Trends of soybean production and productivity: evidence from three districts of southwest Ethiopia

Addisu Bezabeh¹, Efrem Asfaw² and Misganaw Anteneh³

¹Ethiopian Institute of Agricultural Research, P.O.Box 2003, Addis Ababa, Ethiopia.
²³Jimma Agricultural Research Center, P. O. Box 192, Jimma, Ethiopia.

Accepted 16 May, 2016

This study was designed to assess status of soybean production and factors affecting soybean production and productivity with particular reference to three districts in southwest Ethiopia. Three stage-sampling techniques were employed to collect data from 150 soybean-producing farmers. Descriptive and inferential statistical analyses were undertaken for data analysis. The regression analysis revealed that among others, productivity of soybean had been affected by sowing time, agro ecology, participation on recipe demonstration, proximity to farmers training centers. Enhancing soybean production and productivity lay on institutional focuses that not only depends on improving the supply of improved soybean varieties to varying niches, but also improved production packages like sowing date and patterns, fertilizer application rate in the production side while value addition along the soybean value chain.

Key words: Farmers, soybean, production, productivity, trends.

INTRODUCTION

Soybean (Glycine max L. Merrill) is the most important legume worldwide due to its versatile uses as a human food, animal feed and its role in soil amelioration. Among food legumes grown in Ethiopia, soybean is gaining more importance in recent years. Zinaw et al. (2013) indicated that soybean was introduced to Ethiopia in 1953. Extensive works have been done to incorporate soybean as a food legume in people’s diets, either directly in seed form or processed into value-added foods (e.g., soynuts, soymilk, soy pulp) or added as a blends in traditional foods.

Recently, the trend of increment in area under the crop is mainly due to a rising demand from domestic processing industries (Hallu and Kelemu, 2014). Large-scale production of the crop may therefore enhance the income of small-scale farmers. The country can also earn a substantial amount of foreign currency from the export of soybean grain owing to the strategic location of the country to the world's consumers. Argentina is one of the top five soybean producing countries that reached above 2.74 metric tons per ha (Masuda and Goldsmith, 2009). In Ethiopia, soybean productivity is far from world average, which is less than 2 metric tons per hectare (Central Statistical Agency (CSA), 2012), mainly due to lack of appropriate production packages and promotional activities suitable for the different cropping systems and agro-ecologies.

Jimma Agricultural Research Center (JARC), in collaboration with other research partners started adaptation, demonstration and popularization of soybean to coffee based farming system. Yearly a number of soybean field days organized, soybean farm visits paid and recipes exhibited to enhance knowledge exchange on soybean production and use. However, the level of soybean production, productivity, adoption, expansion patterns and consumption behaviors are either not studied or up to date information are not available. Thus, this survey was conducted in three districts viz. Kersa, Omo-Nada and Tiro-Afeta, where soybean production technologies have been demonstrated and promoted by different actors. Information about soybean production and productivity under the circumstance of the three districts uncovered and synthesized to the context of similar agro ecology of southwest Ethiopia.

MATERIALS AND METHODS

Description of the study area

Southwest part of Ethiopia is characterized by the
remaining high forests with *Coffee arabica* gene pool and forest based livelihoods. Soybean was a new crop to the forest linked farming system. From southwest Ethiopia, Jimma Zone is one of the four zones known by high coffee production supply. Jimma Zone lies between latitudes 7°15’ N and 8°45’ S and longitudes 36° 00´ E and 37°40´ E. The Zonal town also called Jimma, which is located 352 km southwest of the capital Addis Ababa. The zone generally lies in altitude ranges between 900 and 3334 m above sea level. More than half of the zone (52%) lies between 1500 and 2000 m above sea level. As a result, Jimma zone enjoys several types of agro-ecological zones from moist to dry arid zones.

This study focused at three districts namely: Kersa, 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. The livelihoods of farmers in study districts depend on mixed farming systems. According to the Jimma Zone Agricultural Development Partners Advisory Council’s annual report (JZADPLAC, 2015), among others, coffee, maize, sorghum, tef (*Eragrostis tef* (Zucc.) Trotter), livestock and chat (*Catha edulis* Forsk) are major sources of income for farming families.

**Sampling procedures**

To contact soybean-producing farmers, a three-stages sampling technique employed. The three stages took the following forms. The first stage was selection of soybean producing districts. The second stage was identifying kebeles (Kebele is the lowest administrative unit after district in Ethiopia) that are familiar with soybean production practices. In the third stage a list of household heads referred for respondent selections. Accordingly, the three districts viz. Kersa, Omo-Nada and Tiro-Afeta selected. Soybean producing Kebeles purposively selected by reviewing crop production reports of the respective district agricultural offices. From the six Kebeles 150 household heads contacted using a systematic sampling technique. The primary data gathered using semi structured interview schedule that was pre-tested by non-sample respondents to improve the reliability of the instrument.

**Analytical tools**

Following data coding, editing and cleaning, the data entry had been made into SPSS. Then the data were exported to STATA 12 for analysis. Both descriptive and inferential statistical analysis techniques utilized. Variables like socioeconomic and demographic variables computed and presented through descriptive analysis. Factors that affect directly or indirectly the soybean production and productivity have been evaluated thorough running the Ordinary Least Square (OLS) model to estimate unknown parameters in the linear regression model. The OLS was used, as its estimator is consistent when the independent variables used are exogenous and there is no perfect multicollinearity. In addition, it is optimal in the class of linear unbiased estimators when the errors are homoscedastic and serially uncorrelated. Under these conditions, the method of OLS provides minimum variance mean unbiased estimation when the errors have finite variance.

Result of the trends of soybean production, productivity and determinants factors revealed by farmers who were engaged in soybean production practices during the last three years. Soybean yield (dependent variable) tested by model how it interacts with household size, landholding size, soybean consumption behavior and distance to extension service centers, sowing date etc, taken as independent variables determining trends of soybean production and productivity. Thus, important variables that potentially affect soybean production and productivity regressed by multiple regression models: \( Y = f (B1+X1B1+X2B2+X3B3+...+\epsilon) \). Where: \( Y \) = mean yield of last three years (quintal), \( X1 \) = (AGRECO) Agro ecology (dummy, 1 if the agro ecology is semi arid 0 otherwise), \( X2 \) = (HHS)=Household size (number), \( X3 \) = (CULLAND) Cultivated land size (hectare), \( X4 \) = SCONS=Soybean consumption (dummy 1 if family consumes at least once in a week or 0 otherwise), \( X5 \) = DIST= Distance to extension and advisory service (kilometer), \( X6 \) = DEMO=Participation on demonstration of soybean dishes (dummy, 1 if participated or 0 otherwise), \( X7 \) = ACESS=Access to improved varieties (dummy, 1 if had access or 0 otherwise), \( X8 \) = SEED= Quantity of seed sown per hectare (kilogram). Variables that either positively or negatively revealed influence on three years mean soybean yield presented at 5% level of significance.

**RESULTS**

**Demographic characteristics**

The study sample comprised of 91.33% male-headed households (MHH) and 8.67% widowed or divorced female-headed households (FHH). The minimum, maximum and average ages of the respondents were 24, 80 and 46.7 years respectively. Also, more than half (i.e. 58.00%) of the respondents explained their family size is 6 - 9 while 24.67% of the respondents 3 - 5 and 17.33% of the respondents have more than 10 family members. Regarding education, 52.67% of the respondents explained that they are not able to read and write, while 23.33% had completed 4 - 6 grades, 13.33% completed grade 7 - 8 and 10.66% completed grade 9 - 10.
**Figure 1.** Trends of farm allocation for soybean production (hectare)
Source: Own survey result, 2014.

**Table 1.** Soybean productivity (t/ha).

<table>
<thead>
<tr>
<th>Productivity category (t/ha)</th>
<th>Number of farmers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1.3</td>
<td>81</td>
<td>54</td>
</tr>
<tr>
<td>1.3-1.4</td>
<td>34</td>
<td>23</td>
</tr>
<tr>
<td>1.5-1.9</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>≥2.0</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Own survey result, 2014.

**Resource ownership**

The landholding size ranges from less than half a hectare to above three and a half hectare. That is 72 respondents (i.e. 48.00%) own 1 - 2 ha of land, 53 respondents (i.e. 35.33%) own ≤ 1.00 ha while 14 respondents (i.e. 9.33 %) own 2.00 - 3.50 ha while 9 respondents (i.e. 6 %) owned ≥ 3.5 ha of land. Through recall method, farmers’ gross annual farm and other income identified accordingly. Ninety respondents (i.e. 60%) got 7501 - 10,000 Birr, 40 respondents (i.e. 26.66%) make 5000 - 7500 Birr, while 20 respondents (i.e. 13.33 %) got ≥10,000 Birr (note that 1 USD equals to 21.50 Ethiopian Birr). Soybean found as fifth preferred crop in terms of money earning source. Despite the fact of its level, soybean production is increasing in the study area as the mean area allocated for soybean production over the last five years showed a drastic increase.

The trend of land allocation for soybean production indicated in the Figure 1 which shows that there is 26.87% growth through five-year time. Likewise, the soybean production knowledge and practices embedded in the existing farming system the study area. In this regard, soybean variety types, planting time, seed rate, fertilizer application, post harvest issues and cropping calendar established in existing farming system. From study sample, 92% of the respondents call soybean as *atte boonsitu* in local language, while 8% of the respondents explained their belief that all available soybean varieties are as improved technologies with other possible scientific naming.

Soybean productivity assessed and summarized in four categories as indicated in Table 1. The majority (i.e. 81 respondents or 54%) obtained less than 1.3 t/ha yield, while 34 respondents (or 22.67%) harvested 1.4 t/ha, 23 respondents (or 15.33%) harvested 1.9 t/ha and 12 respondents (or 8.00 %) harvested ≥ 2.00 t/ha. Comparing the yield harvested at farmers’ field with yield obtained on research station showed considerable disparity. Yield records were not observed during the survey or it is not common with almost all farmers. Thus, farmers in a recall method explained the yield, but recalling could be liable to exclude considerable quantity of yield along post harvest handling processes. Moreover, relatively soybean received minimum land size from the total holding which may liable to yield under estimation. Figure 2 presents major complaints that farmers revealed as existing bottleneck to reach soybean productivity potential.

Figure 2 presents the Pareto analysis, which is a
statistical technique in decision making, which is used for the selection of a limited number of tasks that produce significant overall effect (Russell et al., 2003). Pareto Principle (also known as the 80/20 rule) the idea that by doing 20% of the work you can generate 80% of the benefit of doing the whole job. Alternatively, in terms of quality improvement, a large majority of problems (80%) is produced by a few key causes (20%). Thus, from eight problems, that farmer revealed to be bottleneck of soybean production, productivity can be tackled by targeting on the first two problems that is solving the wildlife damage and facilitating market can enhance the rest soybean production and productivity situation.

Awareness and adoption of soybean production technologies

Farmers in the study area, found to be aware of major soybean production practices. Nearly all respondents (i.e. 91%) revealed that they know soybean production activities which include knowing sowing date, sowing methods, weeding methods and frequency; fertilizer type and quantity of application among others. The farmers in the study area struggled with exhausted soil due to year after year cultivation of the soil for high feeder crops such as maize and sorghum that serve as staple food. Moreover, farmers in one hand hardly afford buying inputs such as improved variety seeds and fertilizer in the other there is different constraints to get credit from existing financial institutes (KIT and IIRR, 2010).

Women’s role in soybean production

With introduction of new technology, there is assumption of gender role issues. Gender roles in relation to major soybean production activities indicated in Table 2.

Like other crops production, task and labor sharing identified between men and women on basis of intensity of task, magnitude of the crop role to farmers and distance from residence. Across the three districts women makes significant task share in soybean production. However, extension advice and technology provisions still inclined to men who are the head of the household. Agbarevo and Obinne (2008) in similar studies on cassava production indicated that majority of gender division among married people are more emphasized than farming families headed by male or female. In Sub Saharan Africa, underperforming agricultural productivity either never considered from gender perspectives or biophysical or technological issues had been complained. According to FAO (2011), one of the key reasons for underperforming productivity in SSA is large gender inequalities in access to and control over resources and opportunities that undermine sustainable and inclusive agricultural development.

Due to gender disparity, legumes are left for women, as
women’s contribution to grow secondary crops such as legumes and vegetables is usually greater than in producing staple crops such as rice, wheat or maize (FAO, 2011). In parts of Africa where legumes are purely subsistence and semi-subsistence crops, women are more visible in the production roles, marketing of perishable products like leaves as vegetables, and seed and small-scale processing (e.g., groundnuts for home and local sale), while men tend to dominate in the marketing of grain in the value chain (FAO, 2011). Men also dominate in the legume value chains (integrating production and marketing) in the few highly commercialized production contexts such as common bean in most part of Ethiopia.

**Analysis of factors affecting soybean productivity**

Regression analysis (Table 3) revealed that among others, agro-ecology, soybean consumption behavior and distance from extension advisory centers affected soybean productivity at varying degree of significance. This implies that agro ecology of the farmer significantly influenced the adoption of soybean technologies and the productivity of soybean. Likewise, soybean consumption, distance to knowledge centers, matching sowing, fertilizing, weeding and harvesting calendar with onset and stoppage of rainfall affected soybean production and productivity.

**DISCUSSION**

Previous studies corroborate that production and productivity of crops determined by socio economic, cultural, physical, biophysical and other factors in time. Also in this study, agro-ecology, soybean consumption behavior, distance to advisory services and access to improved varieties found determining soybean production and productivity. The soybean producers were committed enough to reserve parcel of their land and gained yield increments in steady and gradual manner. Masuda and Goldsmith (2009) analyzed world soybean production

---

### Table 2. Gender division of labor on soybean production.

<table>
<thead>
<tr>
<th>Soybean production activities</th>
<th>Tiro-Afeta</th>
<th>Kersa</th>
<th>Omo-Nada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male %</td>
<td>Female %</td>
<td>Male %</td>
<td>Female %</td>
</tr>
<tr>
<td>Land preparation (cleaning, tillage &amp; leveling)</td>
<td>65</td>
<td>35</td>
<td>70</td>
</tr>
<tr>
<td>Seed acquisition and sowing</td>
<td>87</td>
<td>13</td>
<td>91</td>
</tr>
<tr>
<td>Management activities (hand weeding)</td>
<td>45</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>Harvesting</td>
<td>60</td>
<td>40</td>
<td>55</td>
</tr>
<tr>
<td>Collecting harvests</td>
<td>40</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>Transporting to house</td>
<td>60</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Transport &amp; sale</td>
<td>30</td>
<td>70</td>
<td>40</td>
</tr>
<tr>
<td>Decision on money use</td>
<td>50</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: Own survey result, 2014.

### Table 3. Regression analysis on determinants of soybean productivity (t/ha).

<table>
<thead>
<tr>
<th>Average soybean yield of three years</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agro ecology= (dummy 1 if the agro ecology is semi-arid 0 otherwise )</td>
<td>0.679</td>
<td>0.322</td>
<td>-2.11**</td>
</tr>
<tr>
<td>HHS= household size (number)</td>
<td>-0.002</td>
<td>0.073</td>
<td>-0.02</td>
</tr>
<tr>
<td>CULAND= Size of cultivated land (hectare)</td>
<td>0.035</td>
<td>0.038</td>
<td>0.92</td>
</tr>
<tr>
<td>SCONS=Soybean consumption (dummy 1 if family consumes or 0 otherwise )</td>
<td>2.442</td>
<td>0.996</td>
<td>-2.45**</td>
</tr>
<tr>
<td>DIST= Distance to extension &amp; advisory service (kilometer)</td>
<td>0.438</td>
<td>0.189</td>
<td>2.31**</td>
</tr>
<tr>
<td>DEMO= Participation on demonstration of soybean dishes (dummy 1 if participated or 0 otherwise )</td>
<td>-0.218</td>
<td>0.324</td>
<td>-0.67</td>
</tr>
<tr>
<td>ACESS=Access to improved varieties (dummy, 1 if had access or 0 otherwise )</td>
<td>-0.960</td>
<td>0.326</td>
<td>-2.94***</td>
</tr>
<tr>
<td>SEED= Quantity of seed sown per hectare (kilogram )</td>
<td>-0.015</td>
<td>0.010</td>
<td>-1.48</td>
</tr>
<tr>
<td>_cons</td>
<td>7.871</td>
<td>1.671</td>
<td>4.71***</td>
</tr>
</tbody>
</table>

_t statistics in parentheses,  _p < 0.05, **p < 0.01, ***p < 0.001._

Source: Own survey data analysis, 2016.
and productivity and found that the world average soybean yield doubled from 1.16 metric tons per ha in 1961-65 to 2.31 metric tons per ha in 2005-07. In Ethiopia, productivity of major crops such as tef [Eragrostis tef (Zucc.)Trotter], maize, wheat and sorghum in general and soybean in particular remained far less than the world yield profile. Seyoum et al. (2011) unveiled challenges of smallholder farmers who experience low production and productivity in Ethiopia. The cropping system in Ethiopia characterized by low input-output, rain-fed and smallholding farming. Chemical fertilizer use for example is low. Only 30 – 40% of smallholders in Ethiopian use fertilizer (Spielman et al., 2011). The application rates of fertilizer are also well below those recommended by the extension programs; on average only 37 – 40 kg per ha in 2013 compared with an average of 102.0 kg fertilizer use per hectare across Asia in 1995 (Hazell, 2009). Moreover, fertilization of almost all crops in Ethiopia in general and the study area in particular done by manual operation that subject to use inefficiency. Soybean producers of the study area revealed cost of soybean production from fertilizer purchase perspective than their labor operation.

As Deressa et al. (2010) reported there is positive relationship between farm income, adoption of soil conservation practices and use of different crop varieties. Equally, similar situation reflected in the study area that farmers inclined to uptake technologies with multitude benefits than attributes targeted at increasing yield. In this regard though farmers appreciated the diverse advantages that they drive from soybean, their awareness level on value addition and consumption not developed. Olatunji et al. (2011) concurred; extension and advisory service that focused on production packages will not ensure level of consumption and diversification of meals in the menu. Surprisingly, individual attributes like age, education, religion and family size; economic profile like income and landholding size did not appear significant in the analysis. However, access to and use of advisory service demonstrated to affect soybean production and productivity. Overall, prospects soybean production and productivity rely on provision of improved technologies those matching with biophysical settings, awareness raising on soybean production packages and value addition for better market gain and solving identified soybean production bottleneck.

CONCLUSIONS

The scale of soybean production and productivity in the study area identified as expanding in significant magnitude. Farmers’ commitment revealed in terms of reserving piece of land for soybean production in successive years from their first trial. Considerable number of farmers explained that the level of soybean production kept lesser level due to the nature of soybean consumption as staple foodstuff on daily basis. Meals prepared from soybean considered as nutritious and needed as supplement. In addition to nutritious gain from soybean, farmers give considerable credence to soybean’s soil fertility improvement benefits which most admitted that there is crop rotation and nitrate fertilizer minimal usage. Overall, it can be concluded that awareness and adoption level of soybean technologies are known and growing in gradual manner. There have been gender dimensions where most of the soybean production contributions come from women, men and mature children.

Thus, to improve the levels of soybean production, marketing and consumption of soybean it needs to strengthen the extension advisory services focusing the nutritional and soil fertility benefits of the crop. Therefore, in order to get farmers adhered to available advices and usage of soybean production packages proper land preparation and implementation of all agronomic and field management techniques needs to be put in place so as to raise production and productivity that in return improves gain farmers earn from all costs incurred so that sustainability of soybean production enhanced. Meanwhile, awareness-raising programs need to be provided to improve food culture towards most nutritious crops production like soybean, which allows improving nutrition security and health of the farming families.

REFERENCES


KIT and IIRR, 2010. Value chain finance: Beyond microfinance for rural entrepreneurs. Royal Tropical Institute, Amsterdam; and International Institute of Rural Reconstruction, Nairobi.


