Prioritizing factors affecting sesame (sesamum indicum l.) productivity using analytical hierarchy process model in western Tigray, northern Ethiopia

Tesfay Gidey
MSc in Agronomy
MSc in Forestry and Natural Resources Management
Department of Pant Science, College of Agriculture and Environmental Science
Adigrat University, Adigrat, Ethiopia

Abstract - Sesame production is the primary source of income for many smallholder farmers in Ethiopia. However, its production is challenged by several factors. These challenges have not been prioritized by involving local farmers and experts in western Tigray, northern Ethiopia where the crop is dominantly cultivated. This study was done to prioritize the current factors that affecting sesame productivity in this region of Ethiopia in order to give a greater emphasis on those important factors by all stakeholders. To achieve objective of the present study, 50 farmers were interviewed face to face. In addition, relevant experts from differ offices were also interviewed. The collected data was then summed, ranked and analyzed using Analytical Hierarchy Process model. Fifteen factors were identified during the interview with farmers and experts as current factors that affecting sesame productivity in the study area. However, the most important factors according the respondents prioritization are: drought, lack of technology for sowing and harvesting, unavailability of improve varieties, lack of soil fertility, pests (insects, diseases and weeds) and lack extension works. Hence, it is recommend that all stakeholders (policy makers, researchers, farmers, donors and other relevant bodies) should jointly work together on the above mentioned factors in order to improve sesame productivity in northern Ethiopia, particularly in the study area.

Key words - Drought, improved varieties, multi-criteria decision models, soil fertility, stakeholders

I. INTRODUCTION

Sesame *(Sesamum indicum* L.) is the second high-value cash crop in terms export next to coffee for Ethiopia [1]. Sesame contributes about 1.5 % for Ethiopian national Gross Domestic Product (GDP) and shares about 14% for foreign export earnings [2]. Sesame supports, directly or indirectly, the livelihoods of 4 million Ethiopians, representing 4% of the total population of the country, where there is even popular saying that "sesame is the backbone of our life", meaning how the crop so closely interlinked with income of many farmers [3]. Currently, Ethiopia is ranked as fifth in the world in sesame production and second in exporting it following India [1]. Ethiopia has a suitable agro-ecology for sesame production and it is commonly grown in parts of the country including Tigray, Amhara, Oromia and Benshangul Gumuz regional states [2].

Western of Tigray, northern Ethiopia possess favorable environment and soils for sesame production and contributes about 30% of total sesame production for Ethiopia [4]. Average sesame productivity in western Tigray was found to be 6.5 quintal/ hectare which is lower than the national average yield (7qt/ha) [10]. This lower yield in this region could be associated with several factors, for example: climatic factors such as drought, wind and temperature [4], infertile soil, presence of disease and pests, lack of application of modern inputs, lack of scientific and technical helps, inappropriate post-harvest managements and market fluctuations [1, 4 and 5].

Prioritizing problems in crop production is one of strategy that to determine effective solutions for those factors using relevant stakeholders [6 and 7]. In addition, identifying and prioritizing timely sesame production problems are very helpful in determining their solutions by researches, farmers and policy makers [1 and 8]. However, in western Tigray, the factors affecting sesame productivity have not been yet prioritized according their importance in order to be solved by concerned stakeholders. Therefore, this study was done to prioritize these factors in order to provide list of prioritized factors for immediate actions by relevant stakeholders for improving sesame productivity in the study region of Ethiopia.

II. METHODS AND MATERIALS

2.1 Description of the study area

The Kafta- Humera district is located in the western zone of Tigray region, northern Ethiopia. It geographically located between 14º27'N and 36º27'E. The district shares a border in west with Sudan, in east with district Tahtai Adiabo, in south with Welkait and Tsegede districts, and in north with Eritrea. The district covers an approximately 640,000 ha which is about 23.6 percent of the western zone of Tigray. Kafta-Humera has a lowland and semi-highland agro-ecology with elevation ranging between of 560 to 1849 meter above sea level. Its average temperature and rain fall are 30 ºC and 750 mm [9]. The land use system of the district is characterized by mixed farming system dominated by crop cultivation. Oilseed covers 60% followed by cereals (31%) and pulses (6%). Economy of the district strongly depends on sesame and cotton production which currently over 400 investors who are involved in production of these crops [11].

2.2 Methods were used

In order to prioritize the factors affecting sesame productivity in the study area and achieving the objective, Analytical Hierarchy Process (AHP) model was used. AHP is one of well-known multi-criteria decision analysis models which are used in agriculture [12]. AHP model decomposes a final objective into a hierarchical problems, this allows us to prioritize problems by a series of binary comparisons which finally lead to prioritization [6]. Comparisons between two problems are made using the numerical scale proposed by [12] which goes from 1 to 9, where the value 1 implies that both problems are equal and 9 indicates that from the two problems one problem is extremely important (Table 1). AHP has been widely used to prioritize crop related problems [7, 13 and 14]. The model is implemented in Expert Choice software (it is freely found in http://expertchoice.com).

In this study, AHP model was used for prioritizing problems that affecting sesame productivity in Kafta-Humera district, western Tigray. For this purpose, first, extensive literature review was made for identifying existing sesame productivity problems. Then, the identified problems were well evaluated with key informants in order to be added, amended or deleted. Problems were then compared each other using [12] numerical comparisons (Table 1) by selected farmer using questionnaire. Relevant experts from different offices like agricultural office and research centers were also interviewed to see how response of the farmers fit with the experts. For selection of relevant stakeholders, which was 50 farmers and 10 experts, purposive sampling method was employed. This method of sampling has been commonly used in AHP model for selecting relevant stakeholders [15 and 16]. Moreover, one group of informant was also prepared with help of experts and farmers for discussion about the current factors affecting sesame productivity in the study area. The collected data from these stakeholders was then summed, averaged and ranked using AHP model for prioritization according their importance.

Table 1. Numerical scales used in AHP model for comparisons between two problems (factors) that affecting currently sesame productivity in western, Tigray, northern Ethiopia

Intense of importance	Reciprocal rating	Definition	Explanation
1	1	Equal importance	Tow problems or sub-problems have equally important for the objective
2	1/2	Equally to moderate	One problem slight important than the other
3	1/3	Moderate important	One problem is moderate important than the other
4	1/4	Moderately to strong	One problem is modularly plus important than the other
5	1/5	Strongly important	One problem is strongly important than the other
6	1/6	Strongly to very strong	One problem is strongly plus important than the other
7	1/7	Very strong important	One problem is very strong important than the other
8	1/8	Very strong to extremely	One problem is very strong plus important than the other
9	1/9	Extreme important	One problem is extremely important than the other

III. Results and Discussion

3.1 Demographic characteristics of the respondents

Of the 50 respondents, 2% are females and the remaining are male farmers. Of the total of respondents, 50% only had a primary school (1-8 grade), followed by 40% and 10% who are attended secondary school (9-12 grade) and diploma, respectively.

3.2 Prioritization the current factors affecting sesame productivity

According to the respondents and experts, more than 15 natural and anthropogenic factors that currently affect sesame productivity in western Tigray, northern Ethiopia. However, among the identified factors using stakeholders' opinions, application of fertilizer, amount of seed rate, capsule shattering and infrastructures have not significant effects on sesame productivity in the study area and thus were not considered in the prioritization process of the present study. The remaining 10 factors were prioritized and ranked using the respondents' point of view. Figure 1 below depicted that drought (20%) is the primary factor that decline sesame productivity in the study area. According the respondents, drought was described as early and late water stress. To elaborate this in detail, early drought is lack of available soil water post sowing of the crop due to late rain and lack of supplement irrigation. Such pheromone is common in Ethiopia for a lower productivity of sesame and other important crops [1, 4 and 5]. Similarly, late drought also descried as the main factors for lower sesame productivity in the study area due to creating lower maturity of the crop and insufficient protein and carbohydrate contents in its seeds. Late drought has been mentioned as a primary factor for decreasing sesame yield in Ethiopia as well as East Africa [4 and 5].

According the response of the respondents, following drought, lack of technology with affordable price such as row planter and harvest are the main factors for lower sesame productivity in western Tigray. Due to large arable land for sesame production in this area, during its sowing and harvesting a large numbers of labor are required. If the required number of labors during this peak period is absent, productivity of the crop is significantly decline due to its shattering characteristics. Yield reduction due to labor shortage can reduce using row and harvest machines, but at present time these technologies are

not available with affordable price for farmers. This problem has already been identified by several studies as the main factor for lower sesame productivity in Ethiopia [1, 4 and 5].

After drought and lack of technology, availability of improved sesame varieties is also ranked as third factors for decreasing sesame productivity in the study area (Figure 1). If fact some varieties have already been developed by research centers in Ethiopia, but still lack of improved variety that can tolerate drought and pests stress. In addition, the respondents mentioned lack of soil fertility as fourth factors for a lower sesame yield in the study area. This lower soil fertility is associated with growing of the crop continuously in the field that aggravates soil erosion. Lack of soil fertility, especially nitrogen and phosphorus were mentioned as main soil macronutrients that are insufficient for sesame production in the study area. In line with this study, sesame productivity was observed to provide a lower yield due to lack of soil fertility, particularly soil nitrogen and phosphorus Ethiopia [4 and 5].

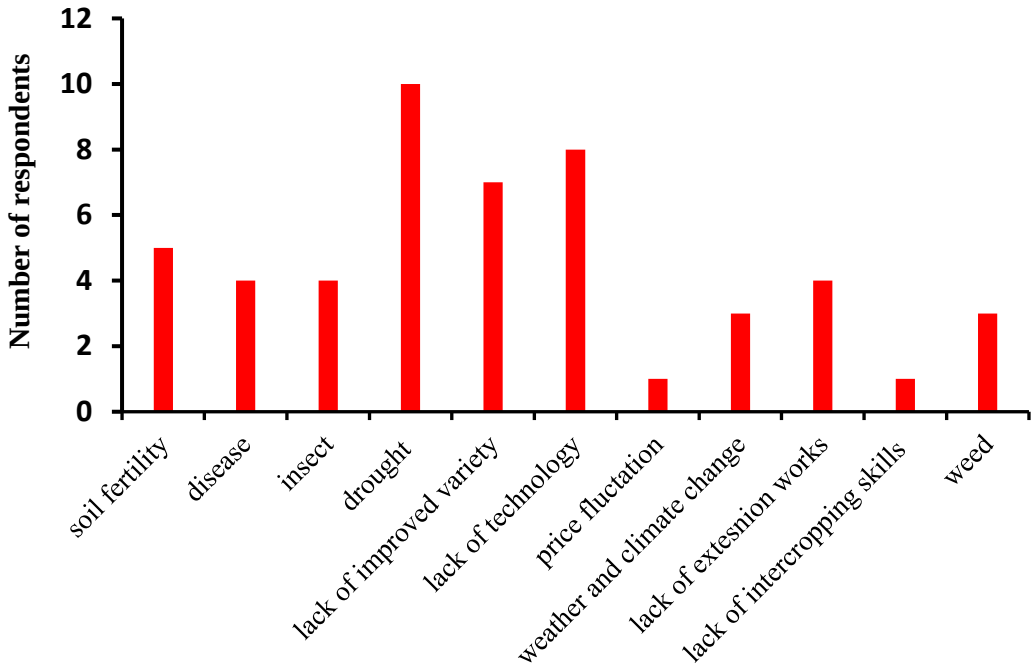

Figure 1 Factors affecting sesame productivity in western Tigray

Pests (disease, insect and weeds) were also mentioned by the respondents as factors that decline the crop productivity in the study area. Pests such as webworm and sesame seed bug, bacteria blight and Phyllody are among the most common pests that significantly affect the crop. Such pests were also identified by several studies in Ethiopia as common pests that would affect yield of the crop [1, 4 and 5]. Besides, lack of extension services including continues training on usage of fertilizers, herbicides, harvesting and others were also mentioned as factors that decline sesame productivity in western Tigray, northern Ethiopia.

IV. Conclusion and Recommendation

Several factors have contributed for lower sesame productivity in western Tigray region, northern Ethiopia. Results of this present study prioritized these factors by involving farmers and experts as drought, lack of technology, lack of soil fertility and pest (insects, diseases, and weeds) and lack of extension works. Therefore, all stakeholders (researchers, investors, farmers and policy makers) should jointly work on the above mentioned factors that currently decline productivity of the crop for improving its future productivity.

V. Acknowledgement

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VI. References

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