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Seed System Analysis of Soybean, *Glycine max* L. Merrill, in South Western Ethiopia

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Abstract: Soybean is the most important legume grown worldwide and Ethiopia. It has versatile uses as a human food, animal feed and it contribute to increases soil fertility. Despite the significance of soybean to address food and nutrition in security problems prevailing in the country, little emphasis has been given to quality seed production, quality seed supply and popularize of this important commodity. Limited information is available on the soybean seed system of Ethiopia. The present study was conducted to study the soybean seed system in southwestern Ethiopia. Three districts vis. Tiro Afeta, Omo Nada and Chawaka of Jimma zone were included in the study. A total of 152 farmers from nine peasant association were interviewed and $n=(N/1+Ne^2)$ formula was used for sampling population size. A considerable proportion of the sampled farmers used their own saved seed out of 152 sampled farmers. From the total 152 sampled household about 85.5% of farmers did not know name of the variety they used. The study showed that, at Tiro Afeta district all the sampled farmers used polypropylene as seed packing material. At Chawak, 59.6% of sampled farmers used polypropylene and 40.4% used fertilizer bag. The average seed replacement rate at Tiro Afata, Omo Nada and Chawaka districts was 1.5, 3.59 and 7.7 years, respectively. Germination percentage was high for JARC seed sample of SCS-1 variety (99.6%) and Chawaka's farmer's seed sample (85.3%). In General at the study area, Access of seed system, market information and market linkage appears was the main constraint in the study area. The problems of producing soybean was not only limited to this but also: low production and productivity, unavailability of improved varieties, Quality of seed, disease and pest, lack of systematic approach in popularizing the crop and Lack of training farmers on the production and processing of soybean.

Keywords: Seed Source, Seed System, Seed Quality, Soybean

1. Introduction

Soybean (*Glycine max* L. Merrill) is the most important legume grown worldwide due to its versatile uses as a human food, animal feed and it contribute to increases soil fertility [1]. It is cheap and rich source of protein for poor farmers, who have less access to animal source protein, because of their low purchasing capacity [2]. There is also a potential to intercrop soybean with long stem crops such as maize and sugarcane [3].

Seed is a key input for improving crop production and productivity. Increasing the quality of seeds can increase the yield potential of the crop by significant folds and thus, is one of the most economical and Efficient inputs to agricultural development [4]. Generation and transfer of improved technologies are critical prerequisites for agricultural development particularly for an agrarian based economy such as of Ethiopian. Despite the release of several technologies, particularly of improved crop varieties, there has been limited use of improved seeds by the majority of farmers [5]. Among others, unavailability of quality seeds at the right place and time coupled with poor promotion system, is one of the key factors accounting for limited use of improved seeds, which further contribute to low agricultural productivity. Poor availability and promotion of improved seeds is due to inefficiency of the seed systems of the country.

Seed system in Ethiopia represents the entire complex organizational, institutional, and individual operations associated with the development, multiplication, processing, storage, distribution, and marketing of seed in the country. Farmers,

particularly smallholder ones, are involved in multiple kinds of seed systems, which can guarantee them in obtaining the quantity and quality of seeds they need and to market their produce.

Despite the significance of soybean to address food and nutrition insecurity problems prevailing in the country, little emphasis has been given to quality seed production, quality seed supply and popularize of this important commodity. The objective of the study was to assess the seed system and quality of soybean southwestern Ethiopia.

2. Methodology

2.1. Study Area

The study was conducted at Buno Badelle and Jimma Zones. Jimma zone lies latitudes between 7°15´ N and 8°45´ S and longitudes 36° 00´ E and 37°40´ E. This study focused at two districts namely: Tiro-Afeta and Omo-Nada. The study areas are found in southern part of the Zone. The altitude of the study area ranges from 1350 to 2940 m.a.s.l. The mean annual rainfall ranges between 1200 - 2500 mm, with mean annual temperature of 20-25°C.

Buno Badelle zone of Chawaka district is located at a distance of 560 km from Addis Ababa, the capital of Ethiopia. The district has climate alternates with long summer rain fall and winter dry season with mean annual rain fall of 900 mm. The altitude ranges between 1000-1800 meters above sea level. The minimum and maximum daily temperature of the district is 36°C and 41°C respectively (Chawaka district bureau of agriculture and natural resource development, 2015.

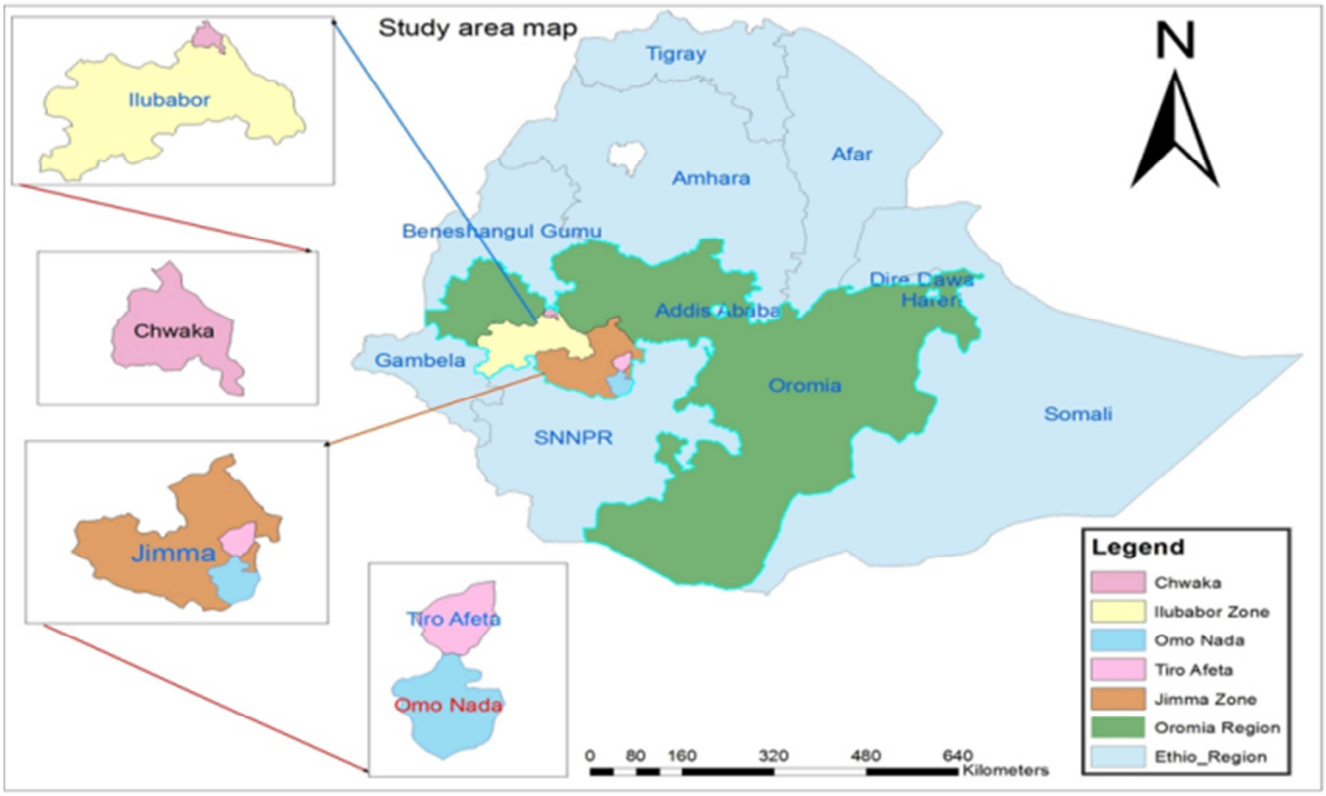

Figure 1. *Study Area Map.*

2.2. Sampling

A multi stage sampling procedures were followed to select sample households. In the first stage, soybean potential districts were selected purposively in collaboration with zone and district experts. In the second stage, three peasant associations from each selected districts were randomly chosen. Finally, households were randomly selected and structure questioners were implemented on a total of 152 randomly selected household and Yamane's formula $n=(N/1+Ne^2)$ was used for determine sample size. Seed samples were collected from the same farmers for quality test. Seed quality test was conducted in the laboratory at JARC.

3. Results and Discussion

3.1. Household Characteristics

Out of the total 152 of the respondent 94.7% were male and the rest 5.3% were female. The Minimum age of the sampled house hold was 18 and the maximum was 75 years old. Majority of the sampled house hold was literate (64.5%) and (35.5%) was illiterate. This means that majority of household heads at least can write and read. This is important to read the label of the tagged on the seed lot and reduce varietal mixture.

Table 1. *Household characteristics.*

Variables	Minimum	Maximum	Mean	Std. Deviation
Age of respondent	18	75	40.32	11.53
Level of education	0	11	2.66	2.79
Experience in growing soybean	1	15	6.18	3.71
Total family house hold	0	15	7.43	2.52
Distance to the nearest main market from residence	0.5	30.0	8.88	6.43
Average single transport cost to main market/person	1	40	12.40	7.42
Distance source of seed dealer from residence	0.1	22.0	2.99	3.72
Distance to source of fertilizer dealer from residence	0.1	20.0	2.56	2.83

3.2. Farmers' Seed Source

The present result showed that among 152 sampled household, 32.9% of farmers used their own saved seed. About 16% farmers got seed from research center (Figure 1). About 20.4% of farmers obtained seed from farmers' cooperatives while 10.5% from agricultural office. Other seed sources included local market, gift from family and neighbor, and seed exchange.

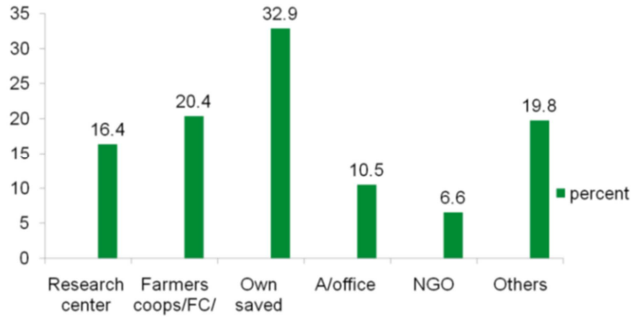

Figure 2. *Source of soybean seed to the farmers.*

3.3. Farmer's Knowledge of Soybean Varieties

The present result showed that out of 152 sampled farmers 85.5% did not know names of soybean variety they used. From the varieties produced in the study area Clark-68k is the most known variety compared to SCS-1 (2%) and Afagat (1.3%).

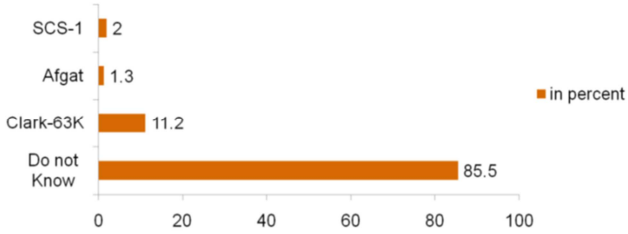

Figure 3. *Farmer's knowledge of soybean varieties.*

3.4. Farmers' Source of Information on Soybean Seed

As the result showed that, majority of information on soybean quality production technologies were addressed to the farmers from office of agriculture through local development agents (67.8%.). In addition, research centers (21.7%) also had contributed in providing information to the farmers of the study area following offices of agriculture.

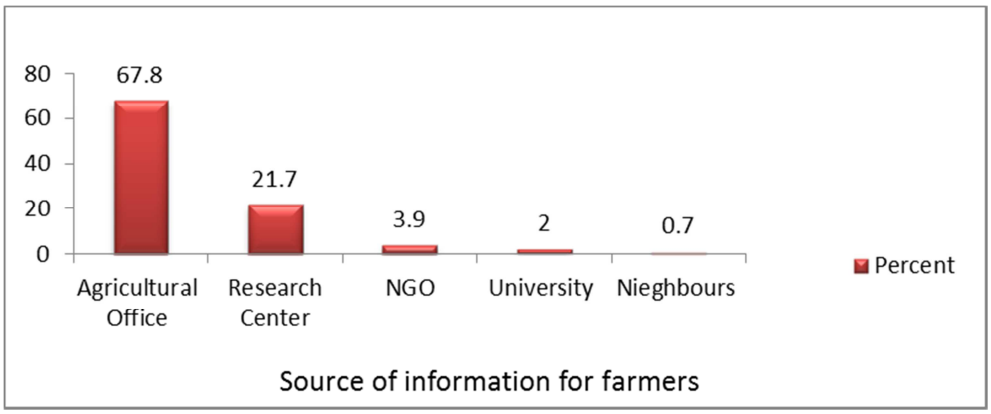

Figure 4. *Farmers' source of information on soybean seed.*

3.5. Farmers' Variety Preference

A considerable proportion of farmers in the study area preferred soybean with bright seed coat (45.4%), while about (44.1%) of farmers preferred soybean varieties of large seed size. Farmers' preference for soybean varieties was dictated by market demands.

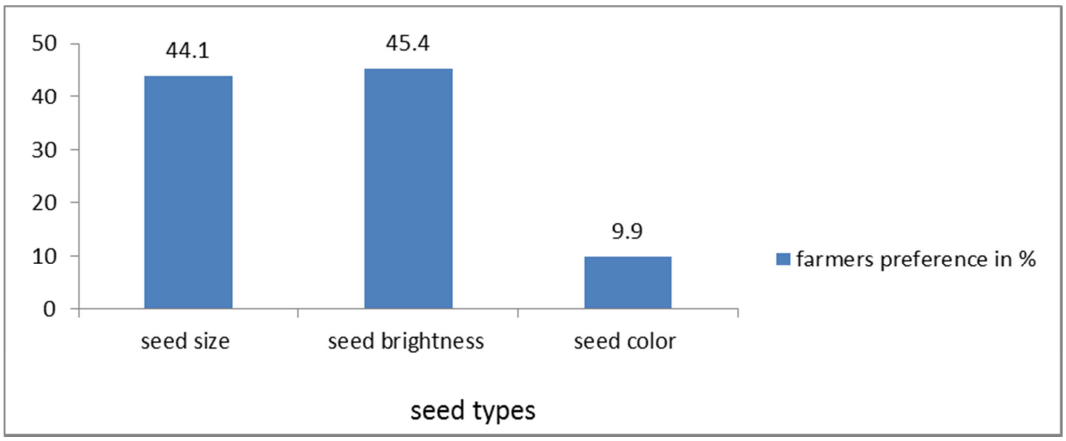

Figure 5. *Farmer's soybean seed preference.*

3.6. Farmers' Perceptions of Biotic and a Biotic Stresses

Soybean rust is the major disease reported by many farmers (71.9%) in Chawaka district. At Omo Nada district birds were reported by farmers (70.3%) as important challenges to soybean production. Birds pick the seed at seedling emergence. According to respondents, different factors contributed for the bird damage to soybean. First, all the farmers in the district are not producing soybean and even those who are producing have also small plots. Second, soybean farmers of Omo Nada district follow different sowing time.

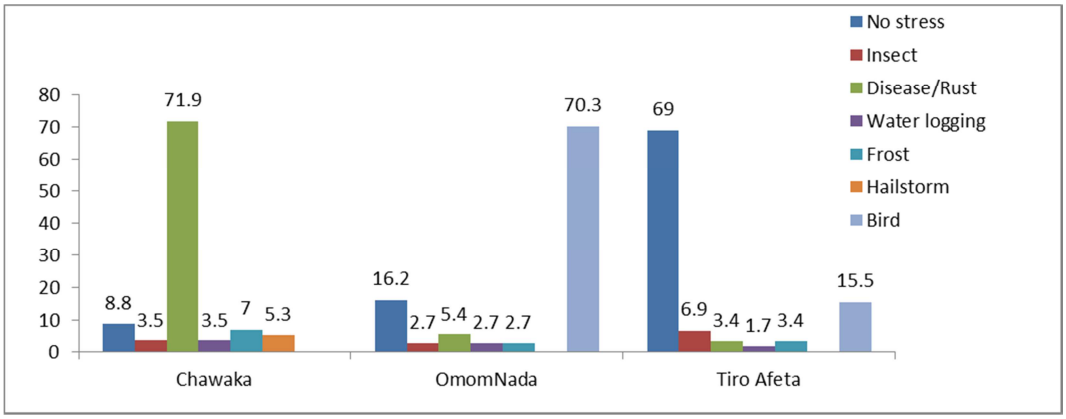

Figure 6. *Percent of Stress incidence at farm plot of each district.*

3.7. Seed Storage Materials Farmers Used in the Study Area

The study results showed that, at Tiro Afeta district all the sampled farmers used sacks as seed storage material. At Chawaka 59.6% of sampled farmers used sacks and 40.4% used fertilizer bag. 94.6% of Farmers used sacks and 5.4% fertilizer bag at Omo Nada district as storage material.

Table 2. *Storage materials farmers used at the study area.*

District	Storage material	Percent of household used
Chawaka	Fertilizer bag	40.4
	polypropylene	59.6
Omo Nada	Fertilizer bag	5.4
	polypropylene	94.6
Tiro Afeta	Fertilizer bag	0
	polypropylene	100

3.8. Pest Seen at Storage

Out of 152 farmers house hold 92.1% farmer seed was not affected by storage pest during storage time. Among the pest attack seen the highest record 3.9% was insect pest of weevil. The lower storage deterioration (1.3%) was by fungal attack.

Table 3. *Types of Pest seen at storage.*

Storage pest seen	Frequency	Percent
Not pest seen	140	92.1
Weevil	6	3.9
Rodent	4	2.6
Fungal attack	2	1.3
Total	152	100

3.9. Seed Replacement /Recycle Rate

The result of the study showed that, majority of Tiro Afeta the average seed replacement rate was 1.5 years and Omo Nada was 3.59 years. At Chawaka district, the average mean of seed replacement rate was 7.7 years. Chawaka district farmers recycle their own saved seed for many years without replace it with new generation seed.

Table 4. *Numbers of year farmers recycle their seed.*

District	Year		
	Minimum	Maximum	Mean
Chawaka	4	14	7.7
Omo Nada	1	10	3.59
Tiro Afeta	1	13	1.5

3.10. Market System, Product Price and Seed Quality Test

As discussion with the farmers in the study area, market system and price was discouraging them to produce soybean. Even if it was not attractive the market price of soy bean was better at Tiro Afeta district 1130 ETB /100kg. At Omo Nada farmers sell soybean at village market for local consumers 840 ETB/100 kg. At Chawaka district brokers and middlemen control the market and they buy the product at farm gates by minimum price 760 ETB/100kg.

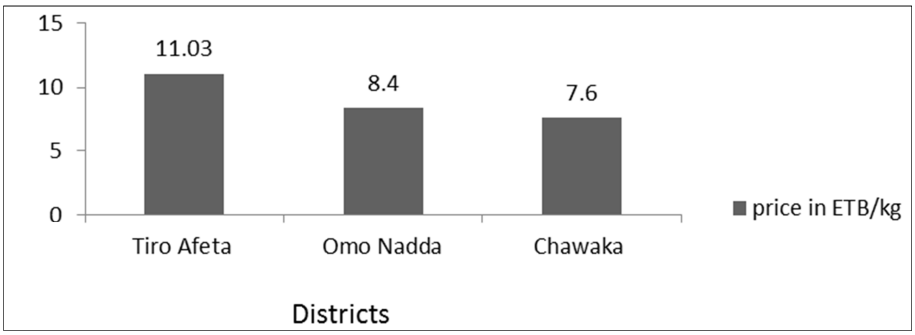

Figure 7. *Mean price of soybean on study area (ETB/Kg).*

There was highly significant different on seed germination between farmers seed and research center seed. Germination percentage was high for JARC seed sample of SCS-1 variety (99.6%). Low germination percentage was from Chawaka's farmer's seed sample (85.3%). There was highly significant different on seed physical purity between the sampled seed. High physical purity 99.8% was obtained on seed sample of JARC of SCS- 1 variety. Low physical purity 85.5% was recorded on seed sampled from Chawaka district. This indicates that at chawaka the seed recycling rate was high which can affect seed quality. In addition there was rust problem and the storage material, poythelene also widely used at chawaka. So the cumulative of postharvest handing storage and packing material used at chawaka district can affect physical and physiological seed quality compared to Tiro Afata and Omo Nada.

Table 5. *Quality test of sampled seed from farmers and Research Center.*

Seed sample from	Germination %age	1000 seed Weight	Moisture content	Physical Purity
Tiro afeta	96^{a}	166.6^{b}	9.2^{bc}	92.02^{b}
Omo Nada	91.6^{ab}	166.6^{b}	9.4^{b}	91.9^{b}
Chawaka	81.3^{b}	159.6^{b}	9.1^{c}	88.3^{c}
Clark-63k variety	99.3^{a}	170.3^{ab}	10.8^{a}	99.7^{a}
SCS-1 Variety	99.6^{a}	181.9^{a}	11^{a}	99.8^{a}
CV	4.51	3.90	1.36	0.70
LSD (0.05)	8.02	12.42	0.25	1.25

Keys; SCS- 1=soybean variety, CV=source of variation, LSD=least significant difference, means followed by different letter within column are significant difference at (p=0.05).

Choosing the right seed source is one of the most important and, it can have huge implications for the early growth, productivity and seed quality. The present result showed that among 152 sampled household, 32.9% of farmers used their own saved seed. About 16% farmers got seed from research center. About 20.4% of farmers obtained seed from farmers' cooperatives while 10.5% from agricultural office. Other seed sources included local market, gift from family and neighbor, and seed exchange.

For sustainable cultivation of any crop, first and foremost requirement is enough knowledge of technical agricultural practices required to grow, harvest and trade that crop efficiently. The present result showed that out of 152 sampled farmers 85.5% did not know names of soybean variety they used. The variety Clark-63k was relatively the most popularized variety in the study area and Afgat is the lowest popularized one. This indicated that soybean varieties may not be well popularized in the study area. The extension education has its positive impact on knowledge level of farmers. Therefore, farmers should be provided with sufficient access to extension services, which can enhance their knowledge of soybean varieties.

Providing information and training on seed use and best agricultural practices can improve crop production and yield. As shown in Figure 3, majority of information on soybean quality production technologies were addressed to the farmers from office of agriculture through local development agents (67.8%.). In addition, research centers (21.7%) also had contributed in providing information to the farmers of the study area following offices of agriculture.

A considerable proportion of farmers in the study area preferred soybean with bright seed coat 45.4%, while about 44.1% of farmers preferred soybean varieties of large seed size. Farmers' preference for soybean varieties was dictated by market demands.

Soybean rust is the major disease reported by many farmers (71.9%) in Chawaka district. At Omo Nada district birds were reported by farmers (70.3%) as important challenges to soybean production. Birds pick the seed at seedling emergence. According to respondents, different factors contributed for the bird damage to soybean. First, all the farmers in the district are not producing soybean and even those who are producing have also small plots. Second, soybean farmers of Omo Nada district follow different sowing time. Therefore, it is important to increase soybean area through introduction of improved varieties and to teach farmers to follow similar planting schedules.

Proper packaging and ideal conditions of storage are required to maintain seed quality. Rao, R. G. S., P. M. Singh and M. Rai reported that, packaging container, storage condition and duration affects seed quality [6]. Seeds deterioration starts after physiological maturity in the field before and after harvesting through processing to storage until seeds become acceptable for planting [7]. Seeds are packaged based on quantity, type of package, duration of storage and prevailing environmental conditions. The study showed that, at Tiro Afeta district all the sampled farmers used sacks as seed storage material. At Chawaka 59.6% of sampled farmers used sacks and 40.4% used fertilizer bag. 94.6% of Farmers used sacks and 5.4% fertilizer bag at Omo Nada district as storage material.

Out of 152 farmers house hold 92.1% farmer seed was not affected by storage pest during storage time. Among the pest attack seen the highest record 3.9% was insect pest of weevil. The lower storage deterioration (1.3%) was by fungal attack. Improper storage handling and crop husbandry increase prevalence of fungi [8].

The number of generations up to which the seed could be used from the previous crop is another important aspect, vital for the maintenance of crop productivity. Deterioration in seed quality may occur due to physical admixtures as well as loss of genetic vigor and germination power. Admixture may occur in the field, at the threshing yard or even during storage when seeds of other crops get mixed with the variety. Further, the germination power may go down due to physical damage to seed through insect and fungal infestation, moisture, breakage of grains and death of embryo due to ageing or prolonged exposure of seed to adverse environment. Deteriorated seed quality results in loss of productivity per unit of area. The result of the study showed that, majority of Tiro Afata the average seed replacement rate was 1.5 years and Omo Nada was 3.59 years. At Chawaka district, the average mean of seed replacement rate was 7.7 years. Chawaka district farmers recycle their own saved seed for many years without replace it with new generation seed. This indicated the limitation of formal seed source and distribution of seed for the district.

In the African context, there can be serious market failures and high transaction costs associated with market participation for small farmers [9]. This calls into question issues to do with the nature of the state and its efficacy in supporting and controlling market dysfunctions. In this respect, small farmers are particularly influenced by policy towards the provision of extension services, input distribution systems and transport infrastructure as well as those relating to producer price levels. As discussion with the farmers in the study area, market system and price was discouraging them to produce soybean. This means the market price of the product do not return the cost of production in all the study area. But comparatively soybean market price was better at Tiro Afeta district 1130 ETB /100kg. At Omo Nada farmers sell soybean at village market for local consumers 840 ETB/100 kg. At Chawaka district brokers and middlemen control the market and they buy the product at farm gates by minimum price 760 ETB/100kg. Conclusively farmers in all the study area does not benefited from soybean product due to disconnected market system and low price of the product.

From the results, the farmers in the area were vulnerable to the lack of availability and access to improve varieties of soybean seed. Due to this seed insecurity and weak seed system is one of the important factors affecting soybean production and productivity. This is aligned with the idea of Abebe, A. and Lijalem, K [10], which indicted that securing the supply of quality seed of the most critical food crops helps the country to sustain food security. In addition as Abebe, G., Alemu, A, Zewdie B. and A. R. T. Gastel stated [11, 12], Seed security could be a requirement for increasing food production, rising farmers' financial gain, alleviating poverty and making certain food security. Seed system is complex and dynamic due to inherent variations in products, supply and demand side factors and their interrelated associations with the policy environment [13]. Hence the use of good quality seed and improved varieties is widely recognized as essential to ensure enhanced crop production and productivity.

The same problem was funded this area as Tilaye, T. M. A., Kassahun, T., Abebaw, A. and Getachew, A. stated [14], The existing seed systems of the country also confronted with inadequate provision of excellent quality Seed at reasonable prices; specialize in few crops (maize & wheat) within the formal system and different useful crops (such as pulses & oilseeds) stay orphans; low even no private sector involvement in the formal system of soybean; inefficient seed promotion, distribution and marketing mechanisms and seed quality assurance system in the area and county. on the other hand market system and low value of the product also discourage the farmers in the study area in the production of soy bean. This is also related to the absence of weak seed system which agree with Kumlachew, A. [15], A good seed system can make sure that top quality seeds of a wide range of crop varieties are produced and absolutely out there on the market in the required time and with reasonable price to farmers and other stakeholders.

4. Conclusion

Soybean is one of the important annual legume crop produced in southwestern part of Ethiopia. The productivity of this crop is still, far below its potential due to lack of supply improved seed. Among the bottle neck of the seed system in the study area, lacks availability of quality seeds at the right place and time, lack of formal seed multiplication schemes, poor marketing system and value chain, insect and disease pest and limited extension service are the major issues. The other problem in this area was lack of linkage and integration among the stakeholders specially research center and agricultural office and development agent. Due to this, the information and training provided on soybean production package, processing, and the pre and post harvest handling extension system were not addressed to the farmers in the area properly and disintegrated. This can affect the product quality and quantity negatively. In general all the stakeholders of formal and informal seed sector should be organized and work together to through proper seed system strategies to solve the disintegrated seed system and problem of supply improved seed in quality and quantity in the study area and country as well. So encouraging formal and informal seed sector, training the farmers to produce their own quality seed and also facilitate market value chain for the product is important.

Acknowledgements

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