6.2. Yield gap analysis

The analysis of yield gaps is important to identify the potential sources of gains in agricultural yields and to develop solutions to reduce these gaps. These solutions can increase crop yields and optimize the use of applied agricultural inputs (Chapagain and Good, 2015). Yield gap analysis and technology index given by (Samui et al., 2000) was calculated using the following formula,

$$\text{Technology gap} = \text{potential yield} - \text{demonestration yield} \quad \ldots\ldots(1)$$

$$\text{Extension gap} = \text{demonestration yield} - \text{farmers practice yield} \quad \ldots\ldots(2)$$

$$\text{Technology index} = \frac{\text{potential yield} - \text{demonestration yield}}{\text{potential yield}} \text{x100} \quad (3)$$

2.6.3. Cost -benefit analysis

Cost-Benefit Analysis (CBA) is an analytical tool for judging the economic advantages or disadvantages of an investment decision by assessing its costs and benefits in order to assess the welfare change attributable to it (Catalano et al., 2014).The broad purpose of CBA is to help social decision-making and to increase social value or, more technically, to improve allocative efficiency (Boardman et al., 2018). For the calculation the following formulas was applied to conduct benefit cost ratio.

$$\text{Benefit cost ratio} = \frac{\text{Total retutn(TR)}}{\text{Total cost(TC)}}$$

Where TR= yield x price per unit, TC= total variable cost +fixed cost.

2.6.4. Break-even analysis

Break-even analysis determines the "break-even point", at which operations neither make money nor lose money (Paek, 2000). Break-even analysis is performed to determine the value of a variable or parameter of a project or alternative that makes two elements equal, for example, the sales volume that will equate revenues and costs (Blank and Tarquin, 2012). The break-even point, there is no gain or loss; hence costs are equal to revenues. And the following formula was used to employ the calculation.

$$\text{Break} - \text{even sale price} = \frac{\text{Average total cost}}{\text{average totla yield}} \quad (4)$$

$$\text{Break even yield} = \frac{\text{Average total cost}}{\text{average price}} \quad (5)$$

2.6.5. Sensitivity analysis

Sensitivity analysis is a technique for investigating the impact of changes in project variables on the base-case (most probable outcome scenario). Typically, only adverse changes are considered in sensitivity analysis. The purpose of sensitivity analysis is: 1, to help identify the key variables which influence the project cost and benefit streams 2, to investigate the consequences of likely adverse changes in these key variables 3, to assess whether project decisions are likely to be affected by such changes 4, to identify actions that could mitigate possible adverse effects on the project (Iloiu and Csiminga, 2009) and was calculated using spread sheet.

2.6.6. Constraint analysis

Major problem was identified in sorghum production and Rank Based Quotient (RBQ) of constraints was calculated based on the ranking done by 30 respondents. Rank Based Quotient was calculated using the following formula given by (Sabarathnam, 1996).

$$(\text{RBQ}) = \sum \frac{\text{fi}(\text{n}+1) - \text{ith}}{\text{N} \times \text{n}} \text{x100} \quad (6)$$

Where
i- is ith rank
fi- Number of respondents giving the particular point at ith rank
N- Total number of respondents
n- Number of ranked items

3. Result and discussion

3.1. Training participants of sorghum cluster farming approach

A total of 842 farmers (686 men and 156 women), 47 development agents and 19 agricultural experts were trained in 2020 and 2021 cropping season as shown in the Table1. Farmers revealed that the training has been made positive impact on sorghum production and management practices and enables them to share information and exchange ideas. Training plays an important role in transfer of new agricultural technology among farming community.

Table 1: Trainees on Sorghum Large-scale Cluster Farm Demonstration (LSCD), 2020-2021).

Participant	**2020**		**2021**		Total
	Men	Women	Men	Women	
Farmers	500	86	186	70	842
Development agents	23	8	9	7	47
Agricultural experts	8	1	9	1	19

Source: LSCD hosted participants

3.2. Beneficiaries

The demonstration was conducted on 26 clusters of 644.9 hectare (ha) land covered in 17 kebeles. From Large-scale cluster farm demonstration 966 men and 177 women farmers were benefited with a total gain of 17, 85860 kg production as presented in Table 2.

Table 2: Demonstration beneficiaries, 2020 -2021

Item	Assosa			Bambasi			Total
	2020	2021	Sub-total	2020	2021	Sub-total	
Men recipients	195.0	77.0	272.0	337.0	357.0	694.0	966.0
Women recipients	26.0	44.0	70.0	58.0	49.0	107.0	177.0
Area coverage (ha)	100.5	40.4	140.9	241.5	262.5	504.0	644.9
Cluster number	6.0	3.0	9.0	8.0	9.0	17.0	26.0
Seed disperse (kg)	1010.0	450.0	1460.0	2420.0	2630	5050.0	6510.0
Production (kg)	2,76380.0	1,23480.0	3,99850.0	6,64130.0	7,21880.0	13,86010.0	1,785860.0

Source: LSCD fields

3.3. Benefits of cluster farming approach and mechanism of dissemination

A total of 2,222 farmers, 138 Das and experts, 126 officials and different stake holders from Non-governmental organization, different projects and universities, were attended. Hosted farmers said ‘’it is the first time to see such remarkable activity in our farms and we perceive the difference between improved and local varieties’’ as well as the benefit of cluster farming. This indicates one of the characteristics of improved varieties that affect farmers' technological adoption behaviors. Improved varieties are technically superior if they produce higher yield to traditional varieties (Hailegebrial and Adane, 2018). Also farmers perceived the approach encouraging habit of team work, controlling different insects, pests and diseases; helps for exchanging ideas, improving cultural practices, strengthening joint problem solving, improving knowledge, encourage planting improved varieties, surplus production for market and home consumption, facilitating market access as well as raising the capacity to deal with traders selling at reasonable price. Field days encourage the learning of cluster farming and its expansion because of the different opinions gathered from more people, non-governmental organization and projects that help expand the cluster approach in the area. Also the events improve the relationship among farmers, extension agents and different stake holders. Thus after the intervention through field days universities, different projects and Non-governmental organization facilitate the experience sharing for the farmers and agricultural experts to gain insight and knowledge about cluster farm approach and new technology of sorghum varieties and practices, demonstrate the approach in different woreda of the region as well purchase the produced seed for further scaling up. This result indicates that the system encourage linkage among research and extension in the region.

Table 3: Participants of the field day, 2020 -2021

participants	2020		2021			Total
	Men	Women	Men	Women	Youth	
Farmers	700	200	942	202	178	2,222
Officials	75	2	47	2		126
DAs and experts	40	10	71	17		138

Source: Author noting from LSCD attended

3.4. Yield performance

As shown in the Table 4 Assosa-1 sorghum variety gave higher yield compared to the local check in Assosa and Bambasi districts for the consecutive demonstration years. Average yield was recorded 2876 kilogram per hectare (kg/ha) having 57.82 percent (%) yield advantage over the local variety.

Table 4: Yield performance of Asosa-1 sorghum variety, 2020-2021

District	Varieties	Productivity by year (kg/ha)		Combined Mean	SD
		2020	2021		
Assosa	Assosa-1	2750.0	2949.0	2850.0	140.7
	local	1700.0	1600.0	1650.0	70.7
Bambasi	Assosa-1	2750.0	3054.0	2902.0	215.0
	Local	1700.0	1650.0	1675.0	35.3
Total	Assosa-1	2750.0	3001.5	2876.0	151.4
	Local	1700.0	1625.0	1663.0	47.9

Source: LSCD fields

As shown in the Table 5 there is significant difference among the varieties. The mean yield of Assosa -1 was significantly difference from the local check. Assosa-1 gave a significant yield advantage of 1213.0 kg per hectare. This result shows Assosa-1 is more preferable than the local check.

Table.5: t-test of yield difference among the varieties

Variety	t	df	Sig(two tailed)	Mean difference
Assosa-1	4.854	25	.000	1213.0

Source: LSCD fields

3.5. Yield gap

As indicated in Table 6 yield gaps was found 924 kg/ha that indicates an option to increase the yield by improving soil fertility and management practices with recommended agronomic package. The extension gap was calculated and found 1213 kg/ha shows focus on the application of appropriate extension methods and practices and familiarize farmers with newly released sorghum varieties.

Table 6: Yield gap analysis of Assosa-1 sorghum variety

District	**Potential yield**	**Demonstration yield**	**Local check yield**	**Technology gap**	**Extension gap**	**Technology Index (%**
Assosa	3800.0	2850.0	1650.0	950.0	1200.0	25.0
Bambasi	3800.0	2902.0	1675.0	898.0	1227.0	23.6
Total mean	3800.0	2876.0	1663.0	924.0	1213.0	24.3

Source: LSCD fields

3.6. Trait and variety preference

Farmers main preferred traits were higher grain yield, white seed color, resistance to striga, resistance to diseases, biomass and baking quality. As shown in the Table 7 both men and women farmers preferred Assosa-1 sorghum variety because of higher yield, white seed color, ability tolerant to striga and moderately resistance to leaf blight and anthracnose diseases. Baking quality was the trait preferred by women farmers. Women said Assosa-1 sorghum variety flour had better water holding capacity and it is better for injera making than the local one. Farmers' preferred local variety because of its biomass such as plant height used for fire wood, fencing and livestock feed.

Table 7: Sorghum varieties based on selected traits. Rank 1= poor, 2= medium =3 =good

	Men			**Women**		
variety traits	Trait weight	Assosa-1	Local	Trait weight	Assosa-1	local
Grain yield	0.33	0.99	0.33	0.31	0.91	0.31
White seed color	0.27	0.81	0.27	0.25	0.75	0.25
Striga resistance	0.20	0.40	0.20	0.19	0.38	0.19
Disease resistance	0.13	0.26	0.13	0.13	0.26	0.13
Biomass	0.07	0.14	0.21	0.06	0.12	0.18
Baking quality	0.00	-	-	0.06	0.18	0.06
Total score		2. 6	1. 14		2. 56	1. 12

Source: Field data

3.7. Cost of sorghum production

Sorghum producer farmers spend mean of 28,306.35 ETB per hectare (ETB/ha). The higher cost was associated with the variable cost such as materials and labour cost. Materials such as seed, fertilizer and packaging accounted mean cost 3,358.20 ETB. Labour contains land clearing; ploughing, row planting, hoeing, weeding, harvesting, threshing and transporting accounted mean cost 22,948.15 ETB. This indicates, sorghum production incurred 87% labour cost compared to materials cost which was 13% of variable cost. Land was considered as fixed asset.

Table 8: Cost of sorghum production (ETB/ha) 2020-2021

Input	**Assosa**		**Bambasi**		**Total**	
Input cost	**Mean cost**	**% cost**	**Mean cost**	**% cost**	**Total mean**	**Total %**
Seed	258	8	258	7. 67	258	7. 68
Fertilizer	2525	75	2525	75. 07	2525	75. 19
Packaging	570	17	580. 40	17. 26	575. 20	17. 13
Sub total	**3353**	**12. 86**	**3363. 40**	**12. 67**	**3358. 20**	**13**
Labour cost						
Land clearing	1500	6. 61	1500	6. 47	1500	6. 54
Ploughing	3500	15. 41	3800	16. 39	3650	15. 91
Row planting	2000	8. 81	2000	8. 63	2000	8. 72
Hoeing	4000	17. 61	4000	17. 25	4000	17. 43
Weeding	4000	17. 61	4000	17. 25	4000	17. 43
Harvesting	3000	13. 21	3000	12. 94	3000	13. 07
Threshing	3000	13. 21	3000	12. 94	3000	13. 07
Transporting	1710	7. 53	1886. 30	8. 14	1798. 15	7. 84
Sub total	**22710**	**87. 14**	**23186. 3**	**87. 33**	**22948. 15**	**87**
Variable cost	26,063	100	26,549. 70	100	26,306. 35	100
Fixed cost	2,000		2,000		2,000	
Total cost	28,063		28,549. 70		28,306. 35	

Source: Author computation from LSCD fields

3.8. Financial return analysis

As shown in Table 9, farmers obtained mean net profit of 29,213.65ETB/ha. The benefit cost ratio accounted 1.03 birr for both Assosa and Bambasi districts implies for every birr invested the farmer gain benefit of 1.03 birr. This shows sorghum production by large-scale cluster farm is a profitable enterprise for smallholder farmers in Assosa and Bambasi districts. Assosa-1 improved sorghum variety through large scale cluster farming gave higher yield than the local variety. It has been recorded 57.82 percent yield advantage over the local variety. Also farmers' financial return from cluster farming of the improved sorghum technology has been increased.

Table 9: Financial benefit of Assosa-1 sorghum production (ETB/ha) 2020-2021

Variable	**Assosa**	**Bambasi**	**Mean**
Mean yield kg/ha	2,850	2,902	2,876
Fixed cost	2,000	2,000	2,000
Variable cost	26,063	26,549. 70	26,306. 35
Total cost	28,063	28,549. 70	28,306. 35
Price	20	20	20
Revenue	57,000	58,040	57,520
Gross margin	30,937	31,490. 30	31,213. 65
Net profit	28,937	29,490. 30	29,213. 65
Net profit margin (%)	50. 77	50. 81	50. 79
Benefit cost ratio	1. 03	1. 03	1. 03

Source: Author computation from LSCD fields

3.9. Break even analysis

Break-even analysis was conducted to know the point at which total cost equals total revenue. A break-even point analysis is used to determine the number of units or price of units needed to cover total cost. The result showed the break-even minimum sales price to cover total cost was 9.8 ETB/kg for both Assosa and Bambasi districts. The break even yield to cover total cost was 1403.2 kg and 1427.5 kg for Assosa and Bambasi districts respectively.

3.10. One-way sensitivity analysis

To determine the effect of yield, variable and fixed cost on the profitability of sorghum production, one-way sensitivity analysis was conducted. As indicated in the Table 10, 25% worse in yield would result 49.22% decrease in profit. As well as 25% worse variable cost and fixed cost would result 22.51% and 1.71% decrease in profit respectively. Thus, the profitability of sorghum is more sensitive to a reduction in yield and increase variable cost other variables remain constant.

Table 10: Sensitivity of Assosa-1sorghum production profit (ETB)

Variable	Original value	Original profit	Assumption 25% worse		
			New value	New Profit	Change %
Mean yield kg/ha	2876.00	29,213.65	2,157.00	14,833.65	49.22
Mean Variable cost ETB	26,306.35		32,882.94	22,637.06	22.51
Fixed cost ETB	2000.00		2500.00	28,713.65	1.71

Source: Author computation from LSCD fields

3.11. Sorghum production constraints

Focus group discussion was conducted with men and women farmers. Preference ranking method was used to identify sorghum production constraints as shown in the Table 11. Based on the ranks given, rank based quotients were calculated and production constraints were documented. The analysis of the data reveled low soil fertility, high fertilizer price, lack of tractor for ploughing, small plot of land allocation followed by lack of thresher were the major constraints to sorghum production. Understanding and addressing limitation to production in the region could have positive impact on production and productivity improvement.

Table 11: Rank based sorghum production constraints

Constraints	**Ranks**					**RBQ**	**Rank**
	1	**2**	**3**	**4**	**5**		
Low soil fertility	21	5	4	0	0	98	1
High fertilizer price	19	5	6	0	0	88.67	2
Small plot of land	17	4	3	3	3	79.33	4
Lack of tractor	18	5	6	1	0	81.33	3
Lack of thresher	15	5	4	4	2	78	5

Source: Author computation from LSCD fields

4. Conclusion and Recommendation

Cluster farming approach have been encouraging habit of team work, controlling different insects, pests and diseases; helps for exchanging ideas, improving cultural practices, strengthening joint problem solving, improving knowledge, encourage planting improved sorghum varieties, surplus production for market and home consumption, facilitating market access as well as raising the capacity to deal with traders selling at reasonable price. Strengthen the relation between farmers, extension and researchers as well as improve linkage among the institution. Cluster farming sites have been used as a learning site and served as seed source for farmers, institutions and for different non-governmental organization involved on agricultural activities in the area. The yield gap result shows the farmer need to use improved sorghum varieties with recommended practice and cluster farm approach to increase production and productivity. Also farmers' grasped financial return from cluster farming of the improved sorghum technology. Assosa-1 sorghum varieties were most preferred because of higher yield, seed color for market, tolerant to striga and moderately resistance diseases as well as better baking quality for injera making. Local varieties were preferred because of plant height advantage. The varietal preference result indicates women and men trait preference were different. Women can have their own varietal preferences for sorghum which is associated with their household activities and thus needs to be considered in cluster based large scale demonstration. Low soil fertility, high fertilizer price, lack of tractor for ploughing, small plot of land allocation followed by lack of thresher were the major constraints to sorghum production.

Thus, it is recommended to grow Assosa-1 improved sorghum variety through cluster farm approach to boost production and productivity for small holder farmers in the area since the variety is preferred by farmers by its most important traits. Further research is needed on the improvement of traits of the variety which meets farmers need for biomass, striga and diseases resistance. Also focus is needed on encouraging large–scale cluster farm in the region. Improvement of production constraint to augment production in the area is needed through finance on production such as machinery and equipment.

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