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The Role of Community Based Institution for Climate Change Adaptation Mechanisms in Choke Mountain, East Gojjam, Ethiopia

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Abstract: *Community based institutions play significant role for community livelihood buildings in a given community. This research had attempted to examine how community based institution(s) initiated watershed development project has a significant impact for the development of climate change adaptation mechanisms, and livelihood improvements. The main purpose of this study was to identify the role of community based institution for the development of adaptation mechanisms and its determinants. The key finding of the research showed that community based organization could play a significant role for the development of adaptation mechanisms. When performing their role it has some gaps in the process of implementation such as lack of participatory decision making process, targeting problem to address the poor, the young and the women; weak stakeholder linkage, some conflicts over communal livelihood resources and lack of the development of social capital. The research has concluded that the project could play a significant role to implement adaptation mechanism with some gaps. Then to fill the gap and go along with the sustainability of the project, the findings recommended frequent negotiation and lobby from the concerned stakeholders is needed. These all solve the conflict, and hence enhance better adaptation mechanisms.*

Keywords: Adaption mechanism, climate change, community-based institution

1. Introduction

In recent years, environment has become a key issue in Ethiopia. It has also fragile highland ecosystems that are currently under stress. This is because of the presence of irregularities and volatilities of the climatic trends, which make low level of economic development and poor access to basic services. Ethiopia is highly dependent on rain fed agriculture where there is poor institutional, environmental and resource based knowledge. The implication of climate risk on different sectors including agriculture, water resource, health and energy is great (NAPA, 2007).

Most parts of Ethiopia in general and the Amhara Regional State in particular is characterized by mountainous agriculture with slope gradients ranging from 5-45%. In addition to this, much of the annual rainfall comes in short violent events of up to 100 mm/day, this exposure of denuded slope areas to these types of rainfall results in Ethiopia having one of the most serious soil degradation problems in the world. Annual rates of soil loss in the Amahara region in some steep lands and overgrazed slopes exceed 300 tons/ha/year, or 250 mm/year. Nationally, on over 2 million hectares, the soil depth is so reduced that the land is no longer able to support cultivation (ANRS, 2000).

Ambaber watershed is found in the Choke watershed and it has deteriorated from a surplus producing to a food deficit area within a span of 20 years with more and more land being abandoned and/or productivity declining to levels below that could maintain even mere subsistence. To combat this, more than 20 community based institutions are established (Belay and Shibru, 2007). This research was designed to examine the role of community based watershed development project for climate change adaptation mechanisms and to determine the factors that affect adaptation mechanism.

2. Materials and Methods

2.1. Description of the study area

The study site, Choke Mountain Watershed, is located approximately between coordinate 10033'06" to 10050'24" North latitude and 37042'36" to 37058'24" East longitude. Topographically, the watershed lies in the altitudes range of 3000 to 4413 m.a.s.l. The macro watershed is found entirely in Eastern Gojjam Zone

of six Woredas such as; Bibugne, Debay Tilatgin, Gozamen, Hulet Eju Enssie, Machakel, and Senan (Bewket, 2010).

The specific site of Ambaber is found in Shemie Kbele, Debay Tilatgin woreda at distance of 350 km North West of Addis Ababa and 60 km east from Dbere Markos, which is the zonal capital of the woreda. The altitude of the Kebele ranges from 3000 to 4000 meter above sea level. The main purposes of the CBO are for natural resources development and to enhance tourism marketing, which was established in 2007. The total land area of the watershed in the Kebele is estimated to be 900ha with total household of 590 of which 500 are males and the rest of 90 are females, and the remaining 747 households are not members of the CBOs (Shemie Kebele, 2011). The total household of the Kebele is equal to 1337(CSA, 2008).

2.2. Research approaches and design

Qualitative data that are required to describe and understand the role of community based organization for climate change adaptation mechanisms and associated constraints which hinder the process were used. Quantitative was also used for dealing with explanatory and descriptive type of data to make hypothetical-deductive analysis among variables

2.3. Method(s) of data collection and analysis

The data collection methods used to address the research objectives were household survey, Focus Group Discussion (FGD), Key Informant Interview (KII), observation, and document review. This study pursues a kind of comparative analysis among CBO members and non-members of the sample households. Descriptive statistics and measures of statistical significance like independent and paired sample t test, one way ANOVA, bivariate correlation, and binary logistic regression were used. The variables were hypothesized to influence adaptation mechanisms, which can be positive or negative. Following Gujarati (2003), the model is specified as:

$$\text{Log (y)} = \text{In (P/ (1-P))} = \alpha + \beta_1 x_2 + \beta_2 x_2 + \ldots + \beta_{11} X_{11} + e$$

Where:

P = Probability and *Y = outcome of interest which can be affected by* | $X1 = x1$, $X2 = x2$

$$Y = \frac{e\,\alpha + \beta 1x1 + \beta 2x2}{1 + e\,\alpha + \beta 1x1 + \beta 2x2}$$

Where variables and hypotheses

X1= Age of house hold head (-)

X2 = gender (+/-)

X3 = Family size (+)

X4 = educational level (+)

X5= Land size (+)

X6= Number of oxen (+)

X7= wealth status (+)

X8= CBO membership (+)

3. Results and Discussion

3.1. Role of community based institution(s) (on) climate change and adaptation mechanisms

Climate change and adaptation mechanisms implemented by the CBI

The major climate change adaptation mechanisms that the community based institution/CBI had been carrying out since its introduction, are many. These include soil conservation, compost preparation, afforestation, preventing deforestation, area closure and management, water management, cut and carry system, conserving and promoting of high yield and disease resistance local crop varieties, conserving indigenous forest species , awareness rising to conserve natural resources, promoting fuel stove dissemination, and preparing hay from communal grazing system. Furthermore, maximizing new opportunities have been implemented as climate change adaptation mechanisms such as growing new crops (peas and beans), having new animals that were not before in this site (example goat), and adoption of other new technologies.

Different researchers as cited in IFAD (2009) stated that the above mechanisms are practices of climate change adaptation mechanisms and they recommend there have to be implementation by developmental stakeholders (IPCC, 2001; IPCC 2007b; IPCC, 2007; IUCN, 2009; Agrawal, 2008; Kurukulasuriya and Mendelssohn, 2008).

Table 1 Respondents on main climate change adaptation mechanism implementation status

Implemented activities	Responses	Frequency	Percent	Implemented activities	Responses	Frequency	Percent
Plant community (wood lot)	Yes	39	40.6	Participate in community forest protection	yes	55	57.3
	No	57	59.4		no	41	42.7
	Total	96	100		total	96	100
Prepare compost	Yes	57	59.4	Participate in area closure management	yes	54	56.3
	No	39	40.6		no	42	43.7
	Total	96	100		total	96	100
Implement soil conservation	Yes	61	63.5	Participate in water resource development	yes	53	55.2
	No	35	36.5		no	43	44.8
	Total	96	100		total	96	100
Participate in rehabilitation of degraded lands	Yes	53	55.2	Practice rotational grazing system	yes	59	61.5
	No	43	44.8		no	37	38.5
	Total	96	100		total	96	100
Participate in managing range lands	Yes	55	57.3	Implement a forestation	yes	52	54.2
	No	41	42.7		no	44	45.8
	Total	96	100		total	96	100
Implement cut and carry system	Yes	56	58.3	Multiply and use local high yield crop	yes	54	56.2
	No	40	41.7		no	42	43.8
	Yes	50	52.1		total	96	100

Source: own survey 2011

Next, it had been compared to [1] project performance status of the local communities between community based watershed development members and non-members. It was examined by using descriptive statistics and independent sample "t" test. Most of the CBO members, above 80% of the respondents, described that they implemented the entire above mentioned project activities individually. However, there were only less than 35% of non-member respondents implemented most activities.

The other tool, an independent sample 't' test of the mean performance difference between members and non-members, validates this fact and it had a significant mean difference for implementation of all activities performance p=0.000-0.001(t=3-18.13, df =94) which proves a significant application difference between communities based watered development project members and non members. This is because the project target groups more internalize resource conservation techniques so that key resources of the area become in good position, due to the intervention. Azmeraw (2010) found the same results what is demonstrated here and EPA (2006) document had also similar investigation with this finding.

From the focus group discussions, the following major points came out that are almost consistent with the survey results of the present study. The participants explained that they have been rehabilitated with the same biophysical activities. The biophysical activities were using indigenous local species such as "Koso" (*Hygenia abyssinica*), "Asta" (*Erica arborea*), "Enjori" (*Morus mesozygia*), "Gemey" (*Hypericum revelutum*) and other bush and grass species plants. Additionally, plantation of new species trees were developed such as; high land Bamboo (*Arundinaria alpina*), "Nech bahirzaf" (*Euclptus globulesis*), "Key bahirzaf" (*Euclptus cameldulesis*), "Tid" (*Junipers procera*). These all reforestation, plantation, and rehabilitation have been practicing in 20 hectares degraded areas with area closure.

1. Choke mountain Rehabilitation Project by Community based organization that plays a role for the development of proper climate change adaptation mechanisms

Similarly, other 25 hectares communal grazing land were properly managed and used to feed their animals on rotational basis. Apple plantation, compost preparation, feeding their animals using cut and carry system, multiplying and distributing local important varieties mainly white barley, black *temeze, and Senef kollo* barley on individual basis have been promoted to revive them. Lime application was also implemented to reduce the acidity of soils. From the triangulation, it can be generalized that there is a strong project performance by the community-based institution than non-member groups.

The secondary data obtained from the project annual report of the woreda supports the above justification. About 9.5 ha soil bund and 1900 m^3 compost have been constructed and prepared. About 15600 seedlings have been planted which, includes "Koso", Junipers, Eucalyptus and Bamboo. "Black *senef kolo*" on 2.4ha, black barely on 0.8 ha, white barely on 11.5ha have been multiplied and grown by the farmers. For rotational grazing 25.5 ha pasture has been delineated and 0.25 ha gully rehabilitated. Moreover, about 8.33 and 20 hectares of community wood lot plantation and forest area closure were rehabilitated and maintained, respectively, for the eco system (WARDO, 2011). The documents reviewed at woreda level have also indicated similar figures observed at the kebele level (Ambaber CBO, 2011). These and other related activities were supposed to be accomplished by CBO as explained in the project document designed by Belay and Shibru, (2007). According to the findings of the present study the proposed activities were partly implemented by CBO.

Project gaps

In addition to achieving the above objectives and activities, the institution has expected to play some roles that contributed to the improvement of local people livelihoods. These roles include accessing communal natural resources with better service, empowering the community, promoting participatory decision making, and equal commitment for all, encouraging collective action, which includes participatory plan and adopting inclusive rules and regulations in the project site (Belay and Shibru, 2007). Nonetheless, as expressed from focus group discussants, these activities in the process also face

some gaps in practice. These include lack of targeting for women and youth, weak institutional linkage and information exchange, lack of collective action plan, lack of developing inclusive rule for the disadvantageous community. Furthermore, there are also lacks of skill to coordinate and mobilize the community for further joint action; lack of participatory decision-making and community empowerment to manage and own the project are some among others. Even if participation difference existed between CBO members and non-members in natural resource management and conservation, the extent of participation in decision making to decide on administrative and institutional issues have been still low. Most of the respondents explain these all are existing problems and will exist in the process of this research project implementation too.

Even if the by-laws of the CBO indicates there is General Assembly Meeting three times on a year basis to evaluate their performance , this has not been made still in this study year as confirmed by the CBO focus group discussion. The non-members of CBO respondents stated that as long as these gaps are existed, we don't want to be members of the CBO.

Similar findings were expressed in the Adaba-Dodola participatory forest management project of the Oromia region that lack of sufficient number of professionals with participatory forest management background, organizational aspects, conflict resolution techniques, and benefit sharing scheme were some of the prevailing constraints in the execution of participatory forest management approach (Tsegaye, 2004). The project document (Belay, 2007) expects the implementation of the above activities; however, these vital issues still did not achieved.

3.2. Factors affecting adaptation mechanisms

In this section, the research tries to address how different community groups develop adaptation mechanisms. Among the different age categories, youngsters whose ages are between 18-30 were interviewed. They responded that they did not implement most of the activities mentioned above or they did not participate in communal resources management and conservation. Most of the youngster respondents also declared that they did not implement or participate to develop adaptation mechanisms. However, the adult respondents whose age was from 31-60 attested that they implemented or participated in the development of the above-mentioned adaptation mechanisms. Furthermore, those of elders whose age was above 60 approved their implementation or participation was low.

While it is shifted to the performance difference between male and female respondents, the majority of the female respondents approved, they did not implement the above climate change adaptation mechanisms. Subsequently, what happened between CBO members and non-members was discussed. In most activities, the CBO member group respondents indicated that they implemented or participated in the implementation process of climate change adaptation mechanism. These activities were by far greater than the non-member respondents. Activity implementation of wealth category for climate change adaptation mechanisms also investigated. Their performances coincide with the previous argument. The fact shows that the poor respondents verified that they have not implemented those activities or are implementing them with low (scale). On the other hand, the medium and better wealthy respondents performed better than others did.

For graphic demonstration, the value of the average implementation is calculated based on the value of 1= implement the activities 0= do not implement the activities. All these are summarized by the pie chart as follows.

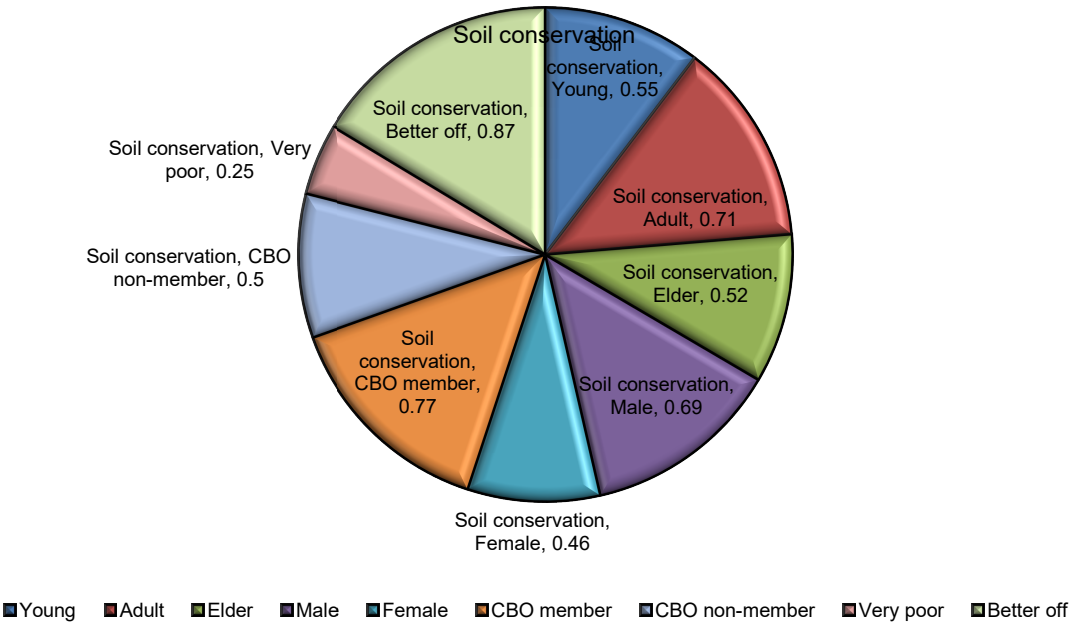

Figure 1 Average adaptation mechanism implemented by different groups of the community

Source: *Own field survey, 2011*

Before going to the determinant factors affecting farmers to implement climate adaptation mechanism, it is better to discuss whether the main climate change adaptation mechanisms of the local communities have a relation (with them) or not. These are: - soil conservation, compost preparation, afforestation, forest protection, area closure management, water development, cut and carry system, rotational grazing, disease resistance and high yield crop conservation, and using fuel saving stove , have correlation with independent variables such as based on age, sex, wealth and CBO members and non-members, family size, land size, oxen number and educational level. These all are analyzed using bivariate correlation analysis tools. The bivariate correlation of sex indicates r-value ranges = 0.4- 0.7 with p value of 0.000-0.003, for the CBO category r=0.4-0.73 at p value of 0.000-004. The bivariate correlation for family size, land size and number of oxen r=0.25-0.3, 0.2-0.44 and 0.2-0.4 with p value of 0.001-0.013, 0.000-0.007, and 0.000-0.049, respectively. However the r value for educational status significant for only compost preparation p=0.026 and r=0.23, for soil conservation p=0.045 and r=0.2, for participation of degraded land rehabilitation and range land management p=0.03 and 0.004 with r=0.22 and 0.3, sequentially. This implies the independent variable, sex, CBO membership, wealth status, family size, land size, and oxen number have a relation with the implementation of the above adaptation mechanisms and educational level for the four selected items mentioned above.

Development of adaptation mechanism by gender and CBO membership

Gender differential in response to climate change and taking adaptation measures have also been investigated. The implementation status of the above-mentioned dependent variable by gender shows there is a significance difference between the two groups. The independent t. test also has indicated the P value, which is equal to 0.000 (t=4.3-9.4, df =94) for all the above mentioned variables which has an implication of a great significance mean difference between the two groups.

Data from the focus discussion also draws various reasons for low implementation status of adaptation mechanisms. Especially the two female group discussions justify, they do not have the exposure to

exercise such activities as most of their time was confined with home management, and childcare. Furthermore, even if they have the knowledge to such measures, they do not have the power to decide to implement such activities due to cultural bound. This implies that in Ethiopian context, most farming activities are implemented by male groups and these groups have better exposure for (adaptation mechanisms). Therefore, the implementation of adaptation mechanism activities are more associated with males than females.

Likewise, gender analysis between CBO members and non-members show there is a significance difference between the two groups with the exception of fertilizer application. In fertilizer application there is no significance difference between the two groups, however, slightly CBO non-members use more fertilizer than member groups, since non-members did not practice more in compost utilization or CBO members develop more inclination for organic agriculture than using fertilizer. Therefore, the independent t-test p value ranges from p= 0.000-0.015(t=2.48-5.98, df=94) for all the above mentioned dependent variables except fertilizer application. This implies that there is a significant difference between the two groups in implementation of adaptation mechanisms. The implementation signifies that CBO members implement or participate in the implementation of adaptation mechanisms more than non-members participate with a meaningful difference. This implies that community based institution play a vital role in the development of climate change adaption mechanisms, since members of this institution have better adaptation performance than non-members groups do.

Similar findings were investigated in other point of Choke mountain water shed development site. It indicates the existences of significant difference in the implementation of conservation mechanisms between members of the CBO and non-member together with significance difference between male-headed farmers with female-headed farmers (Azmeraw, 2010).

Development of adaptation mechanism by wealth status and age groups

The analysis of the implementation of the adaptation mechanisms by different wealth groups indicated that there is significant difference among the wealth groups. It has been proved that most types of adaptation mechanisms were well implemented by the better off wealth categories. The statistical analysis (one-way ANOVA) supports these arguments and it lies between p=0.000-0.003 (F=4.8-15.1, df=3) for all performances. In addition, the post hock analysis of most activities showed that there were significance differences between the very poor and medium, very poor and better off, poor and medium, poor and better off wealth groups. However, no significance difference was recognized between the consecutive category divisions between poor and very poor, medium and better off wealth groups. This indicates that the mentioned adaptation mechanisms were more implemented by the wealthiest groups than the poor and very poor with large proportion difference.

On the other hand the analysis results (one-way ANOVA) based on age groups indicated significance difference only for some adaptation implementation mechanisms that include compost preparation (p=0.043, F=3.2), cut and carry system (p=0.046, F=3.2), and fertilizer application (p=0.43, F=3.3) with degree of freedom (2) for all analysis. Accordingly, the post hock analysis indicated that there were significance differences between the adult and elder groups. However, there were no significance differences between the youngest and the adult groups. The reasons for these were that adults and young have enough labor power to do such adaptation mechanisms compared to the elders. Even if significance difference is observed only for some of the local adaptation mechanisms, the adaptation mechanism implementations have inverse relation with age groups due to shortage of labor force when the age increases. This implies that labor force plays a determinant role for the response of climate change adaptation mechanisms rather than experiences. The labor force availability is the determinate factor that affects the community to take such measures that influence the implementation abilities and capabilities.

Development of adaptation mechanism by land size and oxen number

The analysis (one-way ANOVA) results indicated that large land size contributed for the implementation of adaptation mechanisms (p=0.000-0.035, F=2.7--8.3) at degree of freedom (df=4). Further the post hock multiple group comparison analysis indicated that having no land and having land size between 3.1-5 *timad*, having less than one *timad* and having land size between 3.1-5 *timad*, no land and having land size between 5.1-7 *timad*, having less than one *timad* and having land size between 5.1-7 *timad* have significant difference. However, there is no significant difference between the consecutive land holding sizes. These all indicates that there was significant difference between the extremes land holding sizes. The analysis leads to conclude that land holding sizes have a great contribution for the implementation of adaptation mechanism.

The oxen size on the other hand was significant only for some dependent variables like preparation of compost, participation in community forest protection, water development activities, rangeland management activities, and rehabilitation of degraded lands. Generally, it can be concluded that people that have more oxen number practice and participate in the implementation of adaptation mechanisms than those with no/or less oxen number.

Determinants of climate change and adaptation mechanisms

The area's main climate change adaptation mechanisms such as afforestaion, area closure management, changing of sowing/planting date, compost preparation, soil conservation, multiplication and use of high yield local varieties, cut and carry system, rehabilitation of degraded lands, forest protection, fuel saving stove utilization, rotational grazing and water development were regressed using binary logistic regression. These dependent variables are analyzed against independent variables such as age, education level, sex, wealth, CBO member ship, family size, land size, and number of oxen.

Implementing afforestation in the area by CBO membership and wealth category are explained by 77% and 80% at p value of 0.001 and 0.000, respectively. This implies that implementing afforestation has greatly explained by the CBO members and wealthiest category. It confirms that the independent t test and ANOVAs test showed significant difference exist within each category. Implementing and managing of areal closure, what was observed and predicted also explained by 83% at p= 0.000 for both CBO members and wealth category division. However, changing planting date contradicts the above trend and in all categories p>0.05 shows insignificant difference among the independent variables mentioned. This indicates that this adaptation mechanism was implemented by all categories without a significant difference. Concerning the preparation of compost, it is expressed by 83.3% for CBO members p=0.000 and wealthiest category at p value of 0.023. The soil conservation implementation observed and predicted values were expressed by 80% with CBO membership, p= 0.003 and wealth categories p, value of 0.000. Conserving and promoting high yield local crop varieties are expressed by 75% with p value of 0.000 for CBO membership categories. Practicing cut and carry system was also expressed by 86.5 % for CBO membership with p =0.000 and for wealth categories p =0.008. At the same time, participation in rehabilitation of degraded lands was expressed by 88% with p value of 0.000 for wealthy categories. Implementing utilization of fuel saving stove was also expressed by 83% for wealth categories. Practicing and implementing of rotational grazing, and water development for different purposes were shown by 70% and 84% at P= 0.000 and 0.001 for CBO membership and wealth categories, respectively.

Harmonizing all these arguments the determinant factors that hinder or contribute for the implementation of main adaptation mechanisms are described as follows. As expressed by t test, and one way ANOVAs and there is a significant difference of implementing adaptation mechanisms between male and female, among age groups, different oxen size groups, different land size holding groups, among wealth categories, between CBO members and non members. But the regression result of observed and predicted values shows that the implementation of main climate change adaptation mechanisms were

highly interlinked with CBO membership and wealth categories. Thus, it is concluded that the foremost determinant factors for the implementation of climate change adaptation mechanism were being a CBO member and better in wealth status. The next factors that hinder its implementation were it did not target the disadvantageous groups such as females and elders, low land size and oxen holding, weak information exchange, lack of credit and agricultural extension service.

Moreover, the data found from the focus group discussions and key informants go parallel with what was described by the quantitative data. The focus group discussion raised a few issues of the obstacles for both implementing project activities and climate adaptation mechanisms. It was demonstrated that the existence of conflict between the watershed development kebele(s) communities and its neighbourhood's four other kebeles. Due to this conflict, the two sites of the project were not functional during this study. In addition to computing communal resources, there was no clear boundary between the project site and neighbouring kebeles. Besides, according to their explanation, due to the intervention of the project, communal resources (forest and grazing lands) have been observed in better condition than the other kebeles. Accordingly, the discussion with people in other kebeles claimed to consume these resources by saying cow and honey bee have not clear demarcation to consume whatever they want and the Choke is commented to all and the CBO members do not agree on nonmembers idea, for this reason the conflict continues. Watershed conservation community based institutions at kebele, woreda, and zonal levels did not give recognition for their role and the implementation of adaptation mechanisms were other critical points.

The pervious findings also support these facts (IPCC 2001; NAPA, 2007; Agrawal, 2008). Similar findings were found in the participation of conservation practices that had age has inverse relation to take conservation measure. CBO members could practice more awareness and develop more conservation practices than non-members develop, women participation in those practices was low, and there is significance difference between male and female household heads: which means those of males has developed more conservation mechanisms than females. Even if family size and education contributed positively towards development of conservation mechanisms, there is no significance difference between relatively large land holding size and higher education level (Azmeraw, 2010). These all leads to reach at a conclusion that community based institution(s) can play a vital role for the development of climate change adaptation mechanisms though there were still some gaps in organization management process.

4. Conclusion

Based on the overall investigation, Community Based Development Institution(s) could play a role to achieve climate change adaptation activities that support the local communities' livelihood, such as; area closures, rotational grazing, cut and carry system, liming, preparation of compost, multiplication and distribution of farmers' important local varieties, and forestation and forest protection. These have enabled the achievement of conservation of biodiversity at the local level, reducing deforestation, improved land productivity, reduction of soil erosion, promotion of water development, enhancement of organic agriculture, and increment of the resilience capacity of ecosystem and economic returns. Nevertheless, the study demonstrated that the project has some gaps in the process of implementation. These includes the project did not target at the disadvantaged part of the community, especially youngsters, females and very poor segments of the communities. The determinant factors that have contributed against or towards implementation of adaptation mechanisms were CBO membership and non-membership, and wealth difference categories. Those had better off and CBO members have performed better than the other group with significant difference. Next to these two factors, others are differences in age group where the adults have been performed more. Gender (males have become more implementer than females); Lack of institutional linkage and support, lack of recognition for the implementation of those activities, and existence of internal and external conflicts. To overcome these gaps, concerned bodies (Regional, Zonal, Woreda and Keble Agriculture office; Regional, Zonal ,Woreda and Keble Environmental protection office, Regional, Zonal ,Woreda and Keble

Administrative office; Regional, Zonal ,Woreda and Keble cooperative organization and promotion office) and the larger community shall work together and develop ground rules that enhance development and environmental protection. By minimizing these gaps, this project shall scale up these good practices to other similar areas to promote climate change and adaptation mechanism(s).

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Aluminum Sulfate as Pulsing Preservative for Export-oriented Rose Flowers under Bahir Dar Conditions, Northwestern Ethiopia

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Abstract: *Rose is one of the most important cut flowers in Ethiopia produced mostly for export markets. Maintaining the postharvest life is the most challenging issue for most of the floricultural enterprises in the country. Two sets of experiments were therefore conducted in Tana Flora PLC farm, one of the biggest cut rose producers in Bahir Dar, Northwestern Ethiopia with the objectives of identifying the appropriate concentration of aluminum sulfate as pulsing preservative to maintain the vase life of export oriented rose flowers. In the first set, aluminum sulfate alone and in combination with calcium hypochlorite at different concentrations including the experience of Tana Flora PLC, sucrose and distilled water as control were tested for their influence on physiological status of `Maracuja` rose flowers. In the second set, the best performed pulsing preservative (aluminum sulfate alone) was tested at four concentrations (0ppm, 125ppm, 250ppm and 375ppm) to identify the optimum concentration. After pulsing for about 30 hours, six cut flowers were put in 250 ml glass flask containing distilled water. The flasks with flowers were arranged in Complete Randomized Design with three replications and kept in vase life testing room of Tana Flora PLC. According to the results obtained, aluminum sulfate at the concentration of 250ppm was the best in prolonging the vase life, in producing bigger flower head and maintaining the freshness of flowers. The reduction in percent fresh weight during the vase life of flowers was minimal in 250ppm aluminum sulfate pulsed flowers. The prolonged vase life of aluminum pulsed flowers is due to better water uptake and thus stabilized water balance in the flowers as observed in this study. Thus, it is advised to incorporate aluminum sulfate in flower holding solution at the concentration of 250ppm to maintain the freshness and vase life of export oriented rose flowers and those for local market in the study area.*

Keywords: cut rose, fresh weight, transpiration rate, water balance, water uptake

1. Introduction

Rose (*Rosa hybrida* L.) belongs to the family *Rosaceae* under which more than 150 species and 1400 cultivars are consisted (Elgimabi, 2011). Rose is one of the most popular cut flowers and has been used as garden plant since the dawn of civilization. Rose enjoys superiority over all other flowers being extensively used for decorative purposes and is prized for its delicate nature, beauty, charm and aroma. Rose plants produce an exquisite floral display consisting of many vibrant colors, shapes, sizes and perfumes (Synge, 1971; Zlesak, 2006). Throughout the history of civilization, no other flower has been so immortalized and integrated into daily life as the rose. It plays a unique role in various occasions such as Mother`s Day, St Valentine's Day, birth and even death (ProFlower, 2012). Thus, rose is regarded as the queen of flower (Synge, 1971).

The floriculture sector in Ethiopia is flourishing from year to year. The number of flower exporting farms as well as the types of flowers exported is in increasing trend (Van der Maden *et al.*, 2011). However, roses accounted more than 80% of the cut flower production and the floriculture cultivation area in the country. Other floricultural crops such as chrysanthemums, poinsettia and geranium, and bouquet fillers primarily hypericum, carnation, gypsophila, allium and carthamus are also produced in Ethiopia (EHPEA, 2008). Ethiopia is one of the top five flower supplies in European market including Kenya, Ecuador, Columbia and Israel and holds an impressive second place among Dutch auction suppliers. The share of Ethiopian flowers in European exports doubled from 6% in 2005 to 12% in 2010 (Van der Maden *et al.*, 2011). Many varieties of the so called Hybrid Tea, Intermediate and Sweetheart roses are

now produced in modern greenhouses which are mostly concentrated around Addis Ababa, the capital city of Ethiopia (Van der Maden *et al.*, 2011). Recently however, floricultural enterprises are also established and developed in other parts of the country like Bahir Dar and Hawassa.

A very important challenge of any floricultural enterprise is maintaining the harvest quality of flowers as long as possible. As flowers are harvested, they are literally cut off from their source of life. As living organism however, they respire and transpire after harvesting. As a result, water will be lost and nutrients will be broken down that in turn accelerate the aging process and reduce the vase life of cut flowers including roses (Van der Maden *et al.*, 2011). The main reason for senescence of cut flowers is wilting due to which the floral axis bent just below the flower head which stops the water supply to the flowers (Van Doorn and De-Witte, 1997). The reduction of water supply is mostly attributed by physiological occultation by plant itself, air embolism or microorganisms which plug the stem xylem vessels of the flowers (Van Doorn and De-Witte, 1997; Loubaud and Van Doorn, 2004; Särkkä, 2005; Elgimabi, 2011).

As cut roses are harvested at bud stage, they require nutrients to open. Ichimura *et al.* (2003) in their experiments were able to improve the bud opening and extend the vase life by using sucrose as source of nutrients for cut roses. An experiment done by Lutz and Hardenburg (1968) revealed that the cut flower should be in a healthy condition and should be free from any damages to avoid entry point for decaying microorganisms.

To prolong the postharvest life of cut flowers, various preservative solutions have been recommended by researchers. Such preservatives delay senescence and extend the vase life of cut flowers. Moreover, they prevent ethylene synthesis and pathogen development which shorten the vase life of flowers including roses (Halevy and Mayak, 1981; Gerailoo and Ghasemnezhad, 2011).

According to Ichimura *et al.* (2006), aluminum sulfate ($Al_2(SO_4)_3$) has been recommended to prolong the vase life of several cut flowers and is used as an antimicrobial compound in commercial preservative solutions. The compound acidifies vase solution, diminishes bacterial proliferation and enhances water uptake (Liao *et al.*, 2000; Hassanpour *et al.*, 2004; Tsegaw *et al.*, 2011) and can be used alone or in combination of sucrose (Hussen and Yassin, 2013). According to Seyf *et al.* (2012), aluminum sulfate concentrations ranging from 150 to 300 mg l^{-1} of solution have a positive effect on the vase life of cut roses. 8-hydroxyquinoline sulfate (8-HQS) is also the other important chemicals used in flower industry to reduce the occurrence of decaying microorganisms in vase solutions of cut flowers (De Stigter, 1981; Nowak and Rudnicki, 1990). Silver thiosulfate (STS) is also known to suppress autocatalytic ethylene production by inhibition of ethylene action (Liao *et al.*, 2000; Butt, 2003; Da Silva, 2003; Subhashini *et al.*, 2011).

Although increased trend both in production and foreign exchange earnings (EHPEA and EHDA, 2011; MoTI, 2014), no researches have been conducted in identifying suitable preservative solution to reduce postharvest losses on floricultural crops in the country. On the other hand, since roses are mainly produced for export market, it has been experienced a very high postharvest losses which impact the foreign exchange earnings of the country negatively. Therefore, the aim of this study was mainly to evaluate pulsing preservative solutions on vase life of rose and to identify and advise the best performed preservative for reduction of postharvest losses of export oriented rose flowers.

2. Materials and Methods

2.1. Description of the study area

The experiments were conducted in December 2015 in vase life experimental room of Tana Flower PLC Bahir Dar, Ethiopia, which is one of the biggest producers and exporters of cut roses in the country. The site is located at 11.710 N latitude and 37.30 ^{0} E longitude. The altitude of the site is about 1850 m above sea level and the average annual rainfall and relative humidity are about 1250 mm and 65%, respectively. The minimum and maximum temperatures of the study site during the experimental period were about 10.5^{0}C and 27^{0}C, respectively.

2.2. Experimental materials and preservative solutions

The study was conducted in two sets of experiments. In the first set, the effects of five pulsing preservative solutions including distilled

water as control were evaluated on vase life of rose variety `Maracuja`; which is a dominant rose variety produced in Tana Flora PLC. Pulsing preservative used by Tana Flora PLC for cut roses was also included in the experiment which is represented by treatment four (T4) of this experiment (Table 1). In the second set of the experiment, the best performed pulsing preservative (aluminum sulfate) was tested in four concentrations (0ppm 125pmm, 250ppm, 375ppm) to identify the optimum and area specific concentration of aluminum sulfate which prolog the vase life of rose flowers.

Table 1. Pulsing preservative solutions used in the first set of the experiment

Treatment	Pulsing preservatives & their concentrations
T1	Distilled water as control
T2	$Al_2(SO_4)_3$ (250ppm)
T3	$Al_2(SO_4)_3$ (250ppm)[b] + $Ca(ClO)_2$ (66.7ppm)[c]
T4[a]	$Al_2(SO_4)_3$ (666.7ppm) + $Ca(ClO)_2$ (66.7ppm)
T5	Sucrose (20 g l^{-1})

[a] Concentration used by Tana Flora PLC; [b] Aluminum sulfate; [c] Calcium Hypochlorite

2.3. Handling of experimental materials and pulsing procedures

Matured and uniform sized rose buds with enclosed sepals having about 60 cm stem length were harvested early in the morning, trimmed to 10 cm under water to avoid water embolisms. All leaves on the lower section of the flower stems were removed and put immediately in uniform shaped and sized flower buckets containing the pulsing preservative solutions. The amount of preservative solutions in the flower buckets was determined in such a way that about 15 cm of the rose stem cuttings were covered with pulsing solutions.

For the purpose of field heat removal, flower buckets containing the pulsing preservatives and rose stem cuttings were placed in pre-cooling room having a temperature of about 8-10 ^{O}C for about 6 hours. After field heat removal, the old preservative solutions were replaced by the new once having the same concentration and amount. Flowers were then transferred into cold room with about 2 ^{O}C room temperatures for about 24 hours for final cooling.

After cold room, the pulsing preservatives in flower buckets were replaced with distilled water and six rose flowers were put into 250 ml experimental flasks containing distilled water and transferred into vase life experimental room of Tana Flora PLC with temperature ranging from 22-25^{0}C and relative humidity of 65-70%. The pulsing procedures followed in this study resemble the practices of Tana Flora PLC for export rose flowers. The flasks containing six rose flowers each were arranged in complete randomized design (CRD) with three replications on working table. At the time of transfer to the experimental flask about 2 cm long stem was cut off at the bottom to improve transport of water through the flower stem.

2.4. Determination of physiological status of flowers and analysis

Fresh weight of flower stems (g/plant): The flask was weighed with flask + solution + flowers and weight of flask and solution was subtracted the difference in the weight signifies fresh weight of flowers. This process was repeated everyday and weight per flower stem was computed.

***Water uptake (g/flower)*:** For determining water uptake, flasks were weighed with the solution without flowers and the consecutive difference in weight signifies the water uptake.

***Transpiration loss (g/flower)*:** flowers were weighted daily along with solution and flowers, the consecutive difference in weights represent the (existence of) transpiration loss.

***Water balance*:** Water balance was calculated by subtracting the total transpiration loss from water uptake.

Flower head diameter (cm): The diameters of four randomly selected flower buds at full bloom were measured at the center using caliper and the mean values were used for analysis.

Vase life (days): Vase life of cut flowers was determined on the percentage of wilting. When the neck of 50% of the flowers in the flask bent over, the vase life was terminated as described by Lama et al. (2013). At this point discoloration and loss of petals were started (Halevy and Mayak, 1981; Liao *et al.,* 2000). The number of days starting from harvesting until this stage was counted and used for evaluation.

Collected data were subjected to analysis of variance (ANOVA) using SAS- computer soft ware version 9.1.3. Whenever the ANOVA results showed significant difference among treatments, mean separation was further performed using least significant difference (LSD**)** at 1% or 5% significance level.

3. Results and Discussion

3.1. Physiological status of rose flowers as affected by pulsing preservatives

Water uptake

It is known that cut flowers continue to loss water through transpiration, which leads to wilting. However, when cut flowers are able to absorb water, their water balance can better maintained and thus their freshness and vase life will last longer (Reddy and Singh, 1996). Although there was slight water balance reduction, flowers pulsed with Aluminum sulfate (T2) was better maintained followed those pulsed with T3 compared to other pulsing preservatives as indicated in Figure 1.

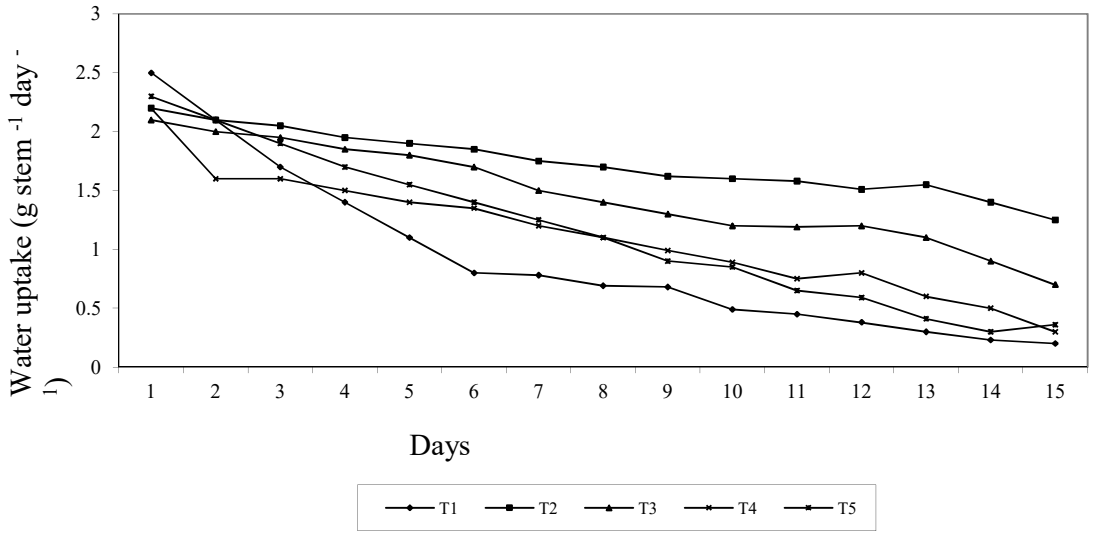

Figure 1. Effect of different pulsing preservatives on water uptake of rose flowers var. Marcuja during the vase life
T1 = distilled water; T2 = 250 ppm $Al_2(SO_4)_3$; T3 = $Al_2(SO_4)_3$ (250ppm) + $Ca(ClO)_2$ (66.7ppm); T4 = $Al_2(SO_4)_3$ (666.7ppm) + $Ca(ClO)_2$ (66.7ppm); T5 = Sucrose (20 g l^{-1})

Water loss through transpiration

According to Halevy (1976) wilting which caused by loss of water is the most common reason for termination of vase life of cut flowers. Moreover, wilting is occurred when water loss through transpiration exceeds the rate of water uptake through cut flowers. As indicated in Figure 2. Aluminum sulfate sustained stable transpiration rate of cut flowers compared to other pulsing preservatives.

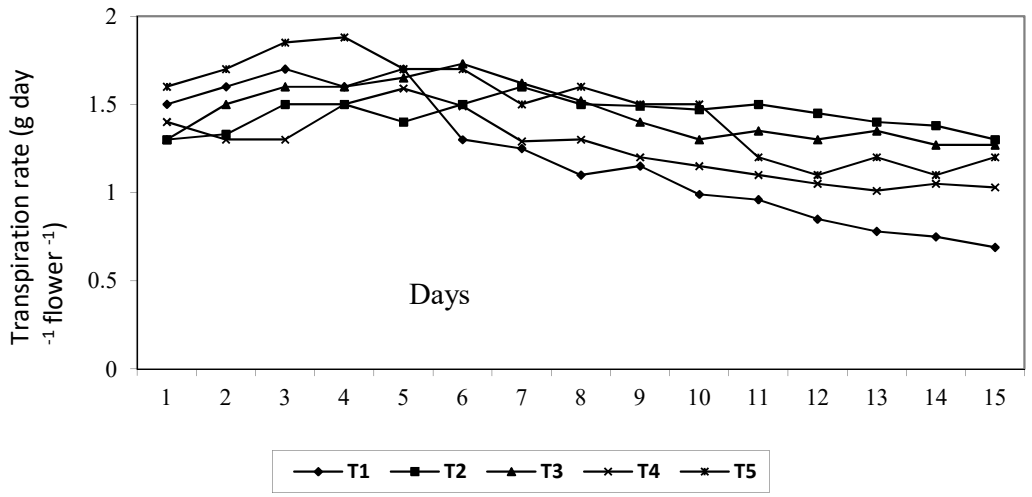

Figure 2. Effect of different pulsing preservatives on transpiration rate of rose flowers var. Marcuja during the vase life

T1 = distilled water; T2 = 250 ppm $Al_2(SO_4)_3$; T3 = $Al_2(SO_4)_3$ (250ppm) + $Ca(ClO)_2$ (66.7ppm); T4 = $Al_2(SO_4)_3$ (666.7ppm) + $Ca(ClO)_2$ (66.7ppm); T5 = Sucrose (20 g l^{-1})

Water balance

In this study, water balance of the cut flowers was determined by the difference between water uptake and water loss as indicated by Halevy and Mayak (1981). According to the author He et al. (2006) wilting is considered as termination of vase life in many flowers which is mostly caused due to water stress than natural senescence. On the other hand, the quality and longevity of cut flowers including roses is determined by water balance, which is influenced by uptake and respiration of cut flowers (Da Silva, 2003). Accordingly, wilting of cut flowers is commonly occurred when the loss of water of cut flowers through transpiration is greater than the volume of water taken by cut flowers (Halevy and Mayak, 1981). The results in Figure 3 indicated that the water balance of rose flowers, which were pulsed by aluminum sulfate (T2), showed the least negative water balance followed by T3, which confirmed relatively balanced rates of uptake and respiration of water during their vase life.

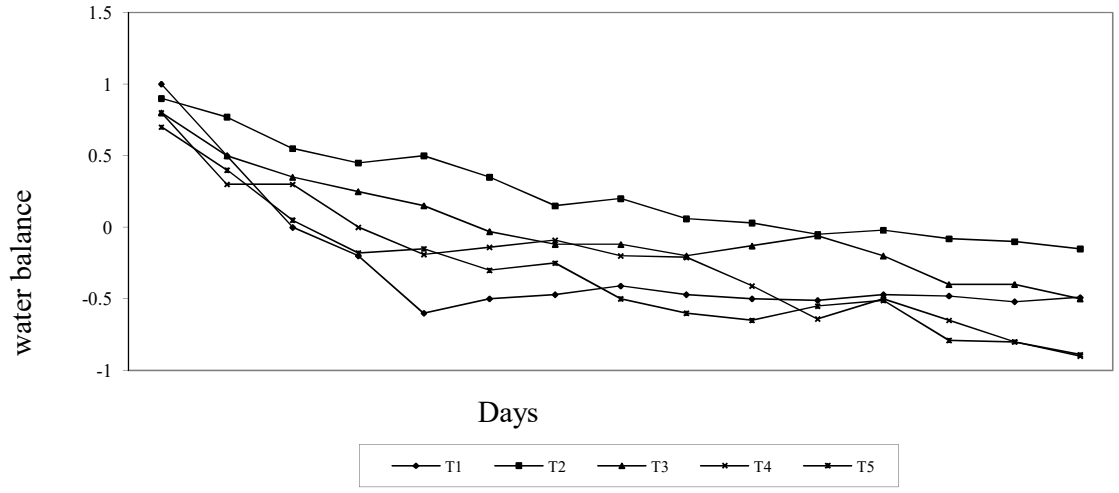

Figure 3. Effect of different pulsing preservatives on water balance of rose flowers var. Marcuja during the vase life

T1 = distilled water; T2 = 250 ppm $Al_2(SO_4)_3$; T3 = $Al_2(SO_4)_3$ (250ppm) + $Ca(ClO)_2$ (66.7ppm); T4 = $Al_2(SO_4)_3$ (666.7ppm) + $Ca(ClO)_2$ (66.7ppm); T5 = Sucrose (20 g l^{-1})

Flower weight percentage

Flower weight was assessed daily. Accordingly, the percentage decrease in flower weight was minimal in aluminum sulfate pulsed rose flowers followed by those pulsed with treatment T3, which was relatively stable up to 11th day when compared with other preservatives as well as control treatment (Figure 4).

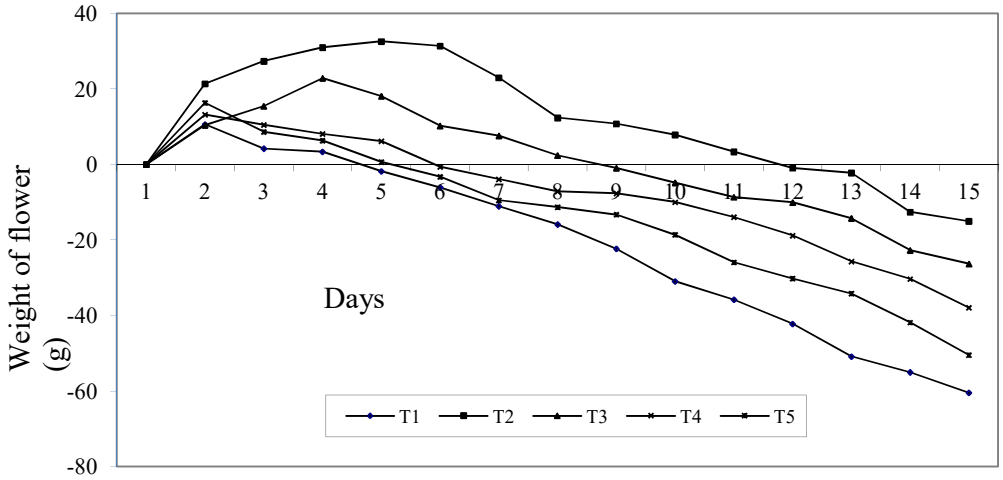

Figure 4. Effect of different pulsing preservatives on percentage of fresh weight loss during the vase life of rose flowers var. Marcuja

T1 = distilled water; T2 = 250 ppm $Al_2(SO_4)_3$; T3 = $Al_2(SO_4)_3$ (250ppm) + $Ca(ClO)_2$ (66.7ppm); T4 = $Al_2(SO_4)_3$ (666.7ppm) + $Ca(ClO)_2$ (66.7ppm); T5 = Sucrose (20 g l^{-1})

Vase life

The vase life of the cut rose flowers was determined by the number of days in which 50% of the flowers in the flask were bent over. According to the results, vase life of rose flowers pulsed with aluminum sulfate alone (T2) and treatment T3 were extended up to 14 and 9 days, respectively (Table 2). The vase life of control cut roses (T1) as well as those pulsed with treatment T4 and T5 were generally low compared to those pulsed with other pulsing preservatives. The extended vase life of those flowers is obviously associated with the stable water balance in aluminum sulfate pulsed cut flowers. The stable water balance on the other hand is probably due to the antimicrobial effect of aluminum sulfate, which reduced the proliferation of bacteria in vase solution responsible for blockage xylem and thus reduction of vase life (Van Doorn, 1997; De Stigter, 1981; Van Doorn *et al.*, 1990; Liao et al.2000, He et al., 2006). Application of aluminum sulfate in vase solutions has been also reduced bacterial blockage of xylem vessel of cut flowers in the findings of various researchers (Liao *et al.*, 2000; Tsegaw et al., 2011; Seyf *et al.*, 2012; Hussen and Yassin, 2013). Moreover, buildup of antimicrobial compounds like metal salts from aluminum sulfate prevent and/or slowdown bacterial growth and ensure proper water uptake and thus delay senescence and prolong the vase life of cut flowers (Liao *et al.* (2000) and Särkkä (2005). Furthermore, aluminum sulfate acidifies the vase solutions and diminishes bacterial growth (Liao *et al.*, 2000; Hassanpour *et al.*, 2004) and acts as a bacterial filter by forming Al $(OH)_3$ sediment on the cut surface of stem (Henriette and Clerkx, 2001). However, use of highly concentrated aluminum sulfate may reduce the vase life of cut flowers as observed in treatment T4 of this study, which is also indicated by Lama *et al.* (2013).

The reduced vase life on sugar pulsed cut flowers in this study may be associated with the proliferation of bacterial growth in sugar solution which cause plugging of vascular vessels and reduction of water uptake and thus acceleration of flower senescence as observed by Ichimura, 2003; Pun and Ichimura, (2003) and Särkkä, 2005. In this regard, Ichimura *et al.* (2003) obtained reduced vase life of flowers due to high bacterial growth in sucrose solution. Therefore, they advised the use of

sucrose preservatives in combination of chemicals having antimicrobial effects.

Table 2. Effect of different pulsing preservatives on percentage wilted Maracuja variety of rose flowers during vase life (days)

Treatment	Percentage wilted flowers														
	Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T1		0	0	5.6	27.8	55.6	77.8	100	100	100	100	100	100	100	100	100
T2		0	0	0	0	0	0	0	0	0	16.7	27.8	33.3	38.9	44.4	61.1
T3		0	0	0	0	5.6	11.1	22.2	27.8	33.3	50	66.7	100	100	100	100
T4		0	0	0	11.1	16.7	27.8	38.9	55.6	66.7	88.9	100	100	100	100	100
T5		0	0	5.6	5.6	22.2	38.9	44.4	61.1	72.2	100	100	100	100	100	100

T1 = distilled water; T2 = 250 ppm $Al_2(SO_4)_3$; T3 = $Al_2(SO_4)_3$ (250ppm) + $Ca(ClO)_2$ (66.7ppm); T4 = $Al_2(SO_4)_3$ (666.7ppm) + $Ca(ClO)_2$ (66.7ppm); T5 = Sucrose (20 g l^{-1})

3.2. Flower head diameter, fresh weight and vase life of rose flowers as affected by aluminum sulfate concentrations

In the first set of the experiment aluminum sulfate with the concentration of 250ppm alone was the best pulsing preservative that maintains the vase life of rose flowers as long as possible. The purpose of the second set of the experiment was to determine the optimum aluminum sulfate concentration specific to the conditions prevailed in the study area, as the concentration of aluminum sulfate used in the first set was obtained from research results done elsewhere.

Flower head diameter

Rose flowers, which are destined for export market, are mostly harvested as matured bud with enclosed sepals. The flower head diameter measured at the time of full bloom was larger in rose flowers pulsed with 250 ppm concentration of aluminum sulfate compared to other concentrations (Figure 5). The improved flower head diameter is probably associated with improved water uptake and thus better water balance of the flowers as indicated in the first experiment of this study.

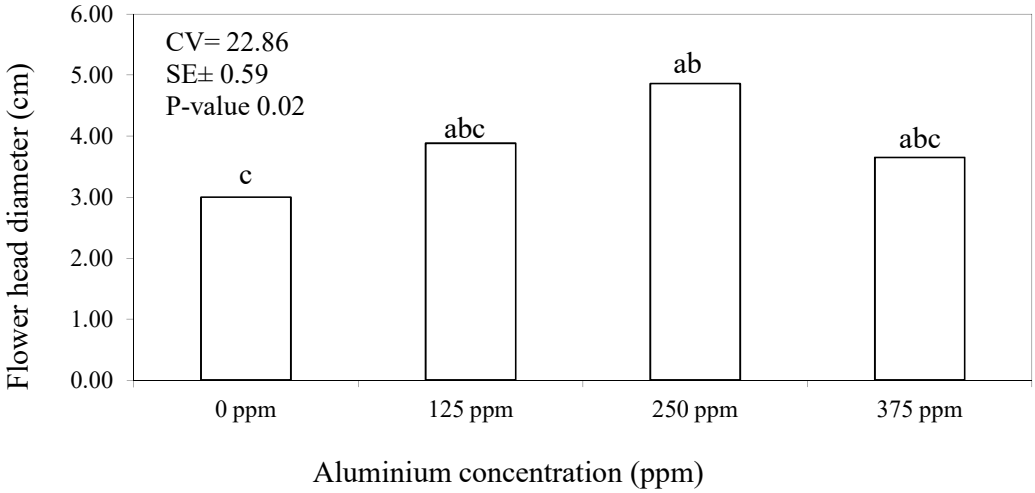

Figure 5. Effect of different rates of aluminum sulfate on flower head diameter of rose flowers var. Marcuja at full bloom

CV = Coefficient of variation; SE± - Standard error; P-value = probability value; Means following with the same letter(s) are not statistically different

Generally, the tested aluminum sulfate concentrations have positive effects on both vase life and fresh weight of Marajuca flowers (Table 3 and Figure 6). Rose flowers pulsed with 250 ppm concentration aluminum sulfate maintained their vase life to more than 13 days. The vase life of rose flowers pulsed with 125 ppm and 375 ppm of aluminum sulfate prolonged to more than 10 and 9 days, respectively; while those pulsed with distilled water terminated their vase life in about 4 days.

Reduction of fresh weight resulted from reduced water uptake is the sign of vase life termination in cut flowers. The fresh weight of rose flowers pulsed with 250 ppm of aluminum sulfate was significantly higher than those rose flowers pulsed with other concentrations as indicated in Figure 6. The results of this study showed that aluminum sulfate at the concentration of 250 ppm maintained the freshness and thus prolonged the vase life of Maracuja rose flowers; which is similar as the results obtained in the first set of the experiment. In agreement with these findings, Ichimura *et al.* (2006) and Särkkä (2005) reported that aluminum sulfate with the concentration of 250 ppm gave the longest vase life of rose flowers. Similarly, the longest vase life of various varieties of rose flowers was observed by the application of 250 ppm aluminum sulfate in the findings of various researchers (Seyf *et al.*, 2012; Hussen and Yassin, 2013; Lama *et al.*, 2013).

Table 3. Effect of aluminum sulfate concentration on percentage wilted rose flowers var. Maracuja during vase life (days)

Treatment	Percentage wilted flowers														
	Days 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0ppm	0	0	11.1	33.3	61.7	88.9	100	100	100	100	100	100	100	100	100
125ppm	0	0	0	0	0	0	0	5.6	16.7	27.9	55.6	66.7	94.4	100	100
250ppm	0	0	0	0	0	0	0	0	0	0	0	22.2	38.9	55.6	77.8
375ppm	0	0	0	0	0	0	5.6	16.7	33.3	61.1	83.3	100	100	100	100

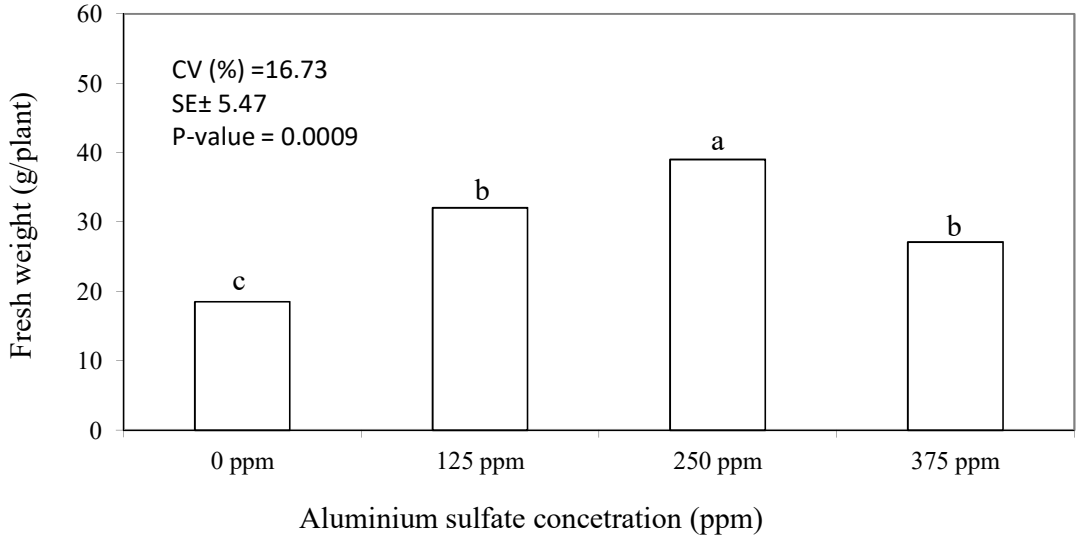

Figure 6. Effects of aluminum sulfate on fresh weight of rose flowers var. Maracuja during the vase life (14 days after pulsing

CV = Coefficient of variation; SE± - Standard error; P-value = probability value; Means following with the same letter(s) are not statistically different

4. Conclusion

The results of the present study showed that pulsing with appropriate preservative solutions maintained the freshness of rose flowers as long as possible and prolonged their vase life. Rose flowers pulsed with aluminum sulfate at concentration of 250 ppm prolonged their vase life for more than 13 days and produced bigger flower heads compared to other concentrations of aluminum sulfate. Moreover, percent in reduction of fresh weight of those flowers pulsed with 250 ppm of aluminum sulfate was minimal compared to those pulsed with other preservatives during vase life which was due to better water uptake and thus stabilized water balance. Based on the results, it is advised to incorporate 250 ppm of aluminum sulfate holding solution at production phase to maintain vase life and freshness of export oriented-rose flowers as well as those for local market.

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Linear Approach Almost Ideal Demand System Analysis of Main Vegetables in Lagos State, Nigeria

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Abstract: *The World Health Organization estimated that low vegetable intake was a factor enhancing high mortality all over the world. Studies have shown that the level of vegetable intake in Nigeria was low. Despite relatively cheap and abundant sources of micro nutrients found in vegetables, wide spread cases of micro nutrient deficiencies are still common in the study area. Thus, this study examined the demand for main vegetables in Lagos state. The result revealed that the average monthly consumption per household was 21kg and 16kg in urban and rural Lagos respectively. However, the average monthly expenditure per household was ₦2, 905.83 in urban and ₦2, 698.60 in rural areas of Lagos state. The result indicated that the coefficient of determination (R^2) falls between 0.54 and 0.92. In both areas the coefficients of all own price, and cross price parameters and household size are all statistically significant at varying levels of probabilities. Own price elasticity of demand for vegetables* indicated *that urban and rural areas are elastic and inelastic, respectively. The values of income elasticity of demand are positive and greater than 1, hence the demands for all the vegetables are elastic in nature in both areas. The cross price elasticities for both urban and rural areas have negative signs and are therefore complementary goods. Policies and strategies that would make vegetables available throughout the year should be vigorously pursued. Furthermore, to enhance vegetable consumption in the area, the public should be enlightened on the health benefits of vegetables.*

Keywords: Vegetables, micronutrient deficiencies, demands, price elasticity, LA-AIDS

1. Introduction

All over the world, there were 868 million people, who suffered from undernourishment, in the period of 2010-2012 and approximately two billion people had negative health consequences caused by micronutrient deficiencies (FAO, 2012). The demand analyses for food items play a critical role in tackling the undernourishment issue. Nigeria is blessed with good natural resources, in spite of her rich agro-ecological diversity (Oladele *et al*., 2004). The country has fertile soil that has the potential critically to add to global food security (Ariyo and Mortimore, 2011). However, the country is listed as the 54th poorest country in the world (UNDP, 2007). About 70.0% of the population lives on less than US $1.25 a day (IFAD, 2012).

The predominant food items in the Nigerian diets are starchy staple foods (rice, gari and yam) and vegetables (okra, tomatoes, onion and pepper). Vegetables are horticultural crops, which are one of the world most important foods consumed by more than half of the world's population (FAO, 2007). It has been an important food commodity for most of the people in sub-Saharan Africa particularly West Africa (FAO, 2012).Vegetables are an important component of healthy human diet. They are good sources of vitamins and minerals, vegetable proteins, protective micronutrients and dietary fibers, which help to prevent constipation (Balasubramanian and Ragunathan, 2012). They are foods with low energy density, i.e. with few calories in relation to the volume of the food consumed, which favors maintenance of healthy body weight (USDA, 2009). Eating vegetables appears to help keep the brain young and may slow the mental decline sometimes associated with growing old (Morris *et al.,* 2006). A diet including mainly spinach can boost memory power and help in cognition and better learning (Vishal, 2014).

There are no fewer than 33 vegetable markets in Lagos and the most prominent is Mile 12. Lagos markets and traders face severe problems and at the same time constitute major challenges to smooth traffic, the environment as well as enforcement of

law and order. Mile 12 Market is typically for all fresh food items in Lagos and popular for retailing in farm produce like pepper, tomato, onions, okra and fluted pumpkin, fruits, yam and other edible goods, which are all beautifully stacked in heaps of unending baskets. It is so popular far beyond the South West to the East and North Central states. Vegetables are normally cultivated in the rural areas of Lagos, while the smallholders bring greater percentages to the state from the northern part of the country.

In spite of the numerous uses of vegetables, literatures have indicated that consumption of vegetables in Africa fall short of the recommended daily intake (Hall *et al.*, 2009). Daily intake of fruit and vegetables in sub-Saharan Africa falls between 70 to 312 g per person per day, far below the WHO/FAO minimum recommendation of 400g per person per day or 146kg per person per year (Ruel *et al.*, 2004). Low vegetable intake is a critical variable influencing malnutrition and deaths all over the world (WHO, 2003). In Nigeria, micronutrient malnutrition is well known as a challenge with negative economic implications (Adish, 2009).

The diets of urban dwellers are generally more diverse than those of their rural counterparts (Smith *et al.,* 2003). It is believed that this is due to a combination of factors including the availability of a wider variety of foods in urban markets, the availability of storage facilities, changes in life styles and cultural patterns. According to Fabiosa and Soliman (2008), urban households show larger differentials in the elasticities for food and non-food items with much smaller elasticities for the food categories. Rural households on the other hand, show higher elasticities in the food categories, especially for meat, fish and dairy. However, urban households are less responsive to income changes than are rural households in the food categories; and more responsive in the non-food category. The main objective of the present study was therefore to examine the demand for vegetables in Lagos state, Nigeria.

2. Hypotheses of the Study

In this study, the following null hypotheses were tested.

- HO_1: there is no significant difference between the consumption of vegetables in urban and rural areas of Lagos state;
- HO_2: the determinants of the consumption of vegetables are not the same in urban and rural areas;
- HO_3: there is no significant difference in the demand elasticities for vegetables in urban and rural areas of state.

3. Justification of the Study

Vegetables consist of myriads of nutrients, which are beneficial to the body and can help prevent diseases and maintain good health conditions if adequately consumed. This could lead to a drastic reduction in the malnourished people in the state. They are relatively cheap sources of essential micronutrients and are therefore cost effective. Studies on demand for vegetables in Lagos state are rear in the literature. This study will broaden the understanding of household level factors that influence the demand for vegetables in urban and rural areas of the state. The result will assist in the promotional efforts to enhance vegetable consumption in the nearest future.

Consumer demand is defined as the various quantities of a particular commodity that an individual consumer is willing and able to buy as the price of that commodity varies with other factors that affect or influence the demand held constant (Tomek and Robinson, 1991). Many factors are known to affect or influence the demand for a product. These factors include own price of the product, prices of other products, consumer's income, tastes and preference (Koutsoyiannis, 1980). Other factors or determinants of demand include distribution of income, total population and its composition, government policy, weather, credit availability, advertising, past levels of demand and habits. According to Pagot (1992), factors like availability of various commodities, eating traditions and relative prices also affect demand.

According to Davis (1982), consumer demand theory investigates the food-expenditure relationships through Engel's demand curve, which is a functional relationship between households in a given period. The slope of Engel's curve measures the expenditure (income) elasticity of demand. A positive, negative, or zero elasticity implies normal, inferior and neutral goods respectively. Engel's

curve shows how purchases of food commodities change when income changes. Engel ascertained that the lower the consumer's money income, the greater the proportion of that income spent on food.

4. Materials and Methods

4.1. Area of study

Lagos state was chosen for this study because it is the second populous state in Nigeria next to Kano state with a population of over 21 million people (NPC, 2016) Nigeria. The state was created on 27th May 1967. Lagos state is arguably the most economically important state of the country (Figure 1). It contains twenty Local Governments Areas (LGAs) namely: Agege, Alimosho, Ifako-jaye, Ikeja, Kosofe, Mushin, Oshodi-isolo, Somolu, Apapa, Eti-Osa, Lagos Island, Lagos mainland, Surulere, Ajeromifelodun, Amuwoodofin, Ojo, Badagry, Ikorodu, IbejuLekki, Epe. The urban areas of Lagos includes: Lagos mainland, Ikeja, Surulere, Lekki, Lagos island etc. while the rural areas includes; Epe, Ojo, Badagry, Ijede, Eputu, Ikorodu etc.

Figure 1. Map of Lagos showing the various communities

4.2. Method of data collection

Primary data and secondary information were used for this study. The primary data were collected with the use of a structured questionnaire for information on quantity of vegetables consumed, households' income, and total expenditure per kilogram of each commodity consumed among others.

4.3. Sampling methods

A three-stage sampling techniques was used in the selection of respondents. The first stage involved random selection of 2 LGAs each of rural and urban areas of Lagos state. This was followed by random selection of 2 communities each from the selected LGAs in both rural and urban Lagos. Thirdly, 15 households were randomly selected in each community to make up a sample size of 120 respondents each for both rural and urban areas of Lagos.

4.4. Analytical framework

Descriptive statistical tools such as mean, frequency distribution and percentages were used to describe the socioeconomic characteristics of the respondents. Following Deaton and Muellbauer (1980) and Afrif *et al*. (2014), Linear Approach Almost Ideal Demand System (LA-AIDS) was used to examine the demand for vegetables as well as their elasticities. The model is given as:

$$w_{i=}\, \alpha i + \sum_j \gamma\, ij \log Pj + \beta\, i \log\left[\frac{X}{p*}\right] + \theta log Art + \delta \log Edu + \varepsilon \log \text{Xpd}$$

Where:

- $w_{i=}$ budget share (expenditure proportion) of i community group with I =1,2, 3……n
- α, β, γ = regression parameter for intercept, vegetable expenditure (with the weighing price) and aggregate price from each commodity

- $\theta, \delta, \varepsilon$ =regression parameter for the number of household member, education level of household head and total expenditure of household
- P_j = aggregate price of j^{th} commodity
- X/p* = vegetable expenditure is divided by the index weighing price
- Art = household size
- Edu = education level of household's head
- Xpd = total expenditure of household

The formula used for calculating the demand elasticities from the model are:

Own price elasticity: $e_{ii=} \frac{\gamma ii}{wi} - 1$

Cross price elasticity: $e_{ij} = \frac{\gamma ij}{wi} \ (i \neq j)$

Income elasticity: $e_{ii} = 1 + \frac{\beta i}{wi}$

5. Results and Discussion

5.1. Socioeconomic characteristics of the respondents

Majority (82.5% and 81.7%) of the respondents in urban and rural areas of Lagos respectively, are male headed households. The average age of the respondents is 48 and 43 years in urban and rural Lagos respectively. The average household size is 8 and 7 persons in the urban and rural areas respectively. It is expected that the higher the household size the higher the demand for vegetables (Table 1).

Table 1. Socio economic characteristics of respondents

	Urban				Rural			
Variable	Minimum	Maximum	Mean	Standard deviation	Minimum	Maximum	Mean	Standard deviation
Age	19	60	48.01	11.504	19	60	43.18	10.586
Household Size	3	15	8	2.486	6	10	7	1.166
Years of education	6	17	9.6	4.408	6	17	9.23	4.201
Income (₦)	60,000	300,000	107716	59279	40,000	250,00	90199	47121

Source: Field Survey 2017

The educational status of the household head was based on the numbers of years spent in school. The average years of education are 9.6 years and 9.23 years in urban and rural areas of Lagos, respectively. Ceteris paribus, the more the numbers of years spent in school the higher the income. Furthermore, the average households' income in rural is low (₦90,199) when compared with ₦ 107,716 earned by the urban households. This could play an important role in stimulating vegetable consumption in the area.

5.2. Consumption level of five vegetable commodities in urban and rural areas of Lagos

Table 2 reveals that all the households (100%) consumed vegetables. They consumed on the average 21 kg in urban and 16 kg in rural areas of Lagos. On the average, every household spends on monthly basis ₦2,905.83 and ₦2,698.60 on vegetables in urban and rural areas respectively.

Table 2. Estimated vegetable consumption in urban and rural areas of Lagos

Percentage of household which consume vegetables	100	100
(kg/capita/month)	21	16
Total expenditure per capita (₦/capita/month)	74,700	36,517
Vegetable expenditure per capital (₦/capita/month)	2905.83	2698.60
Vegetable expenditure as a percentage of the total expenditure	3.89	7.39

Source: Data Analysis, 2017

Note: The official *naira* to *dollar exchange rate* was pegged at ₦301 per $1 while the black market rate was pegged at ₦360 per $1. On the other hand, 1EUR is ₦325 and ₦400 at the official and black market rates, respectively

5.3 Estimation of the model of complete demand of vegetables

Table 3 shows that the value of the coefficient of determination (R^2) falls between 0.54 and 0.92.

Table 3. Estimates of LA-AIDS in urban areas of Lagos

	Tomatoes	Onion	Pepper	Okra	Fluted pump.
Intercept	8.34154 ***	12.5293 ** *	13.4378 ***	14.2083***	14.2580 ***
	(0.480346)	(1.50603)	(1.41676)	(2.16067)	(1.11455)
Ln(price of tomatoes	0.0081***	−1.20125***	−1.19678 ** *	−1.33176***	−1.59679 ***
	(0.0000)	(0.160261)	(0.158972)	(0.228408)	(0.0965315)
Ln (price of onion)	−0.279758 ***	0.00175***	−0.365694***	−0.429687 ***	−0.530363 ***
	(0.037323)	(0.0000)	(0.0876689)	(0.119196)	(0.0706090)
Ln (price of pepper)	−0.282427 ***	−0.370563 ***	0.00162***	−0.356811 ***	−0.426415***
	(0.0375157)	(0.0888362)	(0.000002)	(0.122210)	(0.0773418)
Ln (price of okra)	−0.176054 ***	−0.243908 ***	−0.199879 ***	0.00175***	−0.255804 ***
	(0.0301948)	(0.0676603)	(0.0684599)	(0.000003)	(0.0606547)
Ln (price of Fluted pumpkin)	−0.445524 ***	−0.635401 ***	−0.504153 ***	−0.539894 ***	0.00154**
	(0.0269334)	(0.0845930)	(0.0914417)	(0.128016)	(0.000002)
Ln(household size)	0.0586281	0.0663392	0.214375 **	0.0157076	0.0500097
	(0.0522906)	(0.108785)	(0.106319)	(0.144622)	(0.0994405)
Ln(education)	−0.0410254	0.208563	−0.317992	0.548599 *	0.213960
	(0.104411)	(0.215601)	(0.212952)	(0.282610)	(0.196759)
Ln(income)	−0.0333527	−0.0793321	−0.0629889	−0.244550 **	−0.123114
	(0.0413330)	(0.0855692)	(0.0851240)	(0.111626)	(0.0776045)
Ln (stone price index)	2.33344 ***	3.55509***	3.30010 ** *	3.55813 ***	4.14702 ***
	(0.0847274)	(0.357203)	(0.374391)	(0.557952)	(0.215884)

Source: Data Analysis, 2017. Values in parentheses are the standard errors

The parameters are positive and significant at different levels ranging from 90%-99%. The assumption of own price parameter is all significant at the level of 1% for both urban and rural Lagos. This is in accordance with previous studies. The variables with positive signs suggest a direct relationship between the price of another commodity and the commodity expenditure. Most of the cross price parameters are negative and influences the proportion of vegetable expenditure at 1% level. This implies that all the commodities have the opposing relation between the expenditure proportions of one commodity with the price of another vegetable commodity. The higher the price of another commodity the lower is the proportion of commodity expenditure. Most of the coefficients

of household size were not significant except for the coefficient of pepper, which is positively signed and statistically significant at 5% level of probability. The positive sign implies that an increase in household size ceteris paribus would lead to an increase in budget share.

Also, the coefficients of education were not significant except for the coefficient of okra which is positively signed and significant at 10% level of probability. This means education is not an important variable as far as budget share is concerned. On the other hand, most of the coefficients of income were negatively signed but not significant except for the coefficient of okra, which is significant at 5% level of probability. The negative signs suggest as income increases, the proportion of income spent on consumption decreases (Engel's law).

In the rural areas of Lagos, the signs on the coefficients on all own price parameters are also positive and significant at 1% level of probability. Most of the cross price parameters are negative and important at 1% level of probability (Table 4).

Table 4. Estimates of LA-AIDS in rural areas of Lagos

	Tomatoes	Onion	Pepper	Okra	Fluted pump
Intercept	8.88782*** (0.770357)	14.9338 ** * (1.7333)	11.4328 ** * (1.09423)	26.4045 *** (3.21987)	13.7220 *** (1.30277)
Ln(price of tomatoes	0.0068*** (0.00002)	−0.824222 *** (0.168788)	−1.00903*** (0.0849777)	−2.43185 *** (0.248285)	−1.28208 ** * (0.0928288)
Ln (price of onion)	−0.214549 *** (0.0439362)	(0.00065)** (0.0000)	−0.213305 ** (0.0621083)	−0.585159 *** (0.163800)	−0.364175 *** (0.0700210)
Ln (price of pepper)	−0.554505 *** (0.0466989)	−0.450320*** (0.131120)	(0.00043)*** (0.0000)	−1.23014 *** (0.222537)	−0.783294 *** (0.0857077)
Ln (price of okra)	−0.190635 *** (0.0194633)	−0.176221 *** (0.0493286)	−0.175476 *** (0.031744)	(0.00038)*** (0.0000)	−0.232928 *** (0.0367091)
Ln (price of Fluted pumpkin)	−0.493063*** (0.0357003)	−0.538045 *** (0.103451)	−0.548167 *** (0.0599801)	−1.14273 *** (0.180093)	0.00035** (0.0000)
Ln(household size)	−0.105481 ** (0.0521692)	−0.177287 * (0.102749)	0.0297328 (0.0716028)	−0.416961 ** (0.185556)	−0.170558 ** (0.0841154)
Ln(education)	−0.0409277 ** (0.0338308	0.0351208 (0.0666612)	−0.0265628 (0.0458670)	−0.324411*** (0.117663)	−0.0202504 (0.0548776)
Ln(income)	−0.0409277 (0.0338308)	−0.375484 *** (0.129662)	0.0545426 (0.0924033)	−0.0650103 (0.244962)	0.110962 (0.110128)
Ln (stone price index)	2.28736 *** (0.0966933)	2.97302 *** (0.370630)	2.63052 *** (0.201112)	6.03736 *** (0.626241)	3.38825 * ** (0.208441)

Source: Data Analysis, 2017. Values in parentheses are the standard errors

Most of the coefficients of household size were negative and important of at 5% and 10% levels of probability. The negative signs imply that as the household size increases budget share on vegetables also decreases. Few of the coefficients of education were negative and significant at 1% and 5% levels. This means education is an important variable influencing the budget share in the rural areas of Lagos. On the other hand, most of the coefficients of income were negatively signed, but not significant except for the coefficient of onion, which is important of at 1%.

5.3. Elasticity

Elasticity measures the responsiveness of quantity (demand or supply) to changes in the factors that affect the demand or supply. Elasticity of demand is the responsiveness of quantity demanded of a commodity to changes in the factors that cause the change in the demand. The important elasticities of demand are: price, income and cross elasticity of demand (Table 5).

Table 5. Value of own price elasticity in rural and urban areas of Lagos

Area	Tomatoes	Onion	Pepper	Okra	Fluted pumpkin
Urban area	-0.87084	-0.56395	-0.76473	-0.56849	-0.74415
Rural area	-0.81512	-0.23215	-0.70004	-0.67125	-0.63918

Source: Field Survey 2017

The own price elasticities for each commodity are negative for both the urban and rural areas. This is in line with the law of demand, which states that the higher the price, the lower the quantity demanded. Another notable characteristic is that all the price elasticities are less than 1. This signifies that, the percentage change in quantity of each commodity is smaller than the percentage change in price in both urban and rural Lagos. The elasticities values of all the vegetables are higher in the urban than in the rural areas. This shows that the demand for vegetables in urban and rural is elastic and inelastic respectively.

The income elasticity of demand is the proportionate change in the quantity demanded of a commodity resulting from a proportionate change in the income of the consumer (Table 6). For all the vegetables, the values are positive and greater than 1, hence the demand for all the vegetables is elastic in nature. Income elasticity of demand is used to classify goods into luxuries, necessities and inferior goods. Luxuries have income elasticity that is greater than 1, necessities have income elasticity that is between 0 and 1 and inferior goods have income elasticity that is less than 0. A good may not be superior or inferior every time, it depends on the income level of the consumers (Engel's law).

Table 6. Value of income elasticity in urban and rural areas of Lagos

Area	Tomatoes	Onion	Pepper	Okra	Fluted pumpkin
Urban area	1.505202	1.101812	1.153883	1.039816	1.199287
Rural area	1.436373	1.097128	1.212468	1.060899	1.203133

Source: Field Survey 2017

Cross elasticity is the proportionate change in the quantity demanded of a commodity (X) resulting from a proportionate change in the price of another commodity (Y). Table 7a and Table 7b showed that the cross price elasticity for both urban and rural areas have negative signs. It is normally used to classify goods as complementary and substitute goods. Complementary goods have negative cross elasticity. On the other hand, substitutes have positive cross elasticity. The higher the value of the cross elasticity, the stronger is the degree of substitutability or complementarily of commodities X and Y.

Table 7. Effects of cross price changes towards the demand for vegetables in urban Lagos

Price	Tomatoes	Onion	Pepper	Okra	Fluted pumpkin
Tomatoes	-	-0.043	-0.060	-0.097	-0.027
Onion	0.0218	-	-0.087	-0.027	-0.080
Pepper	-0.020	-0,058	-	-0.103	-0.087
Okra	-0.024	-0071	-0.096	-	-0.094
Fluted pumpkin	-0.068	-0.039	-0.082	-0.062	-

Source: Field Survey 2017

Table 8. Effects of cross price changes towards the demand for vegetables in rural Lagos

Price	Tomatoes	Onion	Pepper	Okra	Fluted pumpkin
Tomatoes	-	-0.040	-0.081	-0.163	-0.090
Onion	0.193	-	-0.062	-0.023	-0.024
Pepper	-0.021	-0.073	-	-0.021	-0.042
Okra	-0.032	-0.062	-0.021	-	-0.024
Fluted pumpkin	-0.090	-0.026	-0.063	-0.071	-

Source: Field Survey 2017

6. Conclusion

The study analyzed the demand for main vegetables in urban and rural areas of the Lagos state. The result revealed that people in the urban areas consumed more vegetables when compared to those in the rural areas. This could be due to the wide gap between their income levels. Furthermore, the average monthly consumption per household was 21 kg and 16 kg in urban and rural Lagos respectively. However, the average monthly expenditure per household was ₦2, 905.83 in urban and ₦2, 698.60 in rural areas of Lagos. The average total expenditure of households was ₦74,700 and ₦36, 517, while the vegetable expenditure as a percentage of the total expenditure were 3.89 and 7.39 in urban and rural areas of Lagos respectively. In both areas the coefficients on all own price parameter, cross price parameter and household size are all important at varying levels of probabilities. Own price elasticity indicated that the demand for vegetables in urban and rural areas are more elastic and inelastic respectively. The values of income elasticity of demand are positive and greater than 1. Hence, the demands for all the vegetables are elastic in nature in both areas. The cross price elasticities for both urban and rural areas have negative signs and are therefore said to be complementary goods. Policies and strategies that would make vegetables available throughout the year by reducing post-harvest losses should be vigorously pursued. Furthermore, the public should be well educated on the health benefits of vegetables.

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Weed-bed Macro-invertebrate Composition and Abundance in Relation to Water Hyacinth (*Eichhornia crassipes* (Mart) Solms) in the North-Eastern Lake Tana, Ethiopia

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Abstract: *The composition and abundance of weed-bed macro-invertebrates were assessed using data from Lake Tana from September, 2012 to May, 2013. Higher weed-bed macro-invertebrates density (6395ind/m^2 inaverage) was recorded in the weed-infested sites. Ephemeroptera was the dominant taxa in weed-infested sites while Hemiptera in the non-infested sites. Statistically there were no significant spatial variations in the density of weed-bed macro-invertebrates in the weed infested and non-infested sites except coleopteran. Seasonally, however, Ephemeroptera, Diptera and Coleoptera showed highest peak density during the dry season in the weed-infested site. While, Hemiptera and Basommatophora, during the rainy reason and Diptera during post rainy season showed peak density in the non-infested sites. The results obtained from Hilsenhoff-Family Level Biotic Index H-FBI categorized site Ribas the highest organic and nutrient polluted site while site Debre-Sinaas the least perturbed site. Though, the results of H-FBI did not show clear difference between the weed-infested and non-infested sites, the observed spatial disparity in taxa may be explained by the variation in the density of prey items, interstitial space for refuge, and presence of predators coupled with small variations in physico-chemical factors. Presence of higher density of beetle species of the families Dytiscidae and Hydrophylidae at the leaf and root interface of water hyacinth seemed to have association between them. Therefore, further investigation is recommended to see their effect and interactions with the weed so as to use those beetles as biological agent to control the weed.*

Keywords: Biotic index; niche diversity; organic pollution; tolerance level; weed

1. Introduction

Ecological effects of Invasive Alien Species (IAS) on inland water ecosystems vary significantly depending upon the invading species, the extent of the invasion, and the vulnerability of the ecosystem being invaded (Levine, 2000). Loss and degradation of biodiversity due to IAS can occur at all levels of biological systems, extending from species to ecosystem levels, and may involve major alterations to the physical habitat, water quality, essential resources and ecological processes. These effects can vary in terms of the lapse of time between the initial introduction and subsequent spread of an IAS, the severity of its effect, the likelihood of synergistic interactions with other threatening processes, and the potential for initiation of a cascade of effects ramifying throughout an entire ecosystem (Levine, 2000; Shuvra, 2013).

Aquatic plants are ideal habitats for macro-invertebrate colonization (Arti *et al*., 2015). However, non-native species such as water hyacinth, through restricting the photosynthetic activities of other aquatic macrophytes via shading effect, may seriously alter the ecosystem functions that other macrophytes provide (Luken and Thieret, 1997). Comparative studies on non-native species, water hyacinth and native species show that native macrophytes supported different macro-invertebrate assemblages (Toft *et al*., 2003).

On the other hand, water hyacinth mat at the edge of open water or the presence of few water hyacinth plants support highest density of macro-invertebrates as compared to other rooted emergent vegetation (Barker, 2011). Therefore, this study was aimed to identify the major changes in the composition and abundance of weed-bed macro-invertebrate community in temporal and spatial bases, comparing water hyacinth-infested areas

with non-infested areas of the lake and check the degree of perturbation using community characteristics and structure of macro-invertebrates.

2. Materials and Method

2.1. The study area

Lake Tana is found in the Abay basin in the north-western highlands of Ethiopia at an elevation of 1800m which is the largest (3150 km^2) freshwater body (Eshete *et al.,* 2002). It is a shallow lake with a mean depth of 8m and with a volume of 28,000km^3 (Margareta 2015). Its water level depends on the volume of the outflow to Blue Nile River and, the recently constructed Tana-Beles hydropower and irrigation scheme and the volume of inflow from the tributary rivers especially during the main rainy season. The lake has eight permanent inflowing rivers (Gilgel Abay, Rib, Gumara, Dirma, Megech, Gelda, Arno-Garno and Enfranz), which contribute more than 95% of the inflow (Tenalem, 2009). The Lake is meso-oligotrophic, turbid and frequently mixed with short duration of thermocline (Eshete *et al*., 2004). The climatic condition of the lake region is characterized by four seasons: post-rainy season, main rainy seasons, dry season and pre-rainy season (Eshetie, 2003). The rainfall pattern is also uni-modal. Mean annual rainfall varies from 947.9 to 1274.2 mm with a mean value of 1102.1 mm. Long-term rainfall distribution data indicates that most of the rain occurs in July followed by August. The mean annual air temperature of the lake area varies between 19.02°C and 22.68°C. Maximum temperature was occurred in March and April and the minimum in December and January (Wondie, 2013).

2.2. Sampling sites and procedures

Sampling was carried out once during each of the four seasons. Sampling stations were selected on the basis of the extent of invasion by the weed and subsequently categorized as infested and non-infested stations (Table 1 and Figure 1).

Table 1. Description of sampling stations

Sampling sites	Site description	Depth Range (m)	Coordinates	
			Latitude	Longitude
Water hyacinth infested site				
Addisgie-Dingie (Ad)	Close to Megech river mouth	0.42 - 0.62	12° 16' 15.3"N	37° 22' 55.7"E
Achera (Ac)	Close to a farm land	0.56 – 1.21	12° 16' 59.9"N	37°21' 43.5"E
Kerigna (Kr)	Sand beach close to a farm land	0.28 – 1.60	12° 07' 29.4"N	37° 36' 22.1"E
Non-weed infested site				
Rib (Rb)	Close to Rib river mouth	0.15 – 0.60	12° 02' 24.9"N	37° 35' 53.8"E
Dirma (Dr)	Close to Dirma river mouth	0.65 – 1.50	12° 15' 49.6"N	37° 18' 18.5"E
Debresina (Db)	Conserved wetland close to the monastery of Debre-Sina	0.98 – 2.30	12° 14' 33.5"N	37° 18' 01.2"E

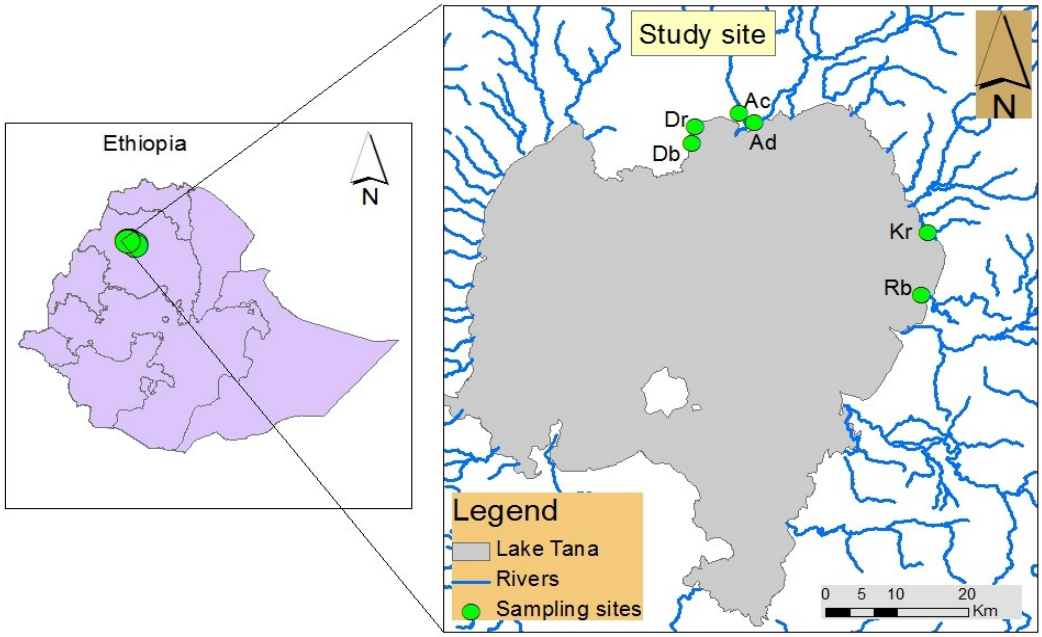

Figure 1. Map of Lake Tana and its catchment areas with sampling sites [Water hyacinth infested sites]

2.2.1. Measurement of physico-chemical parameters

Dissolved Oxygen (DO), pH, specific conductance, Total Dissolved Solid (TDS), salinity and temperature were measured *in situ* using YSI 556 multi-probe system. Transparency of the water was measured by lowering a 30 cm diameter circular disc (Secchi disc) with a calibrated cable into the water column.

Measurements of Ammonia (NH_3-N) were based on an indophenol method, Phosphate (PO_4-P) based on Palintest Phosphate LR method and silica (SiO_2) using Ammonium Molybdate in the form of tablet at 640 nm wave length and Nitrate (NO_3-N) based on Palintest Nitratest method and Total hardness based on a unique colorimetric method using Hardicol No.1 and No.2 tablets at 570 nm wave length and were carried out using a portable water analysis kit (Wagtech International, Palintest transmittance display photometer 5000). Nutrient analyses were made in the shore area immediately after sample collection using water samples filtered through Whatman GF/F.

2.2.2. Weed-bed Macro-invertebrate

Weed-bed Macro-invertebrates were collected using aquatic deep net with an effective area of 0.07065 m^2 and mesh size of 500 µm from the surface of water with Macrophytes (Barbour *et al*., 1999). Samples were collected four times (in September and December 2012, and March and May, 2013) at weed infested and non-infested areas, concurrently the physico-chemical measurements were also done. Triplicate samples were collected from each site within 3 seconds in 3 meter intervals to avoid disturbance. All three samples collected in a station were combined to obtain a composite sample. The samples were, then, preserved in 95% ethyl alcohol and all the dislodged organisms were carried by the water into the net. Then, the net was removed from the water with an upward scooping motion to prevent any of the organisms it contained to wash away; after which the contents of the net were poured into a bucket with water. All debris and organisms were handpicked from the net. The above procedures were then repeated for the collection of the second and third samples within the same station. The macro-invertebrates were carefully separated from the substrate (if present) using forceps in the Bahir Dar Fishery & Other Aquatic Life Research Center. This study was limited to the identification of the aquatic macro-invertebrates to the family level for consistency among samples.

2.3. Statistical analysis

For macro-invertebrate communities, Non-parametric Kruskal–Wallis test was employed to see temporal differences of organisms counted, whereas the Mann–Whitney test was used for pair-wise comparisons when testing spatial variations

between the two sites. Hilsonhoff-Family level Biotic Index (H-FBI), which is an average of tolerance values of all the macro-invertebrates families in a sample, was employed. H-FBI was calculated according to Mandaville (2002).The relationship between the abundance of macro-invertebrate taxa with physico-chemical variables was assessed by using a multivariate analysis tool, Redundancy Analysis (RDA), using CANOCO for windows version 4.5 and verified by Pearson's correlations.

3. Results and Discussion

3.1. Weed-bed Macro-invertebrates Composition and Abundance

In this study, a total of 19,218 individuals from the weed-infested and 10,320 individuals from non-infested sites were collected, which belong to 4 classes, 10 orders and 29 families. Ephemeroptera, with two families, was the dominant taxon, which accounted for 55% of the total macro-invertebrate density in the weed-infested sites, followed by Diptera and Coleoptera, with four and five families that accounted for 18% and 12%, respectively. In the non-infested sites, Hemiptera was the dominant taxon, which accounted for 26% of total macro-invertebrate density (Figure 2). In Lake Tana, dominancy of Ephemeroptera and Hemiptera was reported by Dereje (2009) before the infestation of water hyacinth. In this investigation, however, Ephemeroptera was the most dominant in the weed-infested sites, while Hemiptera was prominent in the non-infested sites. Caenidae and Baetidae (Ephemeroptra), Coenagrionidae (Odonata), Dytiscidae and Hydrophilidae (Coleoptera), and Chironomidae (Diptera) had higher density in the weed-infested site than the non-infested sites. On the other hand, Corixidae (Hemiptera) showed higher density in the non-infested sites.

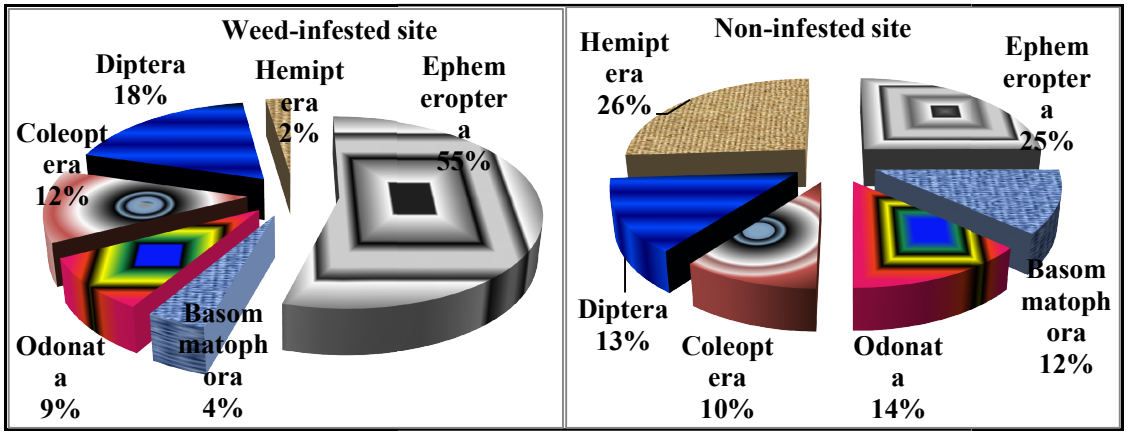

Figure 2. Percentage contribution of different weed-bed macro-invertebrates of the total macro-invertebrate density

No significant spatial variation was observed in the density of weed-bed macro-invertebrates except coleopteran, which exhibited significant differences between the weed-infested and non-infested sites (Mann-Whitney test, $p<0.05$). Seasonally, Ephemeroptera, Diptera and Coleoptera showed the peak density (1853, 704 and 416 ind/m^2, respectively) during the dry season in the weed-infested site. Hemiptera and Basommatophora during the rainy reason and Diptera during the post rainy season showed peak density (651, 293 and 200 ind/m2, respectively) in the non-infested sites (Figure 3). In both sites, density of weed-bed macro-invertebrates was lowest during the pre-rainy season. Ephemeroptra and Coleoptera showed significant seasonal variations in the weed-infested sites (Kruskal Wallis test, $p<0.05$). In this investigation, generally higher abundance of macro-invertebrates was observed in the weed-infested sites. Particularly, higher density of both Caenidae and Baetidae (Ephemeroptera), Dytiscidae and Hydrophylidae (Coleoptera) and Chironomidae (Diptera) was favored by the presence of water hyacinth. The fact that most of their larvae were collected from the complex root structure indicates the fibrous root structure of water hyacinth creates favorable niche diversity. Similar findings were also reported by Villamagna (2009). Floating aquatic plants including water hyacinth support many macro-invertebrates, especially at the edge of the floating mat (Rocha-Ramirez et al., 2007). The positive relationship between surface areas of floating macrophytes and epiphytic macro-invertebrates was also reported by

Brendonck *et al*. (2003) and Rocha-Ramirez *et al*. (2007).

Hilsenhoff (1988) categorized the pollution level of a water body into seven based on scores obtained from the macro-invertebrates density and tolerance value (0 to 10). Based on the scores obtained from weed-bed macro-invertebrates; sites Kr and Db with H-FBI scores of 6.06 and 6.49, respectively, had substantial organic pollution, which signifies fairly poor environmental condition. While sites Ac, Ad and Dr with H-FBI scores of 6.88, 6.50, and 6.65, respectively, had poor environmental condition. However, site Rb with H-FBI score of 7.78 was likely to have suffered from severe organic pollution, which signifies a very poor environmental condition (Table 2.).

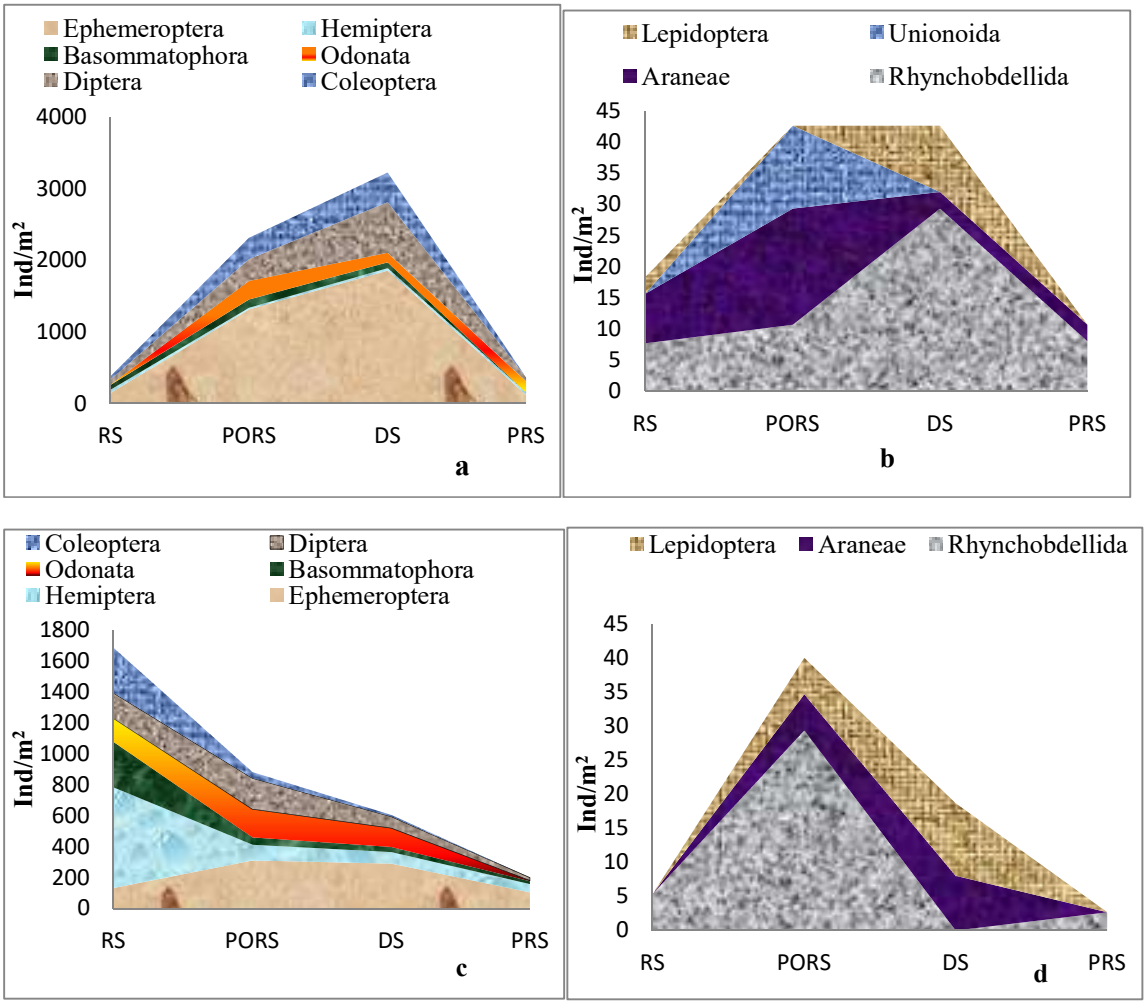

Figure 3. Seasonal trends of weed-bed macro-invertebrates density in the weed infested sites (a & b) and non-infested sites (c & d)

Note: RS = rainy season, PORS = post rainy season, DS = dry season, PRS = pre-rainy season

Nevertheless, the overall results obtained from H-FBI showed that site Rb had the highest organic and nutrient pollution while site Db had the least. The results of this biotic index did not show clear difference between the weed-infested and non-infested sites. However, the observed spatial disparity in taxa may be explained by the variation in the density of prey items, interstitial space for refuge, and presence of predators coupled with small variations in physico-chemical factors (Jonathan, 2001).

Table 2. Composition and abundance of weed-bed macro-invertebrates and their pollution tolerance level and H-FBI scores for the study sites

Order / Family	Tolerance level	Weed-infested sites Abundance (ind./m^2)					Non-infested sites Abundance (ind./m^2)				
		Ac	Ad	Kr	Average	H-FBI	Dr	Db	Rb	Average	H-FBI
Ephemeroptera		**5264**	**2274**	**2744**	**3427**		**464**	**1416**	**640**	**840**	
Caenidae	7	5160	1825	312	2432	2.70	80	928	176	395	0.87
Baetidae	4	104	449	2432	995	0.63	384	488	464	445	0.56
Basommatophora		**272**	**130**	**368**	**257**		**0**	**1064**	**112**	**393**	
Planorbidae	7	200	80	96	125	0.139	0	296	0	99	0.219
Physidae	8	16	40	272	109	0.138	0	424	112	179	0.453
Lymnaeidae	6	56	10	0	22	0.021	0	344	0	115	0.218
Odonata		**352**	**420**	**904**	**559**		**64**	**1208**	**112**	**461**	
Aeshnidae	3	24	1	64	30	0.014	0	360	0	120	0.114
Coenagrionidae	9	328	419	760	502	0.716	64	720	104	296	0.844
Libellulidae	9	0	0	80	27	0.038	0	128	8	45	0.129
Coleoptera		**384**	**395**	**1528**	**770**		**0**	**1000**	**24**	**341**	
Psephenidae	4	0	0	16	5	0.003	0	0	0	0	-
Elmidae	5	0	1	0	1	0.001	0	0	0	0	-
Dytiscidae	5	320	266	584	390	0.309	0	424	0	141	0.224
Hydrophilidae	5	40	120	928	363	0.287	0	552	24	192	0.30
Staphylinidae	-	24	8	0	11	-	0	24	0	8	-
Diptera		**984**	**793**	**1624**	**1134**		**768**	**272**	**336**	**460**	
Chironomidae (Blood-red)	8	320	72	1368	587	0.74	720	216	144	360	0.912
Chironomidae (other)	7	656	718	240	538	0.511	48	8	0	19	0.035
Ceratopogonidae	6	0	0	0	0	-	0	8	0	3	0.005
Culicidae	8	0	3	0	1	0.001	0	32	192	75	0.189
Tabanidae	6	8	0	16	8	0.007	0	8	0	3	0.005
Lepidoptera		**0**	**0**	**8**	**3**	**-**	**0**	**0**	**0**	**0**	**-**

Table 2. Continued

Order / Family	Tolerance score	Weed-infested site Abundance(ind./m^2)					Non-infested site Abundance (ind./m^2)				
		Ac	Ad	Kr	Average	H-FBI	Dr	Db	Rb	Average	H-FBI

Pyralidae	5	0	0	8	3	0.002	0	0	0	0	-
Hemiptera		**88**	**55**	**296**	**148**		**112**	**216**	**2312**	**879**	
Naucoridae	5	56	0	0	19	0.015	8	0	16	8	0.013
Nepidae	8	0	0	32	11	0.013	0	16	8	8	0.02
Gerridae	-	0	8	0	3	-	56	104	40	67	-
Belostomatidae	10	8	0	72	27	0.04	0	48	16	21	0.067
Corixidae	9	0	7	120	42	0.06	0	0	1744	581	1.66
Veliidae	6	0	0	32	11	0.01	48	0	0	16	0.03
Mesoveliidae	-	0	40	8	16	-	0	32	272	101	-
Notonectidae	-	24	0	32	19	-	0	16	216	77	-
Rhynchobdellida		**48**	**15**	**104**	**56**	**-**	**0**	**112**	**0**	**37**	-
Glossiphoniidae	8	48	15	104	56	0.07	0	112	0	37	0.09
Unionoida		**40**	**0**	**0**	**13**		**0**	**0**	**0**	**0**	
Sphaeridae	8	40	0	0	13	0.013	0	0	0	0	-
Araneae		**40**	**8**	**48**	**32**		**16**	**16**	**8**	**13**	
Pisauridae	-	40	8	48	32	-	16	16	8	13	-
Total (mean of three sites)						**6.48**					**6.97**

3.2. Relationship between physico-chemical variables and density of weed-bed Macro-invertebrates

The relationship of physico-chemical variables with weed-bed macro-invertebrate density is shown in Figure 4. In this Redundancy Analysis, the first two axes accounted for 74.4% of the cumulative percentage of variance in species–environment relationship. Axis 1 accounted for 48.7 % of the variation and show strong positive correlation with phosphate, ammonia and temperature and negative correlation with total hardness, silica, TDS, salinity and dissolved oxygen concentration. Similarly, Axis 2, which accounted for 25.7% of variance, was showed positive but weak correlation with Secchi depth, nitrate, phosphate, dissolved oxygen and silica, and negative correlation with total hardness, pH and temperature concentrations.

Density of Hemiptera was strongly correlated with DO and silica (r = 0.99 and 0.96, respectively, at $p<0.01$) and with salinity and TDS (r = 0.91 and 0.90, respectively, at $p< 0.05$), respectively. Lepidoptera showed strong positive correlation with ammonia (r = 0.92, $p<0.01$). Similarly, Araneae showed strong positive correlation with temperature (r = 0.85, $p<0.05$). Odonata, Coleoptera and Rhynchobdellida showed strong but negative correlation with total hardness (r = -0.97, -0.95 and -0.97, respectively, at $p<0.01$).

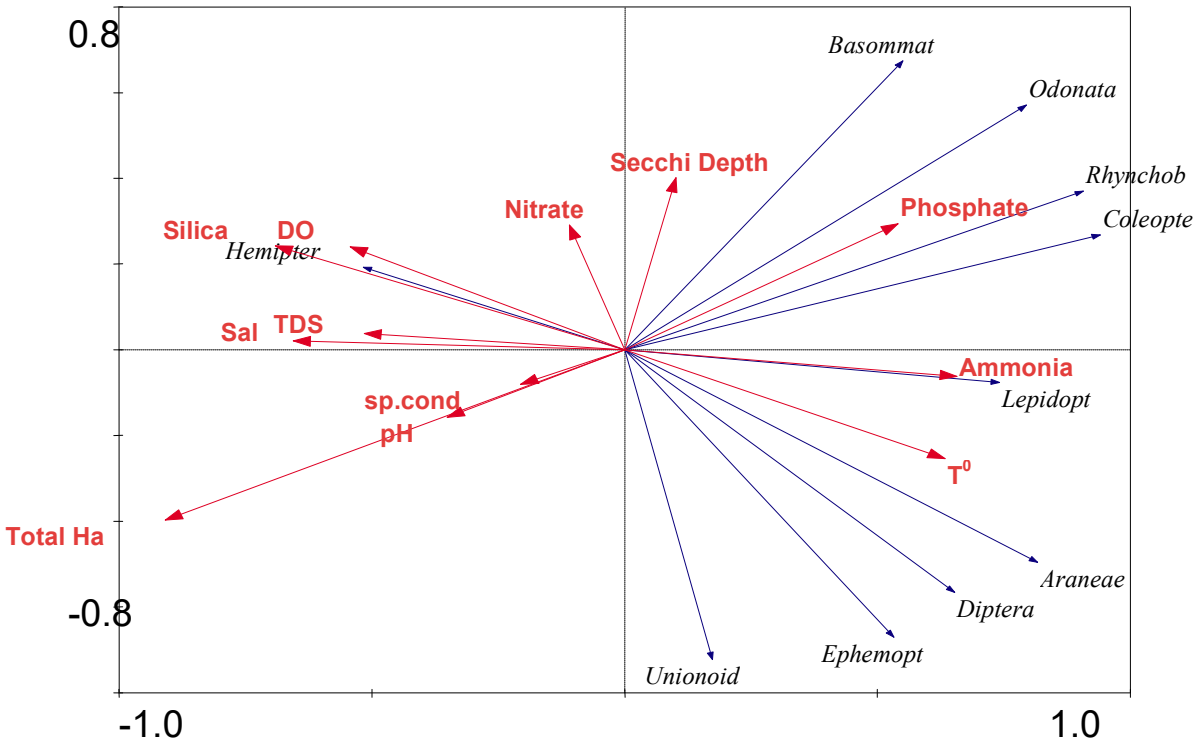

Figure 4. Graph for Redundancy Analysis (RDA) demonstrating the relationship between macro-invertebrate taxa from weed-bed and physico-chemical variables

Note: Ephemopt = Ephemeroptera, Coleopte = Coleoptera, Lepidopt = Lepidoptera, Unionoid = Unionoida, Rhynchob = Rhynchobdellida, Basommata = Basommatophora, T^0 = temperature, TDS = total dissolved solids, sp. cond = specific conductance, sal = salinity and Total Ha = total hardness

4. Conclusion

Though the variation was not statistically significant, higher weed-bed macro-invertebrate diversity and abundance was observed in the weed-infested sites. This may indicate that the presence of water hyacinth mats in the lake did not affect weed-bed macro-invertebrate fauna, which inhabit mainly the uppermost water column. However, the observed density variation between the two sites was due to slight variations in physico-chemical variables together with the availability of abundant food, diverse niche and refuges, which favored their abundance and diversity. In general, the existing water hyacinth biomass did not pose significant effect on lake macro-invertebrates composition and abundance. During this investigation, relatively high density of beetle

species of the families Dytiscidae and Hydrophylidae, were observed at the leaf and root interface of water hyacinth. They could be possible biological agents for controlling water hyacinth proliferation. Therefore, further investigation is recommended to see their effect and interactions with the weed.

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On-farm Lamb Birth Weight and Growth Performance of Indigenous Sheep Breeds in Burie District, North Western Ethiopia

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Abstract: *This study was conducted in Burie District in North Western Ethiopia. The objectives of the study were to assess the on-farm birth weight and growth performance of indigenous sheep lambs. Three kebeles were selected for this study in Burie District. From each kebele 20 farmers having 5 or more breeding ewes were selected randomly. This study was conducted for 6 months. Farmers fed their breeding ewes on grazing lands and crop aftermath. The breeding ewes were supplemented with Atella (a residue of local alcoholic beverage) and food leftover. On average, there were 7.6 (SD =2.58) and 8.0 (SD = 3.50) heads of sheep per household at the beginning and at the end of the study, respectively. The birth weight of male lambs (2.6 kg) was greater ($p<0.001$) than the birth weight of female lambs (2.1 kg). The birth weight of Washera lambs (2.8 kg) was greater than the birth weight of Horro lambs (1.8 kg). There was no difference on the mean growth rate of male and female lambs. In addition, there was no difference on growth rate between Washera and Horro lambs. Generally, Washera lambs were heavier at birth than Horro lambs. There was no difference in body weight and growth rate between the two sheep breed lambs at 112 days of age. The results of this study indicated that Horro lambs had a lower birth weight than Washera lambs, but Horro lambs had similar body weight and growth rate with Washera lambs at 112 days of age when the two sheep breeds are compared within their respective breeding environments. To confirm the current results further studies should be conducted involving more animals and comparing the two breeds within the same environmental conditions.*

Keywords: Birth weight, Ethiopia, growth rate, Horro, sheep, Washera

1. Introduction

Ethiopia has currently 25.5 million heads of sheep (CSA, 2011). Female sheep are primarily kept for breeding purpose in the country. Among the sheep kept age two years and older, about 49.6% are kept for breeding and about 3% for mutton production. Generally, small flock sizes predominate in the highlands of the country and relatively larger flock sizes are found in the lowlands of the country (Solomon *et al.,* 2010).

The sheep population in Ethiopia is genetically diverse. According to Solomon (2008), there are nine sheep breeds in the country. These are Simien, Short-fat-tailed, Washera, Gumz, Horro, Arsi-Bale, Bonga, Afar and Black-head-Somali. The indigenous sheep breeds of Ethiopia are not studied adequately (Markos, 2006). There is lack of information on genetic variability for growth on indigenous sheep breeds in the country.

Lamb growth at early stage is affected by breed, sex of lamb, litter size, season of birth as a reflection of seasonal fluctuation on feed availability and milk yield (Markos, 2006). Research results on birth weight and growth rate of indigenous lambs are very important in sheep production. This information helps in breed improvement activities in the country. There is limited information on birth weight and growth rate of indigenous sheep lambs on-farm in Ethiopia. This study was conducted to assess the on-farm birth weight and growth performance of indigenous sheep lambs in the North Western part of Ethiopia.

2. Materials and Methods

2.1. Description of the study area

Burie district is located between 10˚15′N and 10˚42′N and between 36˚52′E and 37˚7′E in Amhara National Regional State, Ethiopia. It has an estimated area of 838.9 square kilometers with altitude range of 713 – 2604 masl (BOFED 2008; IPMS 2007). The rainy season in Burie is from

May to September with a monomodal pattern and a mean annual rainfall of 1386 – 1757 mm (IPMS, 2007). According to IPMS (2007), the long term annual temperature of Burie ranges from 14 °C to 24 °C. As the district has different ecological settings, it is suitable for different crops and livestock species production. The farming system, livestock production and livestock population of the district is adequately described in IPMS (2007).

According to IPMS (2007), in Burie District about 46.6% of the total area is cultivated and average household cultivated landholding is about 1.6 ha. Human population of the district is estimated at 174,957, of which 143,558 (82%) live in rural areas (BOFED 2008) organized into 22 rural kebeles and 2 town associations. The main cereal crops grown in the district include maize, wheat, *tef*, finger millet and barley.

2.2. Data collection on lamb birth weight, lamb growth and sheep mortality

The study was conducted for 6 months in three representative kebeles of Burie district, namely, Woheni Durebeite, Woyenema Ambaye and Boko Tabo. From each kebele 20 households having 5 or more breeding ewes were selected randomly based on their residence proximity for data collection. Breeding female ewes in each households were identified and recorded in a data recording format including their colour, sex, age and breed together with their owner's data (name, sex, age, etc). In the selected households, lambs born, date of birth, their sex, colour, breed and type of birth were recorded. The body weight (BW) of lambs born was taken in the first 24 hours after birth and after that at 2 weeks interval during the study. Mortality of lambs and causes of mortality were recorded. In addition, the total number of sheep present in each household, sheep loses, causes of sheep loses, purchasing practices and feeding, disease control and housing practices of each farmer were recorded by data collectors every week during the study in each kebele.

2.3. Statistical analysis

The data were analyzed using SPSS (2003) statistical software. Data were summarized using descriptive statistics. Mean comparison was done using ANOVA.

3. Results and Discussion

3.1. Sheep management during the study period

Farmers' managed their sheep flocks traditionally during the study. The breeding sheep grazed during the daytime and local feed supplements were fed during the evenings based on each individual farmer's practice. The supplements given differ from household to household. Generally, most households supplemented their sheep with A*tella* (a residue from local alcoholic beverage) and food leftover. In addition, farmers treated their animals with anthelminitics regularly during the study. Sick sheep was treated in their respective veterinary service areas. There was almost no supplement feed offered to the growing lambs during the study. The animals depended on their dam's milk mainly at the early stages of growth.

There were 458 sheep at the beginning of the study owned by the selected households for this study (Table 1). Among these, 366 were females and 92 were males. One household on average had 7.6 heads of sheep (n = 60, SD = 2.58) at the beginning of the study (Table 2). At the end of the study, one household had on average 8.0 heads of sheep (n = 60, SD = 3.50) per household. There was an increase in sheep number per household at the end of the study. Sheep number per household increased in Woheni Durebetie and Woyenema Ambaye kebeles, while in Boko Tabo kebele it decreased (Table 2). From the total number of sheep (458) at the start of the study, only 362 heads of sheep (79%) of the original sheep were present at the end of the study. About 63% of the male and about 83% of the female original sheep were present at the end of the study. From the 458 sheep present at the beginning of the study 71 heads of sheep (15.5%) were sold within the 6 months, 22 (5%) died due to diseases and 3 (0.7%) were slaughtered by their owners. During the study, there was no loss of sheep due to predators.

Within the 6 months, 2 sheep were bought and added as breeding females and 118 lambs were born. At the end of the study, there were 481 sheep present in the 3 kebeles owned by the selected households including the number of lambs born within the 6 months. From this total number of sheep, 104 heads (22%) were males and 372 (77%) were females. From the total 118 lambs born within the 6 months, 117 lambs have been measured and data collected. Data for one lamb was not taken.

Among the 117 lambs born on-farm during the study, 46 lambs were males and 66 lambs were females. From the total lambs born (117), the sex of the 5 lambs was not recorded.

Table 1. Total sheep number per kebele at the beginning and end of the study in the study kebeles of Burie District

Total sheep number	Woheni Durebetie N = 20	Woyenema Ambaye N = 20	Boko Tabo N = 20	Total N = 60
Beginning of study	177	139	142	458
Male	33	26	33	92
Female	144	113	109	366
End of study	200	141	140	481
Male	46	37	21	104
Female	152	102	118	372

N = Number of households

Table 2. Mean sheep number per household at the beginning and end of the study in the study kebeles of Burie District

Sheep number per HH	Woheni Durebetie N = 20 Mean ±SD	Woyenema Ambaye N = 20 Mean ±SD	Boko Tabo N = 20 Mean ±SD	Total N = 60 Mean ±SD
Beginning of study	8.9±3.94	7.0±1.28	7.1±1.07	7.6±2.58
Male	1.7±1.18	1.3±0.92	1.7±0.67	1.5±0.95
Female	7.2±3.47	5.7±1.31	5.5±1.10	6.1±2.33
End of study	10.0±3.89	7.1±3.10	7.0±2.66	8.0±3.50
Male	2.3±1.46	1.9±1.57	1.1±1.1	1.7±1.45
Female	7.6±3.66	5.1±2.55	5.9±2.38	6.2±3.06

N = Number of households; SD = Standard deviation

3.2. Birth weight, growth rate and sex of lambs

The birth weight of male lambs (2.6 kg) was greater ($P<0.001$) than the birth weight of female lambs (2.1 kg). The mean BW of the two groups is given in Table 3. According to Kassahun (2000), a study conducted on Horro and Menz lambs, males are heavier at birth than females. Male and female lambs had a birth weight of 2.4 ± 0.03 and 2.2 ± 0.02 kg, respectively. The difference between this result and the current study may be due to environmental and genetic differences. According to another study, the birth weight of male lambs is higher than the birth weight of female lambs based on a study on Menz and Horro sheep breeds in Ethiopia (Markos, 2006).

Many factors affect lamb growth rate. The most important are feeding level, genotype, sex, health and management (Gatenby, 1991). According to Gatenby (1991), ram lambs grow faster than ewe lambs whether or not the diet is restricted. On a given diet, ewe lambs get fatter than ram lambs. The mean growth rate per day of male and female lambs up to 112 days of age in the current study is given in Table 3. There was no significant difference ($P>0.05$) in growth rate between the two groups at 112 days of age. According to Gatenby (1991), male lambs grow faster than female lambs.

Table 3. Mean birth weight and growth rate of male and female lambs in the study kebeles of Burie District

Sex of lamb	N	BW (kg) Mean±SE	N	Growth rate (g/ day)
Male	46	2.6±0.10[a]	12	109.3[a]±4.33
Female	66	2.1±0.09[b]	16	114.8[a]±2.95
Total	112	2.3±0.07	28	112.4±2.51

N = Number of lambs; BW = Body weight; g = Gram; SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.001)

3.3. Birth weight, growth rate and breed of lambs

There was a difference in lamb birth weight between Horro and Washera breeds. Birth weight of Washera lambs (2.8 kg) was greater (P<0.001) than birth weight of Horro lambs (1.8 kg) (Table 4). This may be due to breed, environmental factors and/or type of birth effects. In addition, this difference may be due to the effect of genotype and nutrition of the dams during the study as the two breeds are found in different agro-climatic zones. In addition, Horro ewes give birth usually to twins but Washera ewes usually give birth to single lamb at a time. So, type of birth may have also contributed to this result. According to Markos (2006), there was a difference in birth weight between breeds. According to this author's result, Horro lambs had higher birth weight than Menz lambs. In another study, Horro lambs had higher (P<0.001) birth weight (2.4 ± 0.03 kg) than Menz lambs (2.2 ± 0.03 kg) (Kassahun, 2000). According to Kassahun and Solomon (2008), Horro sheep weighs from 2.8 – 2.9 kg at birth and from 13 – 15 kg at weaning (90 days). According to the same source, Washera sheep weighs 2.8 kg and 13.8 kg at birth and at weaning, respectively. According to Kassahun *et al.* (1991), Horro lambs have an estimated birth weight of 2.9 kg. In addition, Horro lambs seem to be heavier at birth and keep their superiority over the Adal and Black Head Somali up to yearling age (Kassahun *et al.,* 1991).

There was no difference (P>0.05) in growth rate between Washera and Horro breed lambs (Table 4). The growth rate of Washera and Horro lambs was 108.9 g and 117.9 g per day during the first 112 days of age, respectively. This result indicates that Horro lambs had low birth weight when compared with Washera lambs, but Horro lambs had similar growth rate with Washera lambs during the first 112 days of age (Table 4). According to Markos (2006), Horro lambs grow faster than Menz lambs during the pre-weaning and post-weaning periods. During the pre-weaning period Horro, and Menz lambs have a growth rate of 78.0 g and 72.6 g per day, respectively. According to Kassahun (2000), there is no significant difference between Horro and Menz lambs from birth up to weaning (90 days). But birth type, dam parity and season of birth had significantly affected (P<0.001) on pre-weaning body weight gain. According to Kassahun *et al.* (1991), Horro lambs have a body weight of 2.9 kg and 15.0 kg at birth and at weaning, respectively. In addition, the breed on average has a weight gain of 134 g per day from birth up to weaning. This difference from the current result may be due to nutrition of the dam or other environmental factors during the studies.

Table 4. Mean birth weight and growth rate of lambs by breed in the study kebeles of Burie District

Breed of lamb born	N	Birth Weight (kg) Mean±SE	N	Growth rate (g/ day) Mean±SE
Washera	56	2.8±0.07[a]	17	108.9[a]±3.66
Horro	56	1.8±0.09[b]	11	117.9[a]±2.29
Total	112	2.3±0.07	28	112.4±2.51

N = Number of lambs; kg = kilogram; g = Gram; SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.05)

4. Conclusion

Birth weight of male lambs (2.6 kg) was greater (P<0.001) than female lambs (2.1 kg). However, there was no difference in growth rate between male and female lambs when the two groups are compared at 112 days of age. Washera lambs had heavier (P<0.05) birth weight (2.8 kg) than Horro lambs (1.8 kg). Nevertheless, there was no difference (P>0.05) in growth rate between

Washera (108.9 g) and Horro lambs (117.9 g) when the two breeds are compared at 112 days of age. In addition, there was no difference (P>0.05) in body weight between the two sheep breeds at 112 days of age (15.2 kg vs 14.7 kg). These results indicated that Horro lambs had a lower birth weight than Washera lambs, but Horro lambs had similar growth rate with Washera lambs in the first 112 days of age when the two breeds are compared within their respective environments. To confirm the current on-farm birth weight and growth performance of lambs further studies are needed involving more animals and comparing the two breeds within the same environmental conditions.

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