DMU JOURNAL OF INTERDESCIPLINARY STUDIES

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Debre Markos University has been doing various activities to popularize and share Scientific research findings nationwide. To extend its reach in disseminating research findings the Vice President Office of Research and Community Service has began publishing an internationally reputable peer-reviewed research journal publication with a brand new title "Debre Markos University Journal of Interdisciplinary Studies" (DMUJIDS), and the office is great full for this journal has already got an ISSN 2521 8115.

Hence DMUJIDS editorial board calls for original and unpublished research papers in all fields of study for the third edition of the journal. All submitted articles will be assessed and reviewed by highly calibrated academicians and researchers gathered as editorial board members of the journal. Therefore, all interested researchers are cordially invited to send original articles to be published on this reputable international research journal via the following Email address: dmuJIDS@gmail.com.

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Contents

Debre Markos University Journal of Interdisciplinary Studies (DMUJIDS)

Debre Markos University, as part of its mission, is responsible not only to assist its academic staff to conduct problem solving research but also to disseminate research findings timely and appropriately. To this end, it has been publishing the research findings on annual symposium proceedings. However, the demand from the academic staff to have a scientific journal to publish their works initiates the launching of Debre Markos University Journal of Interdisciplinary Studies,(here after referred to as DMUJIDS), the first journal in the history of the University. DMUJIDS is an interdisciplinary journal that aims to contribute knowledge to the academic world by publishing original research works from various disciplines. Our dedicated technical and editorial team members from different fields of studies ensure the quality and standard of the journal.

1. Aims and Scopes

This journal is published bi-annually and is peer reviewed, dedicated to issues in all disciplines. The journal publishes original research and review articles in areas of agriculture, technology, science, health, business, justice and humanities. The journal addresses both theoretical and empirical problems related to the areas of study aforementioned.

2. Submission of Manuscript

Authors should read the "Instruction for Authors" section below before making a submission. Manuscript should be prepared according to the style and specifications of the journal's policy (APA style). Submission should be electronic, provided that the text, tables, and figures are included in a single Microsoft Word file in Times New Roman font. The cover letter that contains the corresponding author's full address, i.e. Telephone/fax numbers, and should be sent to the editor as an attachment with the file name that begins with the first author's surname. The author(s) may also suggest three to five reviewers for the manuscript, however, DMUJIDS may designate other reviewers.

The submitting (corresponding) author is responsible for ensuring that the article's publication has been approved by all the other coauthors. It is also the author's responsibility to ensure that the articles emanating from a particular institution re submitted with the approval of the necessary institution. Authors listed on the manuscript should meet the requirements for authorship specified above. The contribution of each of the authors shall be specified.

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therefore assumed that all authors have read and given their approval for its submission. Only an acknowledgement from the editorial office officially establishes the date of receipt. In this regard, a manuscript number will be mailed to the corresponding author within two days. Further correspondence and proofs will be sent to the corresponding author before publication unless indicated otherwise.

3. Instructions to Authors

DMUJIDS welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. English is the official language of the journal. Before submitting articles to the journal, authors must confirm that the submitted manuscript is their original work of and it is not published on or submitted for other journals concurrently. Conflict of interest should be clearly stated, the sources of data used in the development of the manuscript should be properly acknowledged, and all errors discovered in the manuscript after submission must be swiftly communicated to the editor.

3.1. Manuscript preparation guidelines

Preparation of the manuscript to be published in DMUJIDS should be made as per the following guideline.

3.1.1. Manuscript Preparation Checklist

All the articles should adopt the APA style (latest edition) and should include the following items as per their order.

3.1.2. Manuscript Preparation Checklist

As part of the submission process, authors are required to check off their submission's compliance with all of the requirements stated in this guideline. Submissions which do not adhere to this guideline will not be considered.

3.1.3. Types of articles considered for publication in DMUJIDS

Original research papers, review articles, correspondences (letter to the editor), short communications, case reports, and new perspectives are eligible for publication in this journal.

3.1.3.1. Original Research paper

Papers should be prepared in A4 (8.27X 11.69") page size, using standard fonts with size of 12, double-space with at least 1" (2.5cm) margin all around. All pages should be numbered starting from the title page. Times New Roman fonts must be used and remain uniform throughout the text. The authors must strictly adhere to the proper format of the journal for all

sections of the manuscript. Reference should be made to papers in recent issues for the general layout of the paper and also for details. For authors whose native language is not English, DMUJIS strongly recommends serious edition of the language of their manuscripts before submission to avoid delays in receiving and processing its publication.

The manuscript should be organized in the following order:

A. Title

The title should be a brief phrase accurately describing and reflecting the contents of the paper. The title page should include the author's full names and affiliations, the name of the corresponding author along with phone, fax, and email information.

B. Abstract and Keywords

The abstract should be informative and completely self explanatory. It should briefly present the topic, state the scope of the study, indicate significant data, and point out major findings and conclusions. The abstract should not be more than 300 words. Complete sentences, active verbs and the third person should be used. The tense should be in simple past. Standard nomenclature should be used and abbreviations

should be avoided. No literature should be cited. Following the abstract, about 3 to 7 keywords that may provide indexing references should be listed.

C. Introduction

The introduction should provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution.

D. Methodology

Materials and methods should be complete enough to allow the study to be produced. However, only truly new procedures should be described in detail; previously published procedures should be cited and important modifications of published procedures should be mentioned briefly.

E. Results/Findings

Results should be presented with clarity and precision. They should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the results but should be put into the discussion section.

F. Discussion

The discussion should interpret the findings in view of the results obtained in this and in the past studies on the topic. This section can include subheadings, and when appropriate, both sections can be combined.

E. Conclusion and Recommendations

State the conclusions in a few sentences at the end of the paper. Your recommendations should be related to your discussions throughout the paper.

F. Acknowledgement

The acknowledgements (if necessary) of people, grants, funds, etc. should be brief.

G. References

Consult APA (latest edition)

3.1.3.2. Review Articles

It is expected that review articles would be written by individuals who have done substantial work on the subject. The following five types of reviews can be considered for publication in DMUJIDS.

A. *Current Perspectives:* These articles should provide insight into or comments on current directions of research on a topic, or they discuss potential new approaches to an area of investigation. It may include: abstracts (not more than 300 words), Keywords (3-5), up to 20 type written pages for the main body of the text, and minimum of 40 references.

B. *Critical Reviews:* These should cover a current topic of interest that has not been recently reviewed, emphasizing a critical discussion of noteworthy developments in the field; they should not be just a compendium of studies on the topic and should not be only autobiographical. Its components are: abstract (300 words), keywords 3-5, up to 40 typewritten pages for the main body of the text, and maximum of 110 references.

C. *Survey Reviews:* Should be a comprehensive survey of the research on a topic that has not been recently reviewed. It includes: abstract (300 words), keywords 3-5, up to 70 typewritten pages for the main body of the text, and maximum of 320 references.

D. *Forum Mini reviews:* One set of reviews is put together by an organizer(s) on a particular topic; each set is composed of a maximum of 6 mini review articles and a preface. It covers: abstract (200 words), keywords 3-5, up to 15

typewritten pages for the main body of the text, and a maximum of 30 references.

E. *Recent Techniques (in any area):* The purposes of these reviews are to introduce recently developed techniques worldwide. These articles should be written in sufficient scientific detail and format to explain the characteristics of the techniques. It contains: abstract (250 words), key words 3-5, up to 70 typewritten pages for the main body of the text, and a maximum of 300 references.

The journal expects the contributors to give post-publication updates on the subject of review. The update should advance in the field after the publication of the article and should be sent as a letter to the editor.

3.1.3.3. Correspondence (Letter to the Editor)

These should be short and decisive observations. The journal will occasionally consider publishing letters to the editor from readers and authors in the "Correspondence" section. Letters should be comments and clarifications on articles that have recently been published in this journal and be in concise form. They should preferably be related to articles previously published in the journal or they should not be preliminary observations that need a later paper for validation. The letter

could have up to 700 words, and it could be generally authored by not more than four authors.

3.1.3.4. Short communications

Short communications should present a complete study that is limited in scope than is found in full-length papers. The items of manuscript preparation listed above apply to short communications with the following differences: abstracts are limited to 100 words; main body f the text of these communication should be not more than 2,000 words that normally occupy four journal pages and without any subheadings; manuscripts should contain no more than two figures and/or tables; maximum of 15 references and 2-4 keywords or short phrases for indexing should be mentioned.

3.1.3.5. Case Reports

New, interesting and rare case can be reported. They should be unique, describing a great diagnostic or therapeutic challenge for the readers. Cases with clinical significance or implications will be given priority.

The manuscript could be up to 1000 words (excluding references and abstracts). These reports should have the following headings: abstract (150 words), keywords (3-5

words), introduction, case report, discussion and reference (maximum 12).

3.1.3.6. New perspectives

Newly detected diagnostic method, new drug or indication, any new finding or anything still under research which is going to be available can be discussed here. Word count should be the maximum of 800, eight references, two table/figures and four authors.

3.2 Research Ethics

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Factors Affecting Rural Households Savings: The case of Gedeb Hasasa District, West Arsi Zone,Oromia National Regional State, Ethiopia

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Abstract

Saving is the strategic variable in achieving financial security and growth affecting both individual and national wellbeing. However, saving level in Ethiopia particularly in rural areas is limited and little is known empirically about its factors. This study initiated with the objective of identifying forms of savings used by rural households and identifying major factors

affecting rural households' savings in Gedeb Hasasa District using survey data collected from 188 sample households. The descriptive results of the study showed that 43.1% of the sampled households had savings in formal financial institutions during the survey time whereas 56.9% of the sampled households had no saving in formal financial institutions. From the Binary logit results, five variables namely; household head's education level, access to credit service, average annual income, average annual expenditure and distance from formal financial institutions were found to have significant effect on rural households' savings. Based on these findings, the researcher recommended that emphasis should be given towards strengthening different educational opportunities (formal and integrated adult education), government agricultural offices with nongovernmental organizations should work to improve the rural households' agricultural productivity through income diversification and financial institutions should provide saving services by establishing satellite branches reasonably near to the rural households' residences to promote rural households' savings.

Keywords: rural households' savings, formal financial institutions, saver households, non-saver households.

Introduction

Saving has been considered as one of the factors affecting growth to lead the developing countries to the path of development. In developing countries savings are important factors of households' welfare. On the other hand, without savings, households have few other mechanisms to smooth out unexpected variations in their income. For individuals and households savings provide a cushion of security against future contingencies whereas for nation savings provide the funds needed in the developmental efforts (Gedela, 2012).In addition, saving enable households to maintain a relative stable lifetime level of living. It is also likely that households refrain from current consumption to save for payment for children's education (Yao *et al.*, 2011).

Rural households' savings in developing countries particularly in Sub-Saharan Africa remains limited and far behind from other parts of the world. Chaia *et al.* (2009) combine a number of data sources to estimate that only about 20% of households in Sub-Saharan Africa saved their money in formal financial institutions. This is due to high levels of unemployment, low level of income, the engagement of a large proportion of the population in the informal sector and poor performance of the economy (Karim, 2010). In developing countries, economic

fluctuations and climate risk lead to important income variations and leave the households vulnerable to severe hardship. Moreover, their social coverage is restricted and the financial markets are not well developed. Thus, these countries often face saving allocation problems and have difficulties to develop productive investments (Tsega and Yemane, 2014).

Similarly, in Ethiopia rural households' savings is found to be limited and only six million households save money in formal financial institutions with an average of 875 Birr per year (Aron *et al.*, 2013). The average share of gross domestic saving in the year 2012 was 12.4% of the GDP (Girma *et al.*, 2014). The average gross saving rate as percentage of GDP of Ethiopia was also 21% (Tsega and Yemane, 2014). Recognizing this fact, the country has planned to promote rural households savings among citizens so as to mobilize adequate saving. In the five years Growth and Transformation Plan (GTP) of the country, it is envisaged to increase saving rate of GDP. The strategy of the government that have been indicated to mobilize domestic saving resource are creating enabling environment such as increasing financial sector accessibility to rural areas and service diversification by financial sector (MoFED, 2009).

Gedeb Hasasa District is one of the districts of West Arsi Zone, Oromia Regional State. It is one of the most productive areas especially in Wheat and Barley production. And most of the production is carried out by smallholder farmers characterized having limited access for credit. Thus, mobilizing own saving could serve as a main source of finance for investment to the rural households in the study area. Thus, assessing factors affecting rural households' savings in the study area can bring valuable contribution to the accumulation of capital thereby for investment boost. In addition, conducting location specific studies is useful in addressing area specific problems for policy interventions.

Materials and Methods

Description of the Study Area

West Arsi Zone is one of the eighteen administrative Zones of Oromia National Regional State, bordered by Bale on the South, SNNPR on the South West, Shewa on the North West and Afar Regional State on the North and Hararghe on the West. GedebHasasa District is located in west Arsi Zone of Oromia National Regional State, at about 305Kms South East of the capital city of Addis Ababa and at about 108 Kms from Assela town and at about 80 Kms from Shashemane town. According to the information from Agriculture Office of

Sampling Procedures and Sample Size

Multi-stage sampling method was applied to select sample 'kebeles' and respondents to study factors affecting rural households were saving. First, 188 sampled households were determined using the formula given by Becker (2005) from a total of 3972 household heads at 5 percent error and 95 percent confidence level . *He forwards* the procedure as follows:

$$n= \frac{Z^2*P\,(1 - P)}{e^2}$$

Where n is the minimum sample size to be drawn, z is the desired confidence level (the value corresponding to the 95 percent level of confidence (i.e. 1.96), is the desired level of precision that is 5 percent and P is the estimated percentage proportion of the population. The total rural households in all 25 'kebeles' of the district were about 27842. The estimated percentage of the population in the sample 'kebeles' (p) was about 14.3 percent. The researcher divided the rural 'kebeles' as near ('kebeles' located up to ten Km) and far ('kebeles' located over ten Km) using stratified sampling method. Then, four rural 'kebeles' two from near and two from far were selected randomly. In the third stage, the rural households in each 'kebeles' were stratified in to saver and non-saver categories in formal financial institutions based on the source provided by the financial institutions. Finally, systematic

random sampling was used to select sample respondents proportional to sample size was used to determine the number of sampled households from each 'kebeles'.

Model Specification

Binary logistic regression model was a proper model when the dependent variable is a dummy one consisting of two, 0 and 1, or more levels; logistic regression model can be properly used.

Thus, logistic regression model that was employed in this study was a binary logistic regression model, where dependent variable is Y and independent one is X. In order to elucidate the model, the following logistic distribution function was used (Maddala, 1986; Greene, 1993; and Gujarati, 1995).

$$Pi=\in(Y=1/Xi)=\frac{1}{1+e^{-(\beta 1+\beta 2Xi)}} \qquad (1)$$

In the logistic distribution equation, Pi is the independent variable; Xi is the data that is the possibility of a preference by an individual (option of having 1 and 0 values). When $\beta 1+\beta 2Xi$ in Equation 1 is replaced by Zi, Equation 2 is obtained:

$$Pi=\frac{1}{1+e^{-Zi}} \qquad (2)$$

Z is between $-\infty$ and $+\infty$, and Pi is between 1 and 0. When Pi shows the possibility of savers, the possibility of non-savers of

rural households is 1- Pi. Then, the possibility of non-saver can be explained as in Equation 3 as follows:

$$1\text{-}Pi=\frac{1}{1+e^{Zi}} \qquad (3)$$

Equation 4 is obtained by dividing the savers by non-savers:

$$\frac{Pi}{1-Pi} = \frac{1+e^{Zi}}{1+e^{-zi}}=e^{Zi} \qquad (4)$$

When the natural logarithm of both sides of the equation is written, Equation 1 is obtained:

$$Li=\ln\left(\frac{Pi}{1-Pi}\right)=Zi=\beta 1+\beta 2Xi \qquad (5)$$

Thus, non-linear logistic regression model is liberalized based on both its parameters and variables. "L" is called "logit" and models such as this called "logit models" (Gujarati, 1995, 2003). In these situations, Equation 1 is used for proper transformations:

$$Pi=\in(Y=\frac{1}{Xi} = \frac{1}{1+e^{-(\beta 1+\beta 2X1+\beta 3X2+\cdots+\beta kXk)}} \qquad (6)$$

Odds and odds ratio are significant terms in logit model. Odds are defined as the ratio of the number of events that occurred to number of events that did not occur. "Odds ratio" on the other hand, is the ratio of two odds, in other words, the ratio of likelihood to another. In Equation 4, two probabilities, savers

rural households is 1- Pi. Then, the possibility of non-saver can be explained as in Equation 3 as follows:

$$Zi=\beta o+\varepsilon\beta iX+Ui \quad (7)$$

Therefore, the above Binary logit econometric model was used for the study to identify major factors affecting rural households savings.

Data Source and Method of Data Collection

Both primary and secondary data were collected from the relevant sources by employing different data collection methods. The primary data were collected through household survey respondents, focus group discussions and key informant interviews. For household survey of the study, interview schedule consists of close-ended questions were used as data collection instrument. The interview schedule prepared in English and translated into local language (Amharic).

On the other hand, the secondary data were collected from the findings stated in published and unpublished documents and literatures related to the research problem. These were based from the recent literatures such as; articles, journals, reports, working papers, books, and internet sources related to rural

households savings. Information related to factors influencing rural households' savings were collected from secondary sources of data.

The dependent variable has a dichotomous nature measuring rural households' savings status in formal financial institutions in the year 2013/2014. This is to distinguish or discriminate between those savers and non-savers in the study area. It takes a value of 1 if the households save in formal financial institutions otherwise 0.

Results and Discussions

Characteristics of Sampled Households

Sex of household heads

Sex is one of the variables that can explain rural households' savings. As indicated in Table 1, out of the sampled households 125 (66.5%) were male and the remaining 63 (33.5%) were female. Of the total sampled households, 31 (29%) of the non-savers were female headed households where as 76 (71%) of the non-savers were male headed households. On the other hand, 32 (39.5%) of the sampled saver households were female headed households where as 49 (60.5%) of the sampled saver households were male headed

households. The result revealed that male headed saver and non-saver households had greater percentage than female headed households.

Based on Table 1 the Chi- square value (x^2= 2.3; P=0.09) showed that there was no statistically significant association between saving status and sex of saver and non-saver households. This implies that being male or female headed household had no statistically significant effect on saving decision of the households. This possibly indicate that male and female headed households had equal chance to access to information on saving and formal financial institutions make their target on male and female headed households during saving mobilization.

Marital status of household heads

The marital status of the head of the households also affects the saving status of the rural households. Of the total sampled household heads, 111 (59%), 77 (41%) were married single and respectively (Table 1). Among the non-savers 68 (63.6%) were married where as 39 (36.4%) of them were single. On the other hand, 43 (53.1%) of the savers were married where as 38 (46.9%) of the savers were single.

Regarding its association, the chi-square test indicated that there had no statistically significant association between marital status and saving status of saver and non- saver households (x^2 = 4.99; P = 0.17). Therefore, the result in this study clearly showed that being married or unmarried had no significant effect on rural households' savings. This possibly married and unmarried household heads would have similar socio - cultural background regarding to rural households' savings.

Education level of household heads

Education enhances the capacity of individuals to obtain, process, and utilize information through different sources. It is required to make saving decision. As a result, level of education of the head of the households influences the saving status of the rural households. According to the survey result, savers and non-savers who were illiterate were 22 (27.2 %) and 38 (35.5%) respectively and from the savers and non-savers who were literate were 59 (72.8 %) and 69 (64.5%) respectively. The chi-square value χ^2=10.93; p= 0.012) of the sampled households indicated that there was statistically significant difference in the education levels of savers and non-savers (Table 1).

The percentage difference between savers and non-savers in terms of literacy level may mean that literate household heads had more exposure to the external environment and information which helps them to easily associate them to saving from formal financial institutions. It implies that saver rural households with more education were likely to save their money in formal financial institutions. This finding was similar with the finding of (Aron *et al.*, 2013) that indicated as the academic level of households' increase the saving status shows improvement and Girma *et al.* (2014) indicated that showed positive and statistically significant effect on rural households' savings. But, Sebhatu (2012) found that education and rural households' savings had negative relationship and the possible explanation given was some saving schemes might not need good educational background of the respondents.

Table 1.Characterization of saver and non-saver households by demographic factors

Variables			Saving status			
			non-saver (N=107)	saver (N=81)	Total (188)	x^2 value
Sex	Female	N	31	32	63	2.3
		%	29.0	39.5	33.5	
	Male	N	76	49	125	
		%	71.0	60.5	66.5	
Marital status	Married	N	68	43	111	4.99
		%	63.6	53.1	59	
	Single	N	39	38	77	
		%	36.4	46.9	41	
Education Level	Illiterate	N	38	22	60	10.93**
		%	35.5	27.2	31.9	
	Literate	N	69	59	128	
		%	64.5	72.8	68.1	

Family size of sample households

The size of the family is also an important factor for the saving status of the rural households. Accordingly, the average family size of the sampled household was 7.3. The result indicated that the average family size of the sampled savers and non-savers was 7.84 and 7.01 respectively and the standard deviation of the family size of savers and non-savers was 4.54 and 3.47. Thus, the average result revealed that there was no large difference among the family size of the savers and non-savers with respect to their family size. But, the average family size of the sampled households was higher than the national average of 5 persons (CSA, 2010). The possible reason is rural households in the study area practices polygamous marriage.

The t-value indicated that there was no statistically significant mean difference (t-value= 1.33; p=0.18) between the mean family size of savers and non-savers (Table 2). The variation of family size of the two groups had not showed a larger difference and the result indicated that there had no significant effect on rural households saving.

Table 2. Characterization of savers and non-savers by age and family size

	Saving status			
Variables	non-saver (N=107) mean (std)	saver (N=81) mean (std)	Total mean (std)	t-value
Age	33.75 (8.35)	35.20 (10.33)	34.37 (9.25)	1.03
Family Size	7.01 (3.47)	7.84 (4.54)	7.3 (3.69)	1.33

Std =standard deviation

Characterization of Savers and Non-Savers by Socio-Economic Factors

Landholding size of household heads

Land is a vital resource for the rural households as it can be accumulated in terms of money and productive asset at the time of financial emergency. According to the survey result, the average size of landholding of savers and non- savers was 2.67 and 2.30 hectares respectively and the standard deviation of the landholding size of savers and non-savers was 1.30 and 1.28 hectares respectively. The results of the mean value indicated that average landholding size of savers was larger than non-savers. The t-value ($t=1.92$; $P=0.05$) showed that there was statistically significant difference between the mean landholding size of savers and non-savers with respect to their landholding size. This implies that sampled households who had large landholding size had higher possibility to save in formal financial institutions. Rural households who are using their larger size of land for cultivation can utilize more capital and finally their income increases. As the income of the households increase because of cultivation of large farm land, the probability to save in formal financial institutions also increases. In addition, land is used as collateral for rural households for credit access from financial institutions.

Livestock ownership

Livestock is the most important asset for rural households in the study area. Rural households in the study area undertake both crop and livestock production activities. In the study area, livestock holding size varied among the sampled households. Based on Strock *et al.* (1991) the livestock number was converted into tropical livestock unit (TLU) to facilitate comparison between the two groups. According to the survey result, the average size of livestock of the sampled savers and non- savers was 8.62 and 7.54 TLU respectively and the standard deviation of the livestock ownership size of savers and non-savers was 5.30 and 5.45 TLU respectively. The result indicated that there was no greater difference between savers and non-savers with respect to their livestock ownership. The The mean difference of livestock ownership between savers and non-savers was no statistically significant (t=1.37; P=0.17). This finding was similar with Obayelu (2012) that showed negative relationship between rural households savings status and livestock ownership but contrary with the findings of Girma *et al.* (2014) and Degu (2007) that showed positive and significant relationship between households saving status and livestock ownership.

Annual income of sample households

The major sources of income for the sampled households are crop production, livestock production and off farm/nonfarm activities. Income is an important factor of the saving status of the rural households. It is a positive factor that analyses the saving status of households. As shown in Table 3, the annual income of the sampled households was calculated in ETB and found by the researcher. The annual income of the savers and non-savers was 21640.63 and 11197.90 ETB and the standard deviation of the annual income of savers and non-savers was 18175.63 and 7890.40 ETB. As the mean income indicated that there was greater annual income difference between savers and non-savers. The t-value (t=5.32; P=0.00) also showed that there was statistically significant mean difference between the annual income of savers and non-savers with respect to their income levels. As indicated in the relative income hypothesis, higher income leads to higher probability of households to save. This result is consistent with a study by (Aron *et al.*, 2013) that showed income is a significant factor for the saving status of households and the result revealed that when the income level of households increased, the saving rate will also increase by some present. Rehman *et al.* (2010) also showed that household income would increase households saving ability.

Annual expenditure of sample households

As shown in Table 3, the result tried to find out the sampled households spent their incomes on and the expenditure of the money of the sampled households. The result indicated that a significant number of sampled households spent their income on food, clothing and purchase of inputs. The annual expenditure of the sampled households was calculated in ETB. The average annual expenditure of the savers and non- savers was 13364 and 7925.22 ETB and the standard deviation of the annual expenditure of savers and non-savers was 9375.71 and 4170.54 ETB respectively. The result revealed that savers spent more than non-savers. The t-value (t=5.35; P=0.00) showed that there was statistically significant difference between the annual expenditure of savers and non-savers with respect to their expenditure. As the landholding size of saver households is larger and uses their income for the purpose of cultivation, they would have spent more money for purchase of inputs and in turn earns more income from their cultivation.

When the income level of the sampled households' increases, their expenditure also increases but not as income increases and rural households have a possibility that the expenditure is utilized on productive activities and this can again lead to an increase in savings.

Table 3. Characterization of savers and non-savers by socio-economic factors

	Saving status		
Variables	non-saver (N=107) mean (std)	saver (N=81) mean (std)	t-value
Landholding Size	2.30 (1.28)	2.67 (1.30)	1.92**
Livestock Ownership	7.54 (5.45)	8.62 (5.30)	1.37
Annual Income	11197.90 (7890.40)	21640.63 (18175.63)	5.32***
Annual Expenditure	7925.22 (4170.54)	13364 (9375.71)	5.35***

*** Significant at 1 % and ** significant at 5 %
std=standard deviation

Characterization of Savers and Non-Savers by Institutional Factors

Physical distance from financial institutions

Table 4 shows the distance in kilometers that the potential beneficiaries traveled on foot for using saving services in formal financial institutions. The average distance traveled by savers and non-savers to their nearest financial institution was 15.40 and 13.63 km and the standard deviation of the average distance to their nearest financial institution of savers and non-savers was 9.89 and 10.85 km. The result indicated that savers traveled relatively longer distance to save their money in formal financial institutions. But, the mean distance between savers and non-savers to their nearest formal financial institution was not statistically significant ($t=1.15$; $P=0.25$).

Households located relatively in far distance from financial institutions than households located in nearer to financial institutions save money. This is because households in distant area have large landholding size than households located near to the center (2.67 and 2.30 hectares respectively (Table 4) and this contributes for generating more income and in turn motivates households to save. As compared to closer households, distant households are scattered and there is large

variation among households in their landholding size since land is not equally distributed in the study area.

Table 4. Characterization of savers and non-savers by distance from financial institutions

	Saving status		
	non-saver (N=107)	saver (N=81)	
Variable	mean (std)	mean (std)	t-value
Distance from formal financial institutions	13.63 (10.85)	15.40 (9.89)	1.15

std= standard deviation

Access to credit

Credit can increase rural households' access to essential resources and fuel economic growth. It also enables efficient allocation of risk, costs and financial reserves. Besides, rural households can acquire inputs and equipments such as fertilizers, tractors, farming equipments and livestock that make them more productive and enhance overall agricultural productivity. Credit access of sampled households was assessed as indicated in Table 5. Out of the total sampled

households, 72 (38.3%) had credit access in the year 2013/14 where as 116 (61.7%) of the sampled households had not credit access. Accordingly, 40 (49.4%) of the savers and 76 (71%) of the non-savers had no credit access while 41 (50.6%) of savers and 31 (29%) of non savers had credit access.

Based on the Table results, the percentage of non-savers who had no credit access was higher. The result also revealed that savers who had credit access were higher. The Chi-square value (χ^2=9.14; p= 0.002) of the sampled households indicated that there was statistically significant association between credit access and saving status of savers and non-savers. The implication was that households who had more access to credit had higher probability to save their money in formal financial institutions. This possibly credit users would have more information and awareness regarding to saving in financial institutions than non-users. In addition, rural households would have used their loan for agricultural productivity that can increase the households' income.

The current study finding was similar with the finding of Obayelu (2012) but contrary to the findings of Girma *et al.* (2014) indicated that access to credit decreases saving in financial institutions because the available credit was mainly used to purchase agricultural inputs.

Utilization of agricultural extension services

Table 5 showed that utilization of agricultural extension services of sampled households and their saving status. Out of the total sampled households, 185 (98.4%) had used agricultural extension service in the year 2013/14 where as 3 (1.6%) of the households had not used agricultural extension service. Accordingly, 80 (98.8%) of the savers and 105 (98.1%) of the non-savers had used agricultural extension service in the same year while 1 (1.2%) of the savers and 2 (1.9%) of non-savers had not used agricultural extension services.

Based on the Table result, the percentage of non-savers who had used agricultural extension services was higher. The result also revealed that savers who had used agricultural extension services were higher. The chi-square value (χ^2=0.12; p= 0.06) of the sampled households indicated that there was no statistically significant association between utilization of agricultural extension service and saving status of savers and non-savers. This possibly sampled households who had got information regarding saving from development agents were not as such significant. This indicated that the extension system failed to incorporate and address saving issues. Though, savers and non-savers who had equal access to utilize agricultural extension services had no effect to make rural households saving decisions.

Table 5. Characterization of savers and non-savers by credit access and utilization of agricultural extension access

Variables			Saving status		Total	x^2 value
			non-saver (N=107)	saver (N=81)		
Access to credit	No	N	76	40	116	9.14***
		%	71.0	49.4	61.7	
	Yes	N	31	41	72	
		%	29.0	50.6	38.3	
Utilization of agricultural extension services	No	N	2	1	3	0.12
		%	1.9	1.2	1.6	
	Yes	N	105	80	185	
		%	98.1	98.8	98.4	

*** Significant at 1 %

Forms of Savings used by Rural Households

Formal saving

Table 6 shows formal saving status of the sampled households. Out of 188 sampled households considered in the analysis, 43.1% rural households have used formal financial institutions and 56.9% who did not save in the formal financial institutions at the time of data collection. Of the sampled households that had used formal financial institutions, 14 (17.3%), 25 (30.9%), 25 (30.9%), 17 (20.9%) saved their money at Commercial Bank of Ethiopia, Oromia Cooperative Bank, Oromia Saving and Credit Share Company, and Saving and Credit Cooperatives respectively. The average annual saving amount of saver sampled households was higher at Commercial Bank of Ethiopia (10077.42 ETB) with standard deviation of (11184.33 ETB). Based on the feedback obtained from the focus group discussion, households who saved much money in Commercial Bank of Ethiopia mostly received remittances from abroad.

Table 6. Formal financial institutions and saving amount of the sample households

Saving in Formal Financial Institutions	N	%	Mean	Std. Deviation
Commercial Bank	14	17.3	10077.4286	11184.33562
Oromia Cooperative Bank	25	30.9	3872.8400	4144.70405
Oromia Saving and Credit Share Company	25	30.9	1838.0400	1801.80656
Saving and Credit Cooperatives	17	20.9	1435.5294	976.49489
Total	81	100		

Table 6 showed that there were several reasons why sampled households were engaged in formal saving. Out of the saver households who were on what encouraged them to save in formal financial institutions, 55 (67.9%) confirmed that mitigating an emergency was the sole reason, 23(28.4%) did it in order to buy expensive item and 3 (3.7%) since the money value from saving is going up. Similarly, (Rehman *et al.*, 2010) indicated the motivation of rural households to save includes; reserving against unforeseen contingencies, providing future anticipated differences between income and expenditure. The result of the focus group discussion held with staff members of Commercial Bank of Ethiopia showed that the Bank has

started rewarding for savers. This encouraged the rural households to save their money in financial institutions.

During the focus group discussion period, a man from the members of the focus group discussion said that my neighbor had got motorcycle as a reward since he has saved his money in Commercial Bank of Ethiopia. This encouraged him and has started saving at Commercial Bank of Ethiopia.

Summary of Descriptive Results of Explanatory Variables

In order to have a clear picture of the demographic, socio-economic, and institutional and variables related to saving institutions which differentiate savers from the non-savers chi-square and t-test tests were applied. Four continuous variables namely; landholding size, annual income, annual expenditure, distance from market and two discrete variables namely; education level of household heads and access to credit were found to be significant at 1% and 5% probability level (Table 7).

Table 7. Summary results of descriptive analysis of explanatory variables

	Mean value		
Continuous Variables	non-saver	Saver	t-value
Age	33.75	35.2	1.03
Family size	7.01	7.84	1.33
Landholding size	2.3	2.67	1.92**
Livestock ownership	7.54	8.62	1.37
Annual income	11197.9	21640.63	5.32***
Annual expenditure	7925.22	13364	5.35***
Distance from market center	11.14	14.28	2.25**
Distance from financial institutions	13.63	15.4	1.15

Discrete Variables	X^2 -value
Sex	2.3
Marital status	4.99
Education level	10.93**
Religion	3.38
Access to credit	9.14***
Utilization of agricultural extension services	0.12

*** significant at 1 % and

** significant 5%

Results of the Binary Logit Model

The dependent variable households' saving status takes a value of one if the households save in formal financial institutions, and zero otherwise. Binary logit model identifies characteristics that stimulate households to save in formal financial institutions as opposed to those who do not. Before running the Binary logit model, different tests were carried out. The technique of variance inflation factor (VIF) was employed to detect the problem of multi-collinearity among the continuous variables. According to Gujarati (2003), VIF can be defined as: VIF

$(x_i) = 1/1\text{-}Ri^2$

Where, Ri^2 is the square of multiple correlation coefficients that results when one explanatory variable (Xi) is regressed against all other explanatory variables. The larger the value of VIF the more collinear the variable Xi is. As a rule of thumb, if the VIF of a variable exceeds 10, there is a multi-collinearity problem. The VIF values displayed below (Table 8) have shown that all the continuous explanatory variables have no multi-colinearity problem.

Table 8. Variance inflation factor for continuous variables

Variables	Tolerance	VIF
AGE	0.508	1.969
FAMSIZE	0.401	2.492
LANDHS	0.507	1.972
LIVOWN	0.592	1.69
ANEXP	0.308	3.244
ANINC	0.442	2.264
DISTFIN	0.283	3.533
DISTMKT	0.302	3.312

Similarly, contingency coefficients were computed to check the existence of multi-collinearity problem among the discrete explanatory variables. The contingency coefficient is computed as:

$$C = \sqrt{\frac{\chi^2}{N+\chi^2}}$$

Where, C= Coefficient of contingency,

χ^2 = Chi-square random variable and N = total sample size.

The result showed that in all cases, contingency coefficient is

less than one so that there was no high degree of association among the discrete explanatory variables. The decision rule states that when the result approaches to 1, indicates the existence of multi-collinearity where as values less than 0.75 indicates as there is no problem. The values of the contingency coefficients implied that there was no multi-collinearity problem among the explanatory dummy variables (Table 8).

The results of the Binary logit model estimations (Table 9) of factors significantly influencing the decision to save in formal financial institutions and the model was found to be significant at 1% significance level. Out of the total variables; five of the variables were found to be significant while the remaining were not significant in explaining the variations in the dependent variable. The maximum likelihood estimates of the Binary logistic regression model showed that education level of head of the households, annual income, annual expenditure, credit access and distance from formal financial institutions were important factors influencing saving decisions of rural households in the study area. Most of the variables age, sex, marital status, family size, landholding size, religion, and utilization of agricultural extension services, livestock ownership and distance from market center were not powerful in explaining rural households' savings status.

Table 9. Maximum likelihood estimates of the Binary logit model

Explanatory Variables	Estimated Coefficient (B)	S.E.	Wald Statistics	Odds Ratio	Marginal Effect
SEX	-.228	.773	.087	.796	-.056
RELIG	.748	.628	1.421	2.113	.184
AGE	-.020	.028	.509	.980	-.004
FAMSIZE	-.010	.080	.016	1.228	.050
LANDHS	.205	.188	1.198	.990	-.002
LIVOWN	-.039	.049	.631	.962	-.009
ANINC	.000**	.000	4.713	1.000	.000
ANEXP	.000**	.000	5.185	1.000	.000
ACCRT	1.390***	.414	11.241	4.013	.333
UAEXT	1.620	1.928	.706	5.054	-.304
DISTMKT	.061	.035	2.969	1.063	.015
DISTFIN	-.072**	.036	3.986	.930	-.017
MARTS	-1.137	.817	1.934	.321	-.275
EDUL	.978**	.467	4.395	2.659	.228
CONSTANT	-4.331	2.399	3.260	-	-

Source: Model output (2015)

Notes: Odds ratio shows the predicted changes in odds for a unit increase in the predictor, Nagelkerke R Square = 40.8***, Omnibus Tests of model coefficients: Chi-square = 68.18***, -2log likelihood = 188.83***; Percentage of correct prediction=76.6, correctly predicted non-savers = 85, correctly predicted savers = 65.4; df = 14, Significant at 1% and 5% significance level respectively.

Education level of household heads: education increases the analytical ability of individuals to process information received from any source. As the model result on Table 24 revealed, education level of households is statistically significant at 5 % significance level and positively influences the dependent variable, saving status, and it is in line with the hypothesis. This shows as households are getting educated, they are more likely to save in formal financial institutions. Based on the model result, literate household heads had 2.66 times more odds-ratio of saving than illiterate household heads.

Annual income: average annual income showed significance and positive effect at 5 % probability level on rural households saving status and it is in line with the hypothesis. Other factors being constant, the odds-ratio increased by a factor of 1 when their annual income is increased by 1 unit. Part of the

explanation for this result income would increase households saving ability and enhance the probability of households to save in formal financial institutions. This result is consistent with studies done by (Tsega and Yemane, 2014) and Rehman *et al.* (2010) that shows rural households saving is significantly and positively associated to households' income.

Credit access of households: was hypothesized to have positive effect on rural households' savingsand significant at 1% probability level and it is in line with the hypothesis. Keeping other factors constant in the model, the likelihood of rural households with access to credit relative to the base category increased by 4.01 when access to credit increases.

The result implies that rural households with more access to credit would higher tendency to save more in formal financial institutions. This would have possibly meant that credit user households used their loan for production purpose and in turn increases their income. The present study finding was similar to Obayelu (2012) that show positive and significant effect between credit access and rural households saving status and contrary to Adeyeno and Baire (2005) that shows negative and no significant effect between credit access and rural households saving status.

Distance from formal financial institutions: the model result of the study confirmed that distance affects negatively and significantly at 5% probability level and it is in line with the hypothesis. The model result revealed that those households who are residing short distance from formal financial institutions had more access to save whereas those who are residing at far distance from formal financial institutions had less access to save in formal financial institutions due to distance factor. Moreover, the odds ratio in favor of access to save decreases by a factor of 0.93for those sampled households residing at a far distance from financial institutions other things being kept constant. The possible explanation for this is that as the sampled households' are close (near) to the financial institutions; they would have more access to use the service than the one in far place. The current finding was similar to Chemonics International (2007) identified distance remains a major barrier to formal financial saving and other markets in rural areas in SSA specially in rural Uganda, only 10% of the population has access to basic financial services.

Conclusions

The descriptive analysis showed that some rural households practiced saving in formal financial institutions and the common reasons for rural households no saving in formal financial institutions in the study area were; they had no surplus cash to save, low income, they were not aware about saving culture and saving institutions are far.

Besides, the Binary logit analysis showed that household heads' education level enhances households' awareness to decide to save money in formal financial institutions. Households with accesses to credit service enhance rural households' savings. Households with high annual income would like to save in formal financial institutions. Distance from formal financial institutions significantly affects rural households' savings in the study area.

Policy Implications

In order to make illiterate rural households have better understanding towards savings and make decision to save, emphasis should be given towards strengthening different educational opportunities (integrated adult education). The result of the Binary logit model revealed that average annual

income had positive and statistically significant effect on rural households' savings status. Based on this finding, to make non-saver households to save in financial institutions, there is a need to further improve the rural households' income through diversifying their agricultural activities and income source by engaging in nonfarm/off farm activities. Credit access had positive and statistically significant effect on rural households' savings status.

In order to make non-saver rural households to save, financial institutions should have awareness creation, consult program and provide productive loan and follow up their credit utilization so that they can use it to generate additional income and this in turn motivates rural households to save in financial institutions. The Binary logit result revealed that distance from financial institutions had negative and statistically significant effect on the saving status of rural households. Hence, financial institutions should provide saving services by establishing satellite branches reasonably near to the rural households' residences.

References

Adeyeno R, and Bamire A.(2005). Saving and Investment patterns of Cooperative Farmers in South Western Nigeria. *Journal of Social Science,*11 **(3)**:183-192

Aron Hailesellasie, Nigus Abera, Getnet Baye (2013). Assessment of Saving Culture among Households in Ethiopia. *Journal of Economics and Sustainable Development,* **4 (15)**:1

Beck, T., Demirguc-Kunt, A., and Peria, M. S. (2008). Banking services for everyone? Barriers to bank access and use around theworld.World Bank Economic Review.

Becker, W.K. (2005). Statistics for business and economics using Microsoft excel 97. Indian University S.R.B. Publishing, Bloomington:India.

Central Statistical Agency (CSA), (2010). FDRE General Country Data, Addis Ababa, Ethiopia.

Chaia Alberto, Aparna Dalal, Tony Goland, Maria Jose Gonzalez, Jonathan Morduch, and Robert Schiff. (2009). Half the World is Unbanked.Financial Access Initiative Framing Note.

Chemonics International (2007). Improving access to financial services in rural Uganda: Rural SPEED final report: Washington DC, Chemonics.

Dereje, B. (2010). Livelihood diversification as a strategy to overcome food insecurity in Ethiopia, A case study of small holder farmers in BakoTibe District, Ethiopia.

Devaney, S. (2007).The Poor and Their Money. New Delhi :Oxford University Press.

GirmaTeshome, Belay Kassa, ,Bezabih Emana, and Jema Haji (2014). Saving patterns of rural households in East Hararghe. *Journal of Development and Development Economics,* **6(4)**:177-183.

Gujarati, DN (2003). Basic econometrics.Fourth Edition. McGraw-Hill, New York.

Issahaku Haruna. (2011). Determinants of Saving and Investment in Deprived District Capitals in Ghana: A Case Study of Nadowli in the Upper West Region of Ghana.Wilolud Journals, Continental J. Social Sciences,**4 (1)**: 1 - 12.

Karim Moussaly. (2010). Participation in Private Retirement Savings Plans, 200868 **(1)**: 192–204.

Kelley, A.C. and J.G. Williamson. (2009). Household Saving Behavior in the Developing Economies: The Indonesian Case, Economic Development and Cultural Change,**16 (3)** : 385-403.

Kidane B. (2010). Determinants of Gross Domestic Saving in Ethiopia: A Time Series Analysis. Study Mode Com. Available fromhttp://www.Study mode .com. essays. Determinants of Gross Domestic Saving 535269.html.

Maddala,G.S. (1986). Partial Dependent and Qualitative Variables in Econometrics. Cambridge:Cambridge University Press.

Menard S. (2002). Applied Logistic Regression Analysis, Second edition. Sage Publications, California.

(Ministry of Finance and Economic Development). MoFED (2009). Growth and Transformation Draft Plan the Federal Democratic Republic of Ethiopia (GTP) 2010/11-2014/15. Ethiopia.

Newman, C; Tarp F, Broeck K, Quang, C; Khani; L. (2008). Household saving in Vietnam: insight forms a 2006 rural household survey. Vietnam economic management review. **3(1)**:34-40.

Nga, M.T. (2007). An investigative Analysis in to the Saving Behavior of Poor Households in Developing Countries with specific reference to South Africa. University of Western Cap. South Africa.

Obayelu, O. A. (2012). Saving Behavior of Rural Households in Kawara State, Nigeria. *African Journal of Basic Applied Science,* **4(4)**:115-123.

Rehman Hafeez, Faridi Muhammad, and Bashir Furrukh. (2010) Households Saving Behaviour in Pakistan: A Case of Multan District. *Pakistan Journal of Social Sciences* **30(1)**: 17-29.

Touhami, A. Florence, A. Najat, E. and Sabine, M. (2009). A Micro-econometric analysis of Households Saving Determinants in Morocco. African Review of Money Finance and Banking 2010, 7-27.

Tsega Hagos and Yemane Michael. (2014). Determinants of household saving in Ethiopia: A case of North Gondar Zone, Amhara Regional State, Ethiopia. International Journal of Development and Economic Sustainability, **2(4)**: 37-49.

Yao, R., Wang, F., Weagley, R. O., Liao, L. (2011). Household saving motives: Comparing American and Chinese consumers. Family and Consumer Sciences Research Journal, 40,**(1)**: 28–44.

Soil Fertility, Yield and Nodulation Status of Chickpea *(Cicer arietinum L.)* in Gondar Zuria District, North Western Ethiopia

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Abstract

Chickpea is the top most produced pulse crop in North Gondar Zone. However, it is marginally managed crop. Farm assessment was conducted in 2015/16 growing season in two peasant administrations areas of Gondar administrative district. Twenty chickpea farms were assessed to gather information on soil nutrient, nodulation and yield of chickpea. The result showed that the soil of all the assed chickpea farms had low organic matter (0.79 - 1.73%), very low nitrogen (0.04 - 0.09 %) and low to very low available phosphorus (3.24 - 12.55 ppm) contents. The number of nodules was moderately available in the soil (16 - 23.33 plant^{-1}). The average yield of

chickpea was very low (1.96 t ha^{-1}) compared to its potential yield (4 t ha-1). The low yield in the assessed farms could be the result of low soil nutrient status. Since farmers are cultivating chickpea on soils which are poor in organic matter, nitrogen and phosphorus nutrient contents, measures should be taken to maintain the soil fertility status of the farms in the study area. Therefore, it is essential to undertake research on site specific nutrient management options to enhance sustainable productivity of chickpea.

Key Words: Chickpea, assessment, Soil fertility, nodulation, yield

Introduction

Chickpea is the third largest produced food legume in Ethiopia (CSA, 2015), which is the seventh largest producer in the world and the first most important producer in Africa (MoA, 2010). The crop covers 15.38 % area and 17.17 % total pulse production in 2014/15 growing season in the country. Amhara and Oromia are the two major chickpea producing regional states, which cover 95% area and 96% production. North Gondar is the top chickpea producer zone, which covers 31% farm area and 36.70% total chickpea production of Amhara region (CSA, 2015).

Chickpea is produced in such significant quantity because it is a multi-purpose crop. Nutritionally, it is a source of protein for millions of poor people. It has high protein content (20-22%). It is also rich in carbohydrates, vitamins, minerals (phosphorus, calcium, magnesium, iron and zinc) and β-carotene (Gaur *et al.,* 2010). Hence, it reduces malnutrition and improves human health for the poor people who cannot afford livestock products. It also increases livestock productivity as its residue is rich in digestible crude protein compared to cereals. Moreover, the growing demand in both domestic and export markets provides a source of cash for smallholder producers in the country (Menale Kassie *et al.,* 2009).

It also plays a significant role in improving soil fertility by fixing the atmospheric nitrogen. It meets 80 % of its nitrogen requirement from biological fixation. It leaves substantial amount of residual nitrogen for subsequent crops and adds plenty of organic matter that improve soil fertility status (Gaur *et al.,* 2010). Hence it saves fertilizer costs in subsequent crops (Joshi *et al.,* 2001). Its production cost is low as it can withstand drought conditions by extracting water from deeper layers in the soil profile (Asnake Fikre, 2014). Moreover, it intensifies the use of scarce land resources through sequential cropping using residual moisture (Joshi *et al.,* 2001).

Generally, it is marginally managed crop by Ethiopian farmers. However, local specific information on production status of chickpea under farmers' management practices is limited around the study area. The objective of the field assessment was, therefore, to gather information on soil nutrient, nodulation and yield status of chickpea under farmers' management practices in two peasant administrative areas of north Gondar.

Materials and methods

Description of the Study Area

Farm assessment was conducted in 2015/16 growing season in two adjacent peasant administrations (PA's), locally known as Lay Teda Kebele and Tach Teda Kebele. The sites are among the rural areas of Gondar town administrative district, which is found in North Gondar Zone of the Amhara Region, North Western Ethiopia. The site is located at latitude of 12°36′N and longitude of 37°28′E. The altitude range of the area is 1800–2600 meters above sea level. The long term climate data (35 years) showed that the study area receives on average total annual rainfall of 1843 mm. On average the minimum and maximum daily temperature vary between 10.60-15.40°c and 20-31.83°c, respectively (national metrology agency, Bahirdar branch). According to the district annual production

evaluation report of 2015/16 cropping season (unpublished), the major cereal crops in the rural areas of the district are maize, sorghum, teff, wheat, barley and finger millet. The most important pulse crops are faba bean and chickpea. Grass pea is also produced in small areas. The area is categorized under Woyna dega agro climatic zone with altitude of about 1800-2100 meters above sea level. The soils are mainly red and black. The mean daily temperature and mean annual rainfall ranges from 25-30 degree Celsius and 1800-2000 mm, respectively. The topography of the area is 15% hill, 50% plain and 35% mountainous (Haimanot Atinkut, 2016).

Assessment Methods of Chickpea Farms

Twenty chickpea farms were randomly selected in the study areas to take crop and soil samples. Samples were collected at two chickpea crop stages in 2015/16 growing season. Plant samples were collected from 20 selected farms (10 from each PA's) at days to 50% flowering and days to 90% physiological maturity. At 50% flowering stage, 10 plant samples were randomly taken across selected chickpea farms. The whole root systems of the plants were carefully uprooted using pickax and washed. The nodules were removed from the plant roots, counted, dried, weighed and recorded. At 90% physiological maturity, 10 plants were also taken on the same chickpea farms to collect data on yield of chickpea. Since the seeds of all the assessed farms were sown in broad cast method, the numbers of plant stands per unit area were estimated by randomly throwing 0.25 m^2 (0.5 x 0.5 m) wooden

made square on five spots. In each chickpea farm, soil samples were taken within 0-30cm soil depth using augur.

Soil samples were collected within 0-30 cm soil depth using augur from the same spots of each farm where plant samples were collected during 50% flowering stage of chickpea. The collected soil samples at each spot were mixed together in a bucket and 1 kg homogenous composite sample was prepared. The samples were then labeled, bagged and sent to Gondar soil laboratory, where samples were air dried, milled and passed through 2 mm sieves.

Analysis of the result was performed for soil texture, pH, total nitrogen (TN), available P, exchangeable potassium and organic matter content. The soil analysis result of each parameter was qualitatively rated based on different methods of soil nutrient status categories.

Statistical Analysis

The data, which were collected from survey and field assessment, were analyzed using SPSS (statistical package for social scientist) version 20 software (SAS, 2004). Results were presented in descriptive statistics such as frequency distributions, percentages, mean, coefficient of variation and standard deviations.

Results and Discussion

Soil pH

Results of the soil analysis indicated that the soil texture of soil were either clay or clay loam. Globally, vertisols are mostly neutral to alkaline in reaction (Fassil Kebede and Charles Yamoah, 2009). Generally, pH is a major driver of soil fertility. The pH of the soil varied from 6.84 to7.41, with average value of 7.16, which is suitable for chickpea production.

According to the rating of EthioSIS (2016), 90% of the studied chickpea farms fall under neutral (pH= 6.6-7.3) and the remaining 10% were moderately alkaline (pH= 7.4-8.4) (Table 2). In line with the present result, the soil reaction varied from neutral (7.20) to slightly alkaline (7.90) in vertisols of Ethiopian highlands (Hillette Hailu *et al.,* 2015). Similarly, the pH values of vertisol profiles were within 7.25 in Shire to 8.66 in Adwa districts of Tigray region (Fassil Kebede and Charles Yamoah, 2009).

Soil Organic Matter Content

The soil organic matter content of the soil varied from 0.79 - 1.73% with average value of 1.40% (Table 1). The soil had low organic matter content in accordance with Metson (1961) who

rated OC between 1-2%. This could be because of the repeated cultivation of the lands without replenishment of organic sources such as crop residue, green manure, compost and farm yard manures. Similar results were reported from Tigray region (Fassil Kebede and Charles Yamoah, 2009). The organic matter contents were very low (1.6%) to low (3.20%) on the surface soils (Hillette Hailu *et al.*, 2015).

Total Nitrogen Content

The total soil nitrogen content was within the range of 0.04 - 0.09% with average value of 0.07 (Table 1). All the assed chickpea farms had very low nitrogen content (Table 2) based on the soil nitrogen level rating method of Landon (1991), who categorized the total N content of the soils as very high (1.0 %), high (0.5-1.0%), medium (0.2-0.5%), low (0.1-0.2%) and very low (<0.1%). The result indicated that the soils of chickpea farms are deficient in nitrogen content, which is vital for photosynthesis and growth of the plant. The nitrogen content in the present result is more severe than the nitrogen status in vertisols of Wukuro (0.05%) and Adwa areas (1.00%) of Tigray region (Fassil Kebede and Charles Yamoah, 2009) and different sites of Ethiopian highlands (0.10 to 0.20%) (Hillette Hailu *et al.*, 2015).

Available Phosphorus

The available soil phosphorus contents of the assessed chickpea farms ranged within 3.24 - 12.55 ppm with average value of 5.85 ppm (Table 1). As shown in table 2, 50% of the farms had very low and the remaining half had low available soil phosphorus content according to rating of Olsen *et al.* (1954), who grouped as very low, low, medium and high when the value is < 5, 5-15, 15-25 and > 25 mg kg-1 of soil, respectively. This implies that soil phosphorus is deficient in chickpea farms of the study area.

Study by Fassil Kebede and Charles Yamoah (2009) revealed that the available P content is very low, ranging between 0.43 ppm in Shire to 1.95 ppm in Adwa districts of Tigray. It was found to be deficient (3.8mg kg−1) in 80% and medium (14.6 mg kg−1) in 20% of the samples in vertisols of Ethiopia highlands (Hillette Hailu *et al.*, 2015). Generally, phosphorus is the most limiting nutrient next to N (Fassil Kebede and Charles Yamoah, 2009).

Exchangeable Potassium

The exchangeable potassium content of assessed chickpea farms varied from 0.62 -0.95 cmol/kg with mean value of 0.80 cmol(+)/kg (Table 1). As indicated in table 2, 85% of the assessed

chickpea farms had high exchangeable potassium content and the remaining 15% had medium value based on the rating method of Metson (1961), who considered as very high, high, medium, low and very low when soils have the value >2, 0.7-2.0, 0.3-0.7, 0.2-0.3 and 0-0.2 cmol /kg, respectively. This implies that potassium is not deficient in the assessed farms.

The potassium content in Shashamane district of South Ethiopia varied from 0.32 (low) to 3.30meq/100gof soil (high) (Tadesse Hunduma *et al.*, 2016). However, it was found 76% of sample soils in Tigray region were deficient in potassium (Fassil Kebede and Charles Yamoah, 2009).

Table1. Soil nutrient contents of the assessed chickpea farms

Soil Properties	Minimum	Maximum	Mean	CV (%)	SE
Exchangeable K^+ (cmol/kg)	0.62	0.95	0.80	14.00	0.04
pH	6.84	7.41	7.16	3.00	0.06
Electric conductivity (mS/cm)	0.05	0.11	0.08	26.00	0.01
Available P (ppm)	3.24	12.55	5.85	47.00	0.93
Organic Matter (%)	0.79	1.73	1.40	21.00	0.10
Total N (%)	0.04	0.09	0.07	22.00	0.01

By and large, the present result signifies that organic matter, total nitrogen and available phosphorus are deficient in the

assessed chickpea farms that can contribute for low chickpea productivity. This could be attributed to repeated crop cultivation without adding fertilizers and organic manures such as crop residue, compost, farm yard manures and green manures as the plant materials, which could be used for compost and green manures, are used for animal feed and thatching huts.

Cow dung, which could be used as FYM, is also used as cooking fuel. Hence, it is crucial to recover the depleted soil nutrients through available fertilizer sources such as chemical, organic, bio- fertilizers and the possible combination of these sources according to their availability to improve the productivity of chickpea and other crops. Abrham Belete (2014) reported that all macro nutrient balance in cereal lands in each zone of the Tigray region (adjacent to north Gondar) was negative, which is mainly associated to huge export of NPK through nutrient leaching and soil erosion from the system and low application of mineral and organic fertilizers.

Table 2. Frequency table for soil nutrient status of assessed chickpea farms

Nutrient Type	Rating	Frequency		Reference
		Number	%	
Exchangeable K	Medium	3	15	Metson (1961)
	High	17	85	
Available P	Very low	10	50	Olsen *et al.*(1954)
	Low	10	50	
Organic Matter	Low	20	100	Metson (1961)
Total N content	Very low	20	100	Landon (1991)
pH	Neutral	18	90	ETHIOSIS (2016)
	Moderately alkaline	2	10	

Nodulation Status of Chickpea

The farm assessment result showed that the number of nodules per plant ranges between16 and 23.33, with average number of 20.79, which is moderately available according to the 0-5 scale of Bala *et al.* (2010), who grouped nodule number per plant as absent (0), rare (<5), few (5 -10), moderate (11-20), abundant (21-50) and super nodulation (>50). The fresh nodule weight varies between 177.50 and 543.33 mg plant^{-1}, with mean

value of 293.83 mg plant-1 (Table 3). It was suggested that less than 500 mg nodule fresh weight plant-1 to be considered as sub-optimal, 500 to 1500 g plant-1 adequate and more than 1500 g plant-1 good nodulation (Elias, 2009). Based on this suggestion, the nodule availability in most of the assessed farms (90%) is sub-optimal.

The present study is in agreement with assessment study on nodulation status of twenty chickpea crop fields in Pakistan by Khattak *et al.* (2006), who found that native *Rhizobium* population of chickpea in most of the farmers' fields (70%) was less than what is required for optimum symbiotic association and hence it was suggested the need of artificial inoculation.

Table 3. Nodulation and seed yield of chickpea of the assessed chickpea farms

Variables	Minimum	Maximum	Mean	SE	CV (%)
Fresh nodule weight/plant (mg)	177.50	543.33	293.83	41.00	38.17
Nodule number/plant	16.00	23.33	20.79	0.77	3.70
Seed yield (quintal ha^{-1})	12.90	29.63	19.60	1.04	23.78

Seed Yield

Farm assessment result showed that the farmers in the study area produced on average 19.6 quintal ha-1 grain yield (Table 3). The assessment result indicated that the yield of chickpea obtained under farmers' management practice is by far lower than the potential productivity of the crop (4 t ha-1) (Asnake Fikre, 2014). The low yield could be attributed to production constraints of chickpea such as low nutrient status of the soil and poor management practices. The present average yield result is comparable with the national average yield of 1.91 t ha-1 (CSA, 2015)

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References

Abrham Belete. (2014). Estimating soil nutrient balance of cereal lands of Tigray region, northern Ethiopia. MSc thesis submitted to the school of graduate studies of Addis Ababa University, Ethiopia. Pp. 66.

Asnake Fikre. (2014). An overview of chickpea improvement research program in Ethiopia. In: Legume perspectives. In: Rubiales, D (ed.). Legume perspectives. *Journal of International Legume Society. Issue* 3:47-48.

Bala, A., Abaidoo, R. and Woomer, P. (2010). Rhizobia Strain Isolation and Characterization Protocol. Available online: www. N2 Africa. Org.

Central Statistical Agency of Ethiopia (CSA). (2015). Report on area and production of major crops: agricultural sample survey. Statistical bulletin. Volume I. Addis Ababa, Ethiopia.

Elias, N. (2009). Optimizing nodulation in chickpea for nitrogen fixation and yield in the northern grains belt of NSW. Thesis for the degree of Doctor of Philosophy, submitted to the University of Western Sydney. Pp. 228.

Ethiopian Soil Information System (ETHIOSIS). (2016). Soil fertility status and fertilizer recommendation atlas of Amhara national regional state, Ethiopia. August 2016, Addis Ababa, Ethiopia.

Fassil Kebede and Charles Yamoah. (2009). Soil fertility status and Numass fertilizer recommendation of typic Hapluusterts in the northern highlands of Ethiopia. *World Applied Sciences Journal.* **6 (11)**: 1473-1480.

Gaur, P. M., Tripathi, S. Gowda, C.L.L., Ranga Rao, G.V., Sharma, H.C., Pande S. and Sharma, M. (2010). Chickpea seed production manual. Patancheru 502 324, Andhra Pradesh, India. International Crops Research Institute for the Semi-Arid Tropics. Pp. 28.

Haimanot Atinkut, Muluken Melese, Dida Qonchera, Akpodee Nyerhovwo Martins, Demirew Kassa and Aynalem Amalo. (2016). Determinants of rural women's loan repayment performance: The case of Gondar Zuria District, North Gondar, Amhara Regional State. Global Journal of *Agricultural Economics, Extension and Rural Development.* **4 (4)**: 421-432

Hillette Hailu, Tekalign Mamo, Riikka Keskinen, Erik Karltun, Heluf Gebrekidan and Taye Bekele. (2015). Soil fertility status and wheat nutrientcontent in Vertisol cropping systems of centralhighlands of Ethiopia. *Agriculture and Food Security.* **4 (19)**: 1-10.

Joshi, P. K., Parthasarathy Rao, P., Gowda, C. L. L., Jones, R. B., Silim, S. N., Saxena K.B. and Kumar, J. (2001). The world chickpea and pigeonpea economics: Facts, trends and outlook. International Crops Research Institute for the Semi-Arid Tropics. Andhra Pardesh, India. Pp. 68.

Khattak, S.G., Khan, D.F., Shah, S.H., Madani M.S. and Khan,T. (2006). Role of *Rhizobial* inoculation in the production of chickpea crop. *Soil and Environment.* **25(2)**:143-145.

Landon, J. R. (1991). Tropical soil manual: a handbook for soil survey and agricultural land evaluation in the tropics and sub tropics. Longman Scientific and Technical, Longman Group, UK Ltd.

Menale Kassie, Bekele Shiferaw, Solomon Asfaw, Tsedeke Abate, Geoffrey Muricho, Setotaw Ferede, Million Eshete and Kebebew Assefa. (2009). Current situation and future outlooks of the chickpea sub-sector in Ethiopia. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Nairobi and Ethiopian Institute of Agricultural Research (EIAR), Ethiopia. Pp. 1-43.

Metson, A. (1961). Methods of chemical analysis for soil survey samples. New Zealand DSIR Soil Bur Bull 12. Govt. printer, Wellington. New Zealand.

Ministry of agriculture (MOA). 2010. Crop variety registration. Issue number 13. Animal and plant regulatory directorate. Addis Ababa, Ethiopia. Pp. 227.

Olsen, S. R., Cole, C. W. Watanabe, F. S. and Dean, L. A. (1954). Estimation of available phosphorous in soils by extraction with sodium bicarbonate. *Journal of Soil Science* **96**:308-12.

Statistical Analysis System (SAS). (2004). User's Guide. SAS 9.1.3 ETL Studio: Cary, NC: SAS Institute Inc., USA.

Tadesse Hunduma, Kefyalew Assefa and Tilahun Firomsa. (2016). Soil fertility assessment and mapping at Shashamane district, West Arsi Zone, Oromia, Ethiopia. *International Journal of Research and Innovations in Earth Science.* **3 (5):** 2394-1375.

Evaluation of the Selected Botanical Powders Against Bruchids *(Callosobruchus chinensis)* (Coeoptera: Bruchdae) on Chickpea *(Cicer arietnum)* in Semi Field Conditions

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Abstract

Chickpea *(Cicer arietinum L.)* grains are a major source of human food and animal feed because of their high content of lysine rich protein. One of the major limitations for increasing this grain production is losses of seed in storage. So this study was aimed to determining the insecticidal potential of some selected plant powders. The insecticidal potential of *Clematis hirsuta* and *Calpurnia aurea*, against *Callosobruchus chinensis* was evaluated at semi-field trail. Leaf of the botanical plant dried under shed, ground in powders and prepared at the

concentration of 75g, 112.5g and 150g per 1.5kg of chickpea grain at field trail. 120 unsexed adult *C. chinensis* were collected from the host grain chickpea and introduced in to polyethylene bag which contain substratum chickpea seeds. 180 *C. chinensis* with the age of 1-2 day were transferred into the polyethylene bag. Chickpea seeds were separately mixed with botanical powders and tested for 24, 48 and 72 hours. Malathion dust was used as a positive control, but the two selected botanical powders were applied as treatment to determine the mortality of *C. chinensis* after 24 hours. Among the two selected botanicals, *C. aurea* showed significantly higher mortality on *C. chinensis* within different doses and exposure times, which is 91.48% mortality at 10%w/w powder after 48 hours. However *C. hirsut* a leaf powder at lower dose (5%) and short time (24 hours) was relatively less effective (26.30%). The botanical plants treatments reduced weight loss due to bruchids after 60 day. The highest weight loss (3.17%) was scored on *C. hirsute* at lower concentration next to the negative control (7.35) and there was not any harmful effect for chickpea seed germination. Based on the results obtained it can be concluded that the application of those botanical leaves powders had a great potential for protection of chickpea in storage particularly at a high concentration and exposure time.

Key words: botanicals, bruchids, chickpea, mortality, storage

Introduction

Chickpea *(Cicer arietinum L.)* is considered to be one of the founder crops of modern agriculture (Rafael *et al.*, 2015). It is an ancient crop that has been grown in Pakistan, India, Middle East and parts of Africa for many years. The common names used for chickpea are Bengal gram (India), Garbanzo (Latin America), Shimbra (Ethiopia) and Chana in Pakistan (Muhammad *et al.,* 2006).Chickpea is the second most important legume crop after faba bean (Hussein Ahmed, 2011).Ethiopia is the leading country in Africa for chickpea production (Menale *et al.*, 2009). But in some area only few farmers completely allocate the farm for chickpea production and others cultivate the crop using one fourth of their land. This clearly indicated that the crop is not very popular in the area comparing to other crops. In most cases, they produced chickpea for home consumption and partly for sale and some cultivated the crop for seeds to the next season which serve as a good source of income (KebebushTesema, 2015).

Chickpea grains are a major source of human food and animal feed because of their high content of lysine rich protein. In addition, chickpea cultivation plays a significant role in farming system as a substituent for fallow in cereal rotation, where it contributes to the sustainability of production and

reduces the need for fertilization through fixing atmospheric nitrogen (Jukanti *et al.,* 2012). Chickpea has the ability to grow on residual moistures which gives farmer the opportunity to engage in double cropping, where chickpea is sown at the end of the rainy season following the harvest of the main crop (Habtamu Aschale, 2016)

In developing countries agriculture is the driving force for broad-based economic growth. In realizing this, one of the stumbling blocks seems to be the yield losses due to pests. One of the most important constraints of having every day sufficient food is the postharvest preservation of its quality and quantity. During storage, food grains and products are severely destroyed by insects and other pests. Losses at times are so severe so as to lead to famine in large areas in many countries of the world. Bruchid damage renders chickpeas unacceptable for market, consumption and seed. So, priority should be given to post harvest studies, where at least half of the food supply may be lost between harvest and consumption (Oparaek *et al.*, 2005).

One of the major limitations for increasing pulses production is losses of seed viability and damage of grains from insect pest infestation in storage. Pulses in developing countries suffer high qualitative and quantitative losses. The highest losses of grain legumes during storage are due to bruchids. About 12 species of bruchids are serious pests in the field and about six species are very serious pests during storage (Swella and Mushobozy, 2009). Storage insect, particularly the chickpea beetle *(Callosobruchus chinensis),* is considered one of the most important cosmopolitan species of storage insects in many food legumes (Gemechu Keneni *et al.,* 2003). The pulse beetles assume serious proportions usually during July-August in the stores (Savita and Anandhi, 2010). Hossain *et al.,* (2014) stated that *C.chus chinensi scause* damage to pulses both in the field and storage, but infestation is more crucial in stored condition.

At present, pest control methods mostly rely on synthetic insecticides and fumigants. But chemical protection measures may be resulted in many serious drawbacks (Lee *et al.,* 2001). Their extensive and indiscriminate use causes ecological imbalance, resistance of pesticides to pest, pest resurgence and outbreak of secondary pests, creates phytotoxicity, insecticidal residues in foods and feed (Hossain *et al.,* 2014). Synthetic pesticide use has led to the development of resistant strains of pests as well as different environmental and human health problems (Dubey, 2008).

In recent years, there has been considerable pressure by consumers to reduce or eliminate chemical insecticide in foods. Furthermore, the use of synthetic chemicals to control postharvest biodeterioration has been restricted due to their carcinogenicity, teratogenicity, high and acute residual toxicity, hormonal imbalance, long degradation period, environmental pollution and their adverse effects on food and side effects on humans (Talukder, 2009). The increasing concern over the level of pesticide residues in food has encouraged researchers to look for alternatives of synthetic pesticides. Plant products could offer a solution for the problems of availability, health risks, costs and resistance in the case of synthetic pesticides (Rajapakse, 2006).

Plant products have been used for many years by the small scale farmers in parts of Africa to protect stored products from insect infestation (KebebushTesema, 2015). In this regard many efforts have been made to screen plants with better botanical insecticides which can be used as an alternative to synthetic insecticide. In order to protect the stored product from insects, not only pesticides but a formulation of plants and their products as powders, volatile oils, nonvolatile oils and extracts could be effectively used (Rajapakse, 2006). Therefore, the present study was aimed at determining the insecticidal potential of some selected plants depending on the following objectives.

Materials and Methods

Description of the study area

Semi field experiment was conducted in North Gondar Zone, Alefa District, Ethiopia, which is located at 12^0 30 N and 36^0 30 E at an altitude of 1700 m. a. s. l. It is about 605km, 88km and 142km away from Addis Ababa, Bahir Dar and Gondar respectively. The District is characterized by annual rainfall of 900 to 1400 mm and mean maximum and minimum temperature of 22ºC and 28ºC. Chickpea seeds were collected from local market. Identification of bruchids was carried out with Debre Markos university expertise.

Experimental design

The experiment was arranged in a Complete Randomized Design (CRD) with three replications. The numbers of treatments were 8 composed of combination of two botanical plants *(Clematis hirsute* and *Calpurnia aurea)* leaf powder with three rate of application (5, 7.5, and 10% w/w), Malathion dust as standard check and untreated control. The botanical powders were mixed with 1.5kg chickpea grain and then introduced 180 individuals of 1-2 days old unsexed f1 progeny *C. chinensis.* To obtain the same age generation, 200 unsexed adult *C. chinensis* were introduced in two polyethylene bag which contain 4kg each and reared in the semi field condition which temperature fluctuates between 28-30ºC

Rearing of target insect

The parent adult bruchids; *C. chinensis* found from chickpea seeds, were brought from local market in North Gondar Zone, Alefa district. The chickpea grains which were used as a substrate for insect rearing were kept in an oven at 60ºC for 4 hours to disinfest the seeds from any prior infestation before the experiment (Bekele, 2002). The disinfested chickpea seeds were equilibrate under ambient condition where temperature fluctuates between 28±2ºC for 2 hours.

During the semi field experiment, the temperature was about 30ºC and it was optimum temperature for the oviposition of *C. chinensis* is between 30ºC and 32ºC (Yongxue, 1999). The bruchids were reared on stored chickpea *(Ciser arietinum),* in two polyethylene bags. To obtain newly emerged bruchids of the same age generation, 200 unsexed adult of *C. chinensis* were introduced into two polyethylene bags each containing 4kg of chickpea seeds which were disinfected. The polyethylene bags were tied that can allow sufficient aeration and prevent the escaping of the bruchid.

The parent bruchids were sieved out after 5 days of oviposition time and seeds were kept under ambient condition for 26 days. When the new generation emerges, they were sieved out and used for the experiment. The disinfested chickpea seeds were kept in 24 polyethylene bags in each having 1.5 kilo gram disinfested chickpea, which were stored in farmers' house. About 180 adults' unsexed 1-2 aged bruchids were released in each polyethylene bag.

After 2 hours for acclimatization, from 18 treatment container polyethylene bag the two plant leaf powder with 5, 7.5 and 10% w/w of the botanical powder were applied and three polyethylene bags with Malathion 5% dust as standard and three untreated seed container polyethylene bag were used as control. The treatments were thoroughly mixed with chickpea

seeds by shaking and rolling the polyethylene bag gently to ensure uniform coating of the seeds.

Collection and preparation of plant materials

Plant of fresh leaf and seed of *Clematis hirsuta*, and *Calpurnia aurea* (Table 1) were collected from their natural habitats North Gondar Zone Alefa district from November to December 2016. Plant selection in the study was based on interviewed local farmers to specify the indigenous plant species known for their use in the regular control of insects in their localities and through analysis of the relevant literature. Identification of plants was carried out at Debre Markos University by expertise. The botanical plants were dried under shade and crush into fine powder using mortar and pestle that sieved through 25 mm mesh. The grind and labeled botanical powders were kept in plastic bags for a few days until use.

Preparation of extracts

Table 1: List of botanical plants which were tested against C. chinensis(L) on chickpea

Botanical Plants	Local Name (Amharic)	Plant Type	Parts used
Clematis hirsuta	Azoareg	Climbing shrub	Leaf
Calpurnia aurea	Digta	Tree	Leaf

Adult Mortality Test

The experiment was done in three observation time (24, 48, and 72 hours) after treatment application. At each counting time dead bruchids were counted and removed. The bruchids were considered dead when there is no response after checking by touching from the abdomen with a pin. Seven days after treatment application, all dead and live bruchids were removed as natural mortality which may not be expected after this date (Kananji, 2007). Percentage of insect mortality was calculated using Abbott formula (Abbott, 1925).

$$\text{Corrected \% mortality} = [1 - \frac{Nt}{Nc}] \times 100$$

Where:

Nt= Number of Insects in Treated polyethylene bag,

Nc= Number of Insects in Control polyethylene bag.

Chickpea Weight Losses Assessment

Weight losses assessment was done on treated and untreated grains. To determine seed weight losses rate, samples of 200 grains were taken randomly from each polyethylene bag of the treatment. The seeds were divided into damage and undamaged seed to determine percentage of weight loss. The number of damaged (grains with characteristic hole) and undamaged grains were counted. The grain record with and without exit holes were counted and separately weighed and the resultant data was used to calculate the estimate percentage weight loss.

Percent weight loss was calculated following the equation of Gwinner et al.(1996).

$$\% \text{ weight loss} = \frac{UND - DNU}{U\,(ND + NU)} \; X\,100$$

Where, U= Weight of undamaged grain

NU= Number of undamaged grain

D= Weight of damaged grain, and

ND= Number of damaged grain.

Seed Germination Test Assay

Germination test was conducted 60 days after treatment application to determine viability of each botanical treated seed. Three replicates of 180 seeds randomly were picked in each treatment polyethylene bag and then placed on moist Whatman (No. 1) filter paper on flat dish and kept at room temperature. A healthy untreated seeds were set up similarly as control. Germinated seeds were recorded and the remaining samples were watered daily for 5 days. The percent Germination was computed according to Ogendo *et al.* (2004) as follows:

$$\text{Percentage seed germination}=\frac{number\ of\ seed\ germinating}{total\ number\ of\ seed\ in\ petridish}\times 100$$

Purity Test Assay

In addition to germination test, the physical quality of the seed should be assessed; this is especially important before seed sales; seed storage, and during seed processing. For seed purity test, the cleanness of seed, pure seeds were separated from impure seed, and then separately weighed and compared to the sample weight. Seed is considered pure if it appears normal in terms of size, shape, and general outward appearance. A sample of 200-seed were taken at random from each replication of all the treatments and calculated as follows:

$$\text{Purity percentage}=\frac{weight\ of\ pure\ seed}{total\ weight\ of\ sample}\times 100$$

Data analysis

Data entry and analysis were done using Microsoft excel and Statistical Analysis System program (SAS version 9.2) respectively. To examine the effect of the treatments on percentage mortality, percentage weight loss, percentage purity and effect of botanicals on germination of chickpea seeds, one-way analysis of variance (ANOVA) was used. Tukey student test (HSD) was used to separate the means where treatments were found to be significantly different ($P<0.05$). LC_{50}, LC_{90}, value were calculated by probit analysis.

Results

The effect of *Calpurnia aurea* and *Clematis hirsute* leaf powder against *C. chinensis*

The mean mortality of adult *C. chinensis* due to two selective botanical powders with three different doses through three exposure time was presented in Table 2. Those two plant powders applied at varied rate resulted in significantly higher ($P<0.05$) mortality of C. *chinensis* at 24 hours. Leaf powder of *C. aurea* applied at 5, 7.5 and 10%w/w showed a significant

toxicity effect, at 24 hours after treatment application that caused 32.04, 35.93, and 38.89% adult mortality respectively. It causes higher mortality than all other treatments except Malathion 5% dust, which caused 98.15% mortality within 24 hours. While the leaf powder of *C.hirsute* at a lower rate (5%) and short exposure time (24hr) was showed less toxicity effect (26.30%) against C. chinensis. *Calpurnia aurea* resulted in significantly higher mortality than *C.hirsute* and untreated test next to Malathion 5% dust, which caused high mortality within 72 hours.

Table-2 Mean mortality of adult C. chinensis by different plant powder treatments, after different observation time at semi-field trail

Treatment	Conc of Botanical Powder	Mean Adult Mortality After Treatment Application		
		24 hours	48 hours	72 hours
Calpurnia aurea	75	32.04±0.49^{c}	47.22±1.16^{ab}	80.37±0.49^{a}
	112.5	35.93±2.43^{bc}	58.52±0.98^{ab}	86.49±0.49^{a}
	150	38.89±2.55^{b}	72.59±1.34^{a}	91.48±0.49^{a}
Clematis hirsuta	75	26.30±0.87^{d}	37.78±2.10^{b}	60.18±0.98^{b}
	112.5	32.22±0.85^{c}	47.59±0.98^{ab}	70.00±1.16^{ab}
	150	36.11±0.85^{bc}	53.89±0.56^{ab}	77.60±0.67^{ab}
Malathion dust	1.5	98.15±0.49^{a}	99.63±0.19^{a}	99.81±0.19^{a}
Control	0	0.556±0.32^{e}	1.67±0.32^{e}	2.78±0.32^{c}

Mean within the same column followed by the same letters are not significantly different, P > 0.05%, Tukey student test (HSD)

The number of dead bruchids at lower dose within 24 hours was fewer at both botanicals'. The highest dose of *C. aurea* leaf powder showed significantly higher *(P< 0.05)* mortality to bruchids. Both botanical leaf powders applied at 5, 7.5 and

10% showed a significant toxicity effect. Observations on 48 and 72 hours after treatment application indicated that mortality of bruchids was high. That is when the rate and exposure time; increase the mortality of *C. chinensisalso* increase. *C.aurea* leaf powder with 150 gram caused 91.48% mortality and Malathion 5% dust with 1.5 gram caused 99.81% mortality against *C. chinensisat* 72 hours after treatment application

(Table 3). Generally, the cumulative mortality of bruchids after three day treatment application showed that botanicals appeared to be more effective when compared with the untreated control.

Table-3: Probit Analysis of Toxicity of Two Botanicals in Semi-field Trail after 24 Hours Treatment to *C. chinensis*

Botanicals	After 24 hours		After 48 hours		After 72 hours	
	LC_{50}	LC_{90}	LC_{50}	LC_{90}	LC_{50}	LC_{90}
C. aurea	10.37 (9.48-11.63)	18.63 (16.39-22.1)	6.68 (6.25-7.11)	11.91 (11.13-12.9)	4.19 (3.78-4.57)	7.94 (7.51-8.45)
C. hirsute	11.72 (10.55-13.5)	20.62 (17.80-25.2)	8.31 (7.76-8.96)	14.91 (13.59-16.8)	5.70 (5.26-6.11)	10.70 (10.04-11.5)

Effect of botanical powders on weight loss of chickpea grains due to feeding by *C. chinensis*.

Results of assessment of percentage of weight loss caused by infestation of *C. chinensis* on treated and untreated Chickpea seeds are given in (Table. 5). The amount of grain weight losses that caused by *C. chinensis* was reduced in the entire botanical powder admixture significantly ($P<0.05$) compared with the control 60 days after treatment application. The lower weight loss in the powder treatment might be due to the increase in the number of adult mortality that resulted kernel damage. Among the two plants relatively the highest weight loss (3.17%) was observed in *C. hirsute* leaf powder with lower rate (5%) next to the untreated check. The lowest weight loss (0.69%) was observed in *C. aurea* leaf powder. There was a little weight loss recorded on grains treated with Malathion dust 5%. This finding showed that *C.aurea* and *Clematis hirsute* have the efficacy of reduced the weight loss even at the lower dose similar to standard check Malathion dust 5% at recommended rate. The seed weight losses were observed in this treatment percentage ranged from 0.69% to 3.17% and was significantly different from the untreated check (7.37%).

Effects of Botanicals on Germination of Treated Chickpea Seeds

The current study outcome illustrated that the mean percentage of germination of chickpea seeds treated with selected botanical plant powders at three doses and untreated check was presented in (Table. 4). There was no any detrimental effect on chickpea seed germination when treated with *C. aurea* and *C. hirsuta* that no significant ($P > 0.05$) was observed as laboratory cause. The germination of chickpea was ranged from 96.67% *C. aurea* with higher doses and 94.67% *C. hirsutaat* lower dose. This indicated that there was no any adverse effect every dose of the both botanical powders on the germination capacity of seed.

Effect of Botanicals on Purity of Chickpea Seeds against C. chinensis

Mean percentage purity of chickpea seeds treated with the current tested botanical plant powders within a given doses and untreated check was shown in (Table.4). The result explained that the effect *Calpurnia aurea* and *Clematis hirsutaleaf* powder on Chickpea seed purity was significant ($P<0.05$) compared to untreated. The highest purity (91.20%) was recorded on Chickpea seeds treated with *Calpurnia aurea* seed powder at the rate of 10%w/w of grain and the least was

recorded on Chickpea seeds treated with *Clematis hirsute* (87.35) powder at 5g/100g of grain. These indicate that the chickpea seeds were treated with botanicals showed increase seed purity when the powder dose increase 60 days after treatment as standard check.

Table-4: Mean Weight Loss, Germination and Purity of Chick pea Seeds due to Treatment of two botanicals and standard (Malathion dust) at Semi-Field Trail.

Treatment	Concentration (w/w)	%Weight Loss	% Germination	%Purity
C. aurea	75	1.18±0.58c	95.78±0.589ab	88.11±0.28^{e}
	112.5	1.29±0.30bc	94.67±0.38b	90.37±0.36^{c}
	150	0.69±0.09c	95.33±1.15ab	91.20±0.04^{b}
C. hirsuta	75	3.17±0.52b	95.00±0.00ab	87.35±0.02^{f}
	112.5	2.66±0.13bc	94.67±0.38b	88.53±0.06^{e}
	150	1.75±0.62bc	94.67±0.67b	89.65±.05d
Malathion dust	1.5	0.97±0.23c	94.44±0.59ab	97.31±0.16^{a}
Control	0	7.35±1.25a	95.00±0.38ab	60.27±0.35^{g}

Mean within the same column followed by the same letters are not significantly different, P>0.05%, Tukey student test (HSD)

Discussion

Various studies indicate that botanical leaves powders were used for protection of stored chickpea from *C. chinensis*. Thus, the result of the present semi field scale trail study conducted that the selected botanical plant leave powder with three concentrations had different potentials against *C. chinensis* on stored chickpea. In this study there were two locally available botanicals, which were *C. aurea* and *C.hirsuta*. Those tested botanical plant powder mortality effects was significantly ($P<0.05$) different from the untreated check and both of them were like positive control Malathion dust after three days to against *C. chinensis*.

Among the two tested botanicals, *C.aurea* leaf powder at all concentration 75, 112.5and 150gram) applied showed high percentage mortality to *C. chinensis* after 24 hours. This insecticidal potential was like that of the standard check Malathion 5% dust which caused higher mortality. Other researchers also revealed that *C. aurea* leaves and other product were shown promise insecticidal activities against different insect and other arthropod pests. Adedapo et al (2008) reported that *C. aurea* was used to kill lice. Moyo and Masika, (2013) indicated that the extracts of *C. aurea* at concentration of 100% had flea mortality of 73.3%. *Calpurnia aurea*

leaf extracts were used in southern Ethiopia for protecting livestock against ticks. This because of it contains active compounds which are called quinolizidine alkaloid calpurnine (12β, 13α dihyidroxylic acid Easter (Zorloni, 2007). These quinolizidine alkaloids are toxic to insect and animals Adedapoet al (2008). In the present study, *C.hirsute* was effective against *C. chinensis* particularly at higher doses and after 72 hoursscored60.18%mortality next to *C. aurea*

In the present study, higher doses and longer exposure period are required to achieve possible management of *C. chinensis* especially at small scale trail. All the plant leaves powder mixed with a chickpea caused more significant adult mortality of *C. chinensis*. Three days after application, adult chickpea weevil mortality was 91.48%. The insecticidal effect of plant powder may attribute different effects on insects. Insect repellency, stomach poisoning effect where insects feed on admixed grain and pick up a lethal dose of treatment particles, and botanical powders might reduce insect movement and also cause death through occlusion of their spiracle, thereby, preventing respiration via trachea (Tesfu Fekensaa, 2011).

Hence, in the present finding, in addition to mortality, all botanical powders significantly lower numbers of chickpea seeds exit hole compared with the untreated chickpea seed.

Mean weight loss caused by *C. chinensis* treated those botanicals resulted in significantly lower. Chickpea grains treated with Malathion dust followed by *C. aurea* were highly significant ($P<0.05$) difference with untreated on weight loss. This reduction of grain weight loss was due to increase adult mortality of *C. chinensis* within short time. The higher dosage plant powders in addition to directly pests poison; it affects the egg laying and larval development of bruchids that could be hampered by covering the seed and affects the insect movement to screech the partner for mating (Adugna, 2003). In relating to this Aselam and Suleman (1999) in their study of storage grains reported that fraction of the dust particles with insect cuticle leads to desiccation and hamper the development of pests. Adugna *et al*, (2003) in their survey of storage pests reported farmers in Eritrea uses a mixture of small size grain and fine sands give a better control of grain storage pests.

The current finding has showed that *C. aurea*, and *C. hirsuta* powder were able to minimize the chickpea seed weight loss as none significantly Malathion dust 5%. The highest chickpea weight loss was recorded on the untreated check. In likewise to this study other botanical products also used to reduce weight loss that caused by *C. chinensis*. Tesfu Fekensa (2011) recorded that, there were *C. chinensis* adult mortality and lower seed damage when treated with different parts

Parthenium hysterophorus plant powder with different rate exposure time. Kebebush Tesema (2015) also reported that neem leaf powder and basil leaf powder significantly cause for *C. chinensis* adult mortality and lower seed weight loss.

Chickpea seeds treated with, *C. aurea* and *C. hirsuta* powders were pure compared to the untreated check. So, those plants had a potential to keep seeds as normal appurtenance. This was due to immediate mortality of adult bruchids during treatment application before they injure chickpea seeds. The highest purity of chickpea grains were recorded on Malathion dust and *C. aurea* with 150 gram powder/ 1.5 kilo gram seeds, which was 91.20% purity recorded. On the other hand relatively lower percentage purity was shown on *C. chinensis* (87.35%) next to untreated (27%).

From the viability of seed germination, it was concluded that the current tested botanical plant materials have no significant effect on seed germination. All the botanical treatment, including Malathion dust showed favors the seed germination mean percentage germination ranged 94.44-95.33%. There were no significant difference (P = 0.27) from the untreated check and treated with Malathion dust. Different scholars reported on the effect of botanicals on seed germination. The current study agrees with Tabu *et al.* (2012) proved that

M. ferruginea seed powder treatment does not impair the germination of seed with 3%, 4% and 5%.

The overall test of efficacy between the treatments showed that mortality of the target was directly related to the dosage and exposure time. This indicated higher dosage was more efficient in management of *C. chinensis* the extent to which the botanical affected the survival of the subsequent adult has found to vary among them this indicated that the active ingredient of botanicals which are responsible for the toxicity of plant kill the insects gradually.

References

Abbot, W.S. (1925). A method for computing the effectiveness of an insect. *Journal of Economic Entomology.* **18**:265-267.

Adedapo, A., Jimho, F., Koduru, S., Afolayan, A. and Masika, P. (2008). Antibacterial and antioxidant properties of the methanol extract of the leave and steam of *Calpurnia aurea. BMC complement. Altern., Med* **8(53)**: 1-8.

Adugna Hail, Dagnaw G/Selassie, Biniam Zereyacob, and Biniam Abreham (2003).On farm storage studies in Eritrea. Dry land coordination groups report. p.28

Aselam,. M., and Suleman, M. (1999). Pest management of stored from comedies. *The Nation,* **11 (53)**:5.

Askale Gizaw (2015). In vitro efficacy of methanolic extracts of *Vernonia amygdalina, Croton macrostachus, Ricinus communis* and petroleum ether extract of *Millettia ferruginea* against Bovicolaovis and rhpicephalus (boophilus) decoloratus. MSc Thesis

Bekele Jembere. (2002). Evaluation of the toxicity potential of *Millettia ferruginea* (Hochst) Baker against *Sitophiluszeamais* (Motsch. *Journal Pest manage.* **48 (1)**:29-32).

Dubey, N.K. (2008). Current Status of Plant Products as Botanical Pesticides. *Journal of Biopesticides*, **1(2)**:182-186.

Gwinner, J., Harnsch, R. and Muck, O. (1990). Manual on the prevention of Post- Harvest grain Losses. Post-harvest project, Pickben 4, D-200 Hamburg **11**, FRG, pp.294,

Hailu Tadege. (2004). Phytopharnceutical studies of some medicinal plants locally used in the treatment of skin disorder. MSc thesis, Addis Ababa University.

Habtamu Aschale. (2016). Efficacy of some botanicals against African bollworm, *Helicoverpaarmigera* (Hubner) (Lepidoptera: noctuidae), on chickpea in Assosa, western Ethiopia. MScthesis, Haramaya University,.

Hossian M. A., Bachuchu M.A.A., Ahmed K.S. and Haque. M. A. (2014). Effectiveness of indigenous plant powders as a grain against *Callosobruchus chinensis* in stored chickpea *(Cicer arietinum). Bangladesh Journal of agriculture Resource* **39 (1)**:93-103

Hussein Ahmed. (2011) Evaluation of Chickpea Genotypes *(Cicer arietinumL.)* for Genetic Parameters and Drought Tolerance thesis, Addis Ababa University.

Jukanti A. K, Gaur P. M, Gowda and Chibbar, R. N. (2012). Nutritional quality and health benefit of chickpea *(Cicerarietinum L.): A review. British Journal of Nutrition* **108**: 11-26

Kanaji, G.A.D. (200). Small holder farmers perceptions of dry bean damage by bean weevil and varietal preference in Malawi and their implications for breeding .PhD Kwanzulu University, natal republic of south Africa pp4-162.

Kebebush Tesema. (2015). Evalution of plant powders, caw dug ash and malathon dust againest *Callosobruchus Chinensis* L. (Coleoptera: Bruchidae) on Chickpea. . *Journal of Agricultural Studies.***3(2)**: 133-139

Lee. B.W. Choi, Lee, S, and Park, B. (2001). Fumigant toxicity of essential oil and their constitute compounds towards the rice weevils *Sitophilus orezae.* Crop Prot. **20**:317-320.

Menale Kassie, Bekele Shiferaw, Solomon Asfaw, Tsedeke Abate, Geoffrey Muricho, Setotaw Ferede, Million Eshete, and Kebebew Assefa. (2009). *Current Situation and Future Outlooks of the Chickpea Sub-sector in Ethiopia.* International Crops Research Institute for the Semi-Arid Tropics, Nairobi and Ethiopian Institute of Agricultural Research, Debre Zeit Agricultural Research Centre, Debre Zeit, Ethiopia.8p.

Moyo. S and Masika, P.J. (2013).Insecticidal properties of materials used by resource-limited farmers to control fleas in free-range chickens in the Eastern Cape Province, South Africa *African Journal of Biotechnology Vol.* **12(14)**, pp. 1682-1688,

Muhammad Aslam, Farid Asif Shaheen, Muhammad Asad Abbas, and Ambreen Saba (2006). Management of *Callosobruchus chinensis* through use of resistance in stored chickpea varieties. *World Journal of Agricultural Sciences.* **2 (1)**: 82-84

Ogendo, J. O., Deng, A. L., Belmain, S.R., Walker, D.J. and Musandu, A. A. O. (2004).Effect of insecticidal plant materials, *Lantana camara L.* and *Tephrosiavogelii* Hook, on the quality parameters of stored maize grains. *J. Food Technol. Afr.* 9:29-36.

Orwa C, Mutua,A.,Kindt, R., Jamnadass, R, S. and Anthony. (2009). Agroforestry Database: a tree reference and selection guide version 4.0

Rafael M. Jimenez-Diaz, Pablo Castillo, Maria del Mar Jim enez-Gasco, Blanca B. Landa Juan A. and Navas-Cortes (2015). Fusarium wilt of chickpea:Biology, ecology and management.www.elsivier.com/locate/cropro. *Crop protection* 73 16-27

Rajapakse, R. H. S. (2006). The potential of plant and plant products in stored insect pest

SavitaVarma and Anandhi, P. (2010). Biology of pulse beetle *(Callosobruchus chinensislinn.,* Coleoptera: Bruchidae) and their management through Botanicals on stored mung grain I allahabad region. *Agricultural research communication center Research,* **33(1)**: 38-41

Swella and Mushobozy. (2009). Comparative Susceptibility of different legume seed to infestation by Cowpea bruchid *Callosobruchus maculatus* (F) Coleoptera: Chysomelidae). *Plant protection Science* **1**:19-24

Tabu D., T. Selvaraj, S.K. Singh and Mulugeta,N. (2012). Management of Adzuki bean beetle *(Callosobruchus chinensis L.)* Using some botanicals, inert materials and edible oils in stored Chickpea. *Journal of Agricultural Technology* **8(3)**: 881-902.

Talukder, F. (2009).Pesticide Resistance in Stored-¬Product Insects and Alternative Biorational Management, *Agricultural and Marine Sciences,* **14**:9-¬15.

Tesfu Fekensa and Emana Getu. (2013). Evaluation of *Parthenium hysterophorus* L. powder against *Callosobruchus chinensis L.* (Coleoptera: Bruchidae) on chickpea under laboratory conditions *African Journal of Agricultural Research,* **8(44)**: 5405-45010

Yongxue Deng, Shiyuan, Wu. and Longshu, L. (1999). Temperature effect on development and reproduction of Chinese cowpea weevil, *Callosobruchus chinensis.* L (Coleoptera: Bruchidae). Proceedings of the 7th International Working Conference on Stored-product Protection 1: 125-127

Zorloni, A. (2007). Evaluation of plants used for the control of animal ectoparasites in southern Ethiopia (Oromiya and Somalia regions). MSc Thesis, University of Pretoria

Rural Household Poverty and Its Determinants: the case of Basoliben Woreda; A Comparative Measurement Approach: Consumption Poverty and Multidimensional Poverty

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Abstract

The research was conducted to measure rural household poverty and to examine its determinants in Basoliben Woreda by employing Foster-Greer-Torebecke and multidimensional poverty index approaches comparatively. Accordingly, the study found that the prevalence, gap and severity of rural household consumption poverty in the study area are 26.3%, 4% and 0.01 respectively, and the prevalence, average deprivation and adjusted multidimensional poverty are found to be 64%, 44.75% and 0.286 respectively on the cross sectional survey time. This assures that multidimensional poverty is profound than consumption poverty in Basoliben Woreda. In local agro-ecological comparison, rural household consumption poverty and multidimensional poverty are more rampant in the Qolla agro-ecology of the Woreda compared

with its counterpart, the Woyinadega agro-ecology. Apart from poverty measures, the study also proved that an increasing number of adult equivalent household size and longer market distance increases the consumption poverty prevalence and the poverty gap whereas higher livestock ownership in TLU and access to irrigation decrease household's probability of being consumption poor and the poverty gap. Besides, age of household heads is found to have a positive correlation with poverty gap while the intensity of agricultural extension service and crop diversification are found to have an inverse relationship with poverty prevalence. On the other hand, poor access to electricity and solar energy, lack of improved fuel sources, poor sanitation privilege, lack of access to safe drinking water and lack of access to road are found to increase multidimensional poverty prevalence in the study area.

Keywords:-Foster-Greer-Torebecke, consumption poverty, multidimensional poverty, Qolla, Woyinadega

Introduction

Poverty has remained to be a tough global problem even in the new millennium. Although different integrated efforts both at global and local levels were made to alleviate the problem, still more than 1.4 billion eople on earth are recognized

as poor (earning bellow $1.25 per day), of these 1 billion are suffering from hunger and Sub-Saharan Africa and Asian countries hosted the lion's share (IFAD, 2012). Especially, sub-Saharan Africa countries of which Ethiopia is one, host most of the people who are living under abject poverty.

Despite its ample natural resources, Ethiopia is one of the poorest countries ranked 174th out of 187 (UNDP, 2013). Trickled from its macro level underdeveloped status, 39% of the population live under poverty with a daily income of below $1.25 per day and worse by assuring that 90% of the populations are multidimensional poor (Alkier and Santos, 2010).

Apparently, the rural and the urban people in Ethiopia experience poverty differently. The extent of poverty is worse in rural areas as compared to urban settings. The rural people are more vulnerable to poverty with a prevalence rate of 45% compared with the urban with a prevalence rate of 37% (Asmamaw, 2004). Similarly; MoFED (2012) had also reported that rural household consumption poverty prevalence is 30.4% on 2010/11. In addition, Addisu and Sundara (2015) in their study of determinants of poverty in rural Ethiopia assure that poverty is rampant with a prevalence of 39.3%. Moreover, the multidimensional poverty prevalence of rural

Ethiopia was reported 53.7% in 2011 (UNDP 2016). This higher extent of poverty in rural areas is attributed to the fragile nature of the rural economy (rain- feed agriculture), poor infrastructure and the diminution of arable land size per household.

Basoliben Woreda, where the study is conducted, is a typical rural context in Ethiopia with 57499.5 k/m2 arable land and favorable climatic condition for agriculture. But, poverty is still acute in the area and being poor in this typical rural context mean having no enough food to eat and no adequate clothing to wear. Besides deprivation in the basic need aspects, there is also fragile social and infrastructural development in the area where there are only 53 schools, 5 health centers, 1 deep - water wall (with only 64.3% provision rate) and only 87.5 kilometer dry weather road for a total of 164,588 population (BWFEDO, 2016).The health center - population ratio of the Woreda is 1:132,917 which is below the country's rural standard, 1: 1:25,000. Likewise, according to the rural dry weather road provision standard, which is supposed to be 255 K/m on 2016, the area has limited road infrastructure.

Other than the above noticed crude facts, an attempt was never made by previous researchers to measure poverty and examine

its determinants in this particular rural area, Basoliben, of Ethiopia. Even in researches conducted in other rural areas of the country with similar context, there are limitations in using primary in employing a couple of approaches, FGT and MPI, jointly and comparatively to get more meaningful findings. Bouncing on these gaps, this paper attempts to measure rural household poverty in the study area. The tools to collect data were FGT and MPI approaches jointly, to compare and contrast measurement results from the two approaches and to examine determinants of rural household poverty. In the meantime, the methodological procedure followed in doing the research is expected to give lessons and clue on perspective shift from one-dimensional measurement to multidimensional measurement in poverty analysis for the research community.

Materials and methods

Research design

Mixed (quantitative and qualitative) research design was employed to undertake the study. In addition, cross sectional survey method was employed.

Data sources and data collection methods

Because of the absence of up to date comprehensive data on the socio-demographic and economic characteristics of the households in the study area from the Ethiopian rural household survey (ERHS), primary data was used to undertake the study. From the study area, 186 randomly selected sample households were surveyed to collect data on their socio-demographic and economic characteristics and to figure out the poverty profile. To determine the sample size, Yeman's simplified formula cited in Israel (2013) was used and to assure the representativeness of the sample, proportional stratified sampling procedure has been employed.

The study area constitutes two local agro-ecologies and 22 rural kebeles. Besides, CSA had estimated that 23,374 rural households, of which 2,902 are women headed, found in the Woreda on 2015. The report by BWFDO (2016) also shows that these households are evenly distributed across the local agro- ecologies and more or less across kebeles. Depending on these statistics, from the 22 rural kebeles two randomly selected were added to the sampling basket. These kebeles have a total of 2013 households which distributes evenly in the two dominant agro-ecologies, the Qolla and the Woyinadega. So, proportionally 91 households from the Qolla agro-ecology

and 95 households from the Woyinadega agro-ecology were selected and surveyed using multi topic semi structured questionnaire as a data collection tool.

Measuring poverty

As indicated in the introduction part, the current study employed two measurement approaches, consumption (conventional) and multidimensional poverty index. These approaches are comparatively used to give clear insight on the effect of looking perspective variation on poverty measures.

Obviously, consumption poverty measurement approach is the most common type of measurement approach. At the household level analysis and using adult equivalent consumption expenditure as a fundamental welfare indicator, the study first attempts to measure poverty index, gap and intensity.[q]To measure these poverty indices, the first step was to set an objective poverty line of the study area. Having the data from the survey, the poverty line of the area is fixed based on the procedures of the cost of basic needs approach and by taking FAO's 2,300 calories per day as an adult equivalent metabolic requirement of the study area. Then, aggregation of poverty measures is made using the FGT family of poverty measurement which can be mathematically expressed as:

$$Pa=\frac{1}{n}\sum_{i=1}^{q}\left(\frac{gi}{Z}\right)^{a} \qquad (1)$$

Where Pa is poverty indices, Z is poverty line, q is the number of households which has adult equivalent consumption below the Z, gi is an adult equivalent consumption shortfall, a is poverty aversion parameter (which will take the value of 0, 1 and 2 which gives poverty headcount ratio, poverty gap and poverty intensity ratio respectively) and n represents sample population.

What comes second is Multidimensional poverty measurement. By adopting Alkire and Santos's (2010) approach, referring to the millennium development goals and customizing to the context of the study area, the study measured multidimensional deprivation from the angle of three dimensions. These were health, education and living standard and in consideration of eleven indicators which includes years of schooling, child enrolment, child mortality, nutrition, cooking fuel, drinking water, sanitation, house flooring, source of light, day to day used assets and distance of the by- near weather road.

The dual cut- off method is used to identify households with acute multidimensional poverty. In the health and education dimension each indicator has a score of 16.67% and households

having a deprivation score of 16.67 % and above in a single indicator is counted as multidimensional poor in that particular indicator. Similarly, in the living standard dimension each indicator has a value of 4.76% and households with a deprivation score of 4.76 and above are considered as deprived in that particular indicator. At dimension level, in the health and education dimension households which has a deprivation rate of 16.67% and above are considered as deprived while households which has a deprivation rate of 19.04% and above are counted as multidimensional poor in the living standard dimension.

Knowing the deprivation status of each household in each indicator, the next issue is the estimation of the sum total deprivation score (S_i). This value is taken by adding scores in each indicator and symbolically it can be expressed: $S_i=w_1I_1+w_2I_2+w_3I_3+$---$w_nI_n$ where *w* represents weights given to each indicator, n=(1,2,3…10) number of represents indicators and *I =1* if the household is deprived in indicator i but *I=0* otherwise. Then the total score Si of each household is evaluated against the given overall poverty cut-off K, which is equal to 0.33 or 33.33%. Based on this, households with Si ≥ 0.33 or 33.33% falls into the poor category but non-poor otherwise. But, the deprivation score Si for non-poor must be censored to consider deprivation score of only the poor and to

get more accurate results. So, given poverty cut-off K = 0.33, a shared deprivation score Si, the value Si (k) = Si when Si ≥ K and Si (k) = 0 when Si < K.

Finally, aggregation is made to generate the multidimensional poverty profile of the study area. This aggregation needs basically two information which are the incidence (H) or prevalence and average deprivation (A).

Depending on the above information, the incidence of multidimensional poverty in the study area is estimated as:

$$H = \frac{q}{n} \qquad (2)$$

Where q is the number of poor households and n represents the total number of sample rural households and the depth of deprivation or shared deprivation can be estimated as:

$$A = \frac{\sum_{i}^{n} = 1 \, Si\,(k)}{q} \qquad (3)$$

Where *Si(k)* is the censored deprivation score of household *i* and *q* are the number of households which face multidimensional deprivation.

After all, the combination of the headcount index (H) and poverty intensity (A) gives multidimensional or adjusted poverty (Mo) estimate:

$$MPI \text{ or } Mo = H \times A \qquad (4)$$

Finally, after estimation of poverty using the two approaches, consumption approach and MPI approach, comparison of results is made.

Econometric models

In accordance with the requirement of the research theme under interest, two econometric models are employed in the study. The first one is the binary logit model which is used to analyze the determinants of consumption poverty prevalence. The poverty status of households is a kind of binary response and dummy which will be poor or non -poor and which will be determined by their adult equivalent consumption expenditure. In turn, the adult equivalent expenditure of households is expected to be affected by different explanatory variables and symbolically the model can be specified:

$$Li = \ln \frac{Pi}{1-Pi} = Ci = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon i \qquad (5)$$

Where βo is a constant term, X1, X2,…Xn are lists of explanatory variables which affect the consumption poverty

poverty status of households, β_1, β_2... β_n are coefficient of variation for explanatory variables and εi is the disturbance term.

The second one is the Tobit model which is employed to analysis determinants of the depth or gap of poverty. To see the effect of explanatory variables on the depth or gap of poverty among the poor, consumption per adult equivalent Ci need to be censored from above which means it is continuous but must be fixed at the poverty line for observations which have an adult equivalent consumption of equal or greater than the poverty line which means Ci* = Ci if Pi > 0; Ci* = Z otherwise where Z is the poverty line.

Then censored regression model to identify poverty depth or gap determinants and their level of significance is specified as:

$$Ci = \beta o + \beta i Xi + \varepsilon i \quad if \ \ Pi > 0 \qquad (6)$$

Where Xi denotes vector of explanatory variables, βi denotes the coefficient of explanatory variables and εi denotes the error term.

Results

Socio-demographic and characteristics of the respondents

The socio-demographic characteristics of surveyed households was analyzed from the perspective of different parameters which includes the sex of household heads, age of household heads, educational level of household heads, family size and dependency ratio. The descriptive analysis result shows that 86% of households included in the survey are male headed. The average age of heads of surveyed households is also found to be 43 1/2years.

The highest level of education the household head attained is obviously supposed to have correlation with the households economic status and the descriptive statistics result shows that 65.6% of surveyed household heads have not attended any kind of formal education while 14.5% attended from grade 1-4, 10.8% attended from grade 5-8, 5.4% attended religious education and the rest 3.8% attended adult education. In sex disaggregation, 85% of female household heads, which are included in the study haven't attended any kind of formal education. Family size and age dependency ratio are the other two variables which are seriously analyzed and the result shows that average family size and average dependency ratio are 5.3, slightly higher in the *Qolla* agro-ecology, and 0.45 respectively.

The status of surveyed households in terms of land ownership, livestock ownership and asset holding was also examined and the following results are found out. The average land holding status of households is found 1.4 hectares, which is higher in the *Woyinadega* agro-ecology where households have 1.5 hectare average land holding. Besides, land renting and crop sharing are found very common practice among surveyed households which makes the size of annually cultivated land of households slightly higher which is 1.67 in the 2016/17 harvest season. The average livestock ownership in TLU and the asset holding status of households in monetary value (excluding the house), are also estimated to be 6.5 TLU and 5482.3 Birr respectively. Apparently, asset ownership is slightly higher in the *Qolla* agro-ecology which is 5549.8 Birr. In addition, access to irrigation and livelihood diversification are also key variables which can be used to see economic status and the descriptive analysis result indicates that from the total surveyed households only 20% have access to irrigation and 24.7% have income sources other than farming. Finally, average daily adult equivalent consumption expenditure of households in the study area is found 18.62 birr where it is higher in the *Woyinadega* agro-ecology which has 19.4 birr consumption expenditure per adult equivalent.

Poverty Measures

Consumption poverty: By capturing the average value of most commonly consumed commodity bundles and by employing the cost of basic needs approach and taking FAO's 2,300 calories daily metabolic requirement as a base of scaling, the food expenditure poverty line of the study area is estimated 10.31 Birr. In addition, by taking the average value of adult equivalent non-food expenditure of surveyed households, the non–food consumption poverty line is estimated 4.73 Birr per day. Summing up these two estimates, the overall poverty line of the study area is fixed at 15.04 Birr per day per adult equivalent. Having the above poverty cut of point, 26.3% of surveyed rural households are consumption poor. In local agro-ecology disaggregation surveyed households from the *Qollaagro*-ecology have greater share of consumption poverty prevalence. Similarly, the gap and intensity of consumption poverty are found 0.4 and 0.001 respectively among surveyed households on the cross sectional survey time.

Multidimensional poverty: Multidimensional poverty prevalence, average deprivation and adjusted deprivation rates of households included in the survey are found 64%, 44.8 and 28.6% respectively in the cross sectional survey year, 2016. In

In local agro-ecology disaggregation, multidimensional poverty prevalence and adjusted deprivation are higher in the *Qolla* agro-ecology which are 67% and 29.7% compared with the *Woyinadega* agro-ecology with a prevalence and adjusted deprivation score of 61% and 27.6%, respectively, while shared deprivation is slightly higher in the *Woyinadega* agro-ecology which is 45.3% relative to the *Qolla* with a shared deprivation score of 44.3%. At the same time dimension and indicator specific level variations have been observed in the prevalence, shared deprivation and adjusted deprivation scores.

The finding prevails that surveyed multidimensional poor rural households are deprived more of in the living standard dimension with the prevalence rate of 79.6%compared with the other two dimensions, health and education as indicated in table 1.Similarly, the study assures that indicator level deprivation rate is higher in improved fuel source provision and safe drinking water provision with a deprivation score of 99.5 and 82.79 respectively (table 1).

Table 1: Indicator Specific Deprivation Measures

		Measures		
Dimensions	List of indicators	Prevalence H (%)	Average derivation A (%)	Adjusted MPI
Education	Adult education	58.06	16.67	0.097
	Child education	26.34	16.67	0.044
	Overall education deprivation	9.7	145.40	0.141
Health	Child mortality	5.91	16.67	0.001
	Nutrition	4.30	16.67	0.007
	Overall health deprivation	0.5	316.73	0.016
Living standards	Access to Light	74.19	4.76	0.123
	Access to improved Fuel	99.46	4.76	0.165
	Safe drinking Water	82.79	4.76	0.138
	Sanitation	33.33	4.76	0.055
	Housing Roof	8.60	4.76	0.014
	Key Assets availability	73.66	4.76	0.123
	Access to Road	82.26	4.76	0.137
	Overall living standard	79.6	27.18	0.755
Overall deprivation		63.98	44.75	0.286

Source: Computed from own survey, 2017.

The analysis result shows that multidimensional poverty is highly sensitive to cut-off points. While we get the above results at cut-off point K=1(poor if a household is deprived at least in a single dimension), multidirectional poverty prevalence, shared deprivation and adjusted deprivation are found 1%, 76% and 0.08% respectively when cut off K is increased to two dimensions(at k=2).

Comparatively, the analysis result shows that multidimensional poverty prevalence, which is 64%, is significantly higher than consumption poverty prevalence, which is 26.3% as it is shown in table 2. Similarly, multidimensional poverty is found to be deeper and intense, with an average and adjusted deprivation of 44.8% and 28.6%, respectively, than consumption poverty, with a depth and intensity of 4% and 1% respectively.

Table 2: Cross -tabulation of Consumption Poverty and Multidimensional Poverty Prevalence, Depth and Severity in Basoliben Woreda

Poverty measures	Types of poverty	
	Consumption poverty at poverty line Z =15.04 birr	Multidimensional poverty at deprivation cut-off k = 33.33%
Incidence	0.263	0.640
Depth/shared deprivation	0.040	0.448
Severity/adjusted deprivation	0.010	0.286

Source: Computed from own survey, 2017.

Regression analysis results

As the regression result from binary logit showed household size, market distance, access to irrigation, livestock ownership in TLU, intensity of agricultural extension service and crop diversification trend have statistically significant effect at 99% and 95% confidence interval on the consumption poverty status of surveyed households. More specifically, the regression analysis result, as presented in table 3, shows that larger household size, longer market distance and having no

access to irrigation found to increase the surveyed household's probability to be consumption poor. While, more livestock ownership in TLU, more frequent agriculture extension service and additional crop types cultivated annually decreases households probability to be poor.

Besides, age of household heads and livestock ownership in TLU is found to have a negative correlation with consumption poverty depth. Similarly, increased livestock ownership also tends to decrease the consumption poverty depth. But, larger household size, having access to irrigation and longer market distance is found to increase consumption poverty depth or gap (table 3).

Table 3: Results from Binary Logit and Tobit Regression

Variables		Binary logit regression results (determinants of poverty prevalence)		Tobit regression results (determinants of poverty depth or gap)	
		Coef.	P>|z|	Coef.	P>|t|
Sex of household heads		.907	0.280	0.88	0.139
Age of household heads		-.0345	0.302	-0.005	0.033**
Educational status of household heads	From grade 1-4 attended	-1.924	0.026**	-0.124	0.061
	From grade 5-8 attended	.525	0.547	-0.002	0.971
	Religious education	-.605	0.610	0.026	0.825
	Adult education	1.049	0.314	0.128	0.034**
Adult equivalent household size		2.443	0.000*	0.176	0.000*
Dependency ratio		1.986	0.169	.123	0.094
Total annually cultivated land		.057	0.756	-.009	0.390

Livestock ownership in TLU	-.306	0.012**	-.021	0.009*
Frequency of agriculture extension workers visit	-.342	0.019**	-.017	0.093
Have no access to irrigation	1.583	0.044**	.128	0.004*
Livelihood diversification	-.677	0.304	-.015	0.726
Frequency of health extension workers visit	-.610	0.114	-.015	0.603
Distance of by near market in minutes walked	.018	0.012**	.001	0.008*
Asset ownership in birr	-.00001	0.874	3.54e-06	0.556
Crop diversification	-.352	0.040**	-.023	0.091
_constant term	-5.926	0.004	-.589	0.002
/Sigma			.1447892	-

Source: Computed from own survey, 2017. Coef. = Coefficient; * is significant at 99% confidence interval;** is significant at 95% confidence interval.

Apart from the determinants of consumption poverty, indicators of multidimensional poverty are free standing determinants which need only interpretation. As shown in

table 1, findings implied that households have improved access to health service and education but they are under acute deprivation in indicators listed in the living standard dimension.

Discussions

Looking at the socio-demographic characteristics of the rural households in the study area, the survey found that 65.6% of household heads, even 85% of women headed households, have not attended any kind formal education and the average age of rural household heads is found 431/2years. This indicates that there is higher rural adult illiteracy rate in the study area and the result is consistent with the report of CSA (2013) regardless of the time dynamism.

The average rural family size and average rural age dependency ratio are also estimated 5.3 and 0.45 respectively in the study area. Compared with the reports of CSA (2013), which estimate the average rural family size of Amhara region and the country 4.6 and 5.1 respectively, the area has higher average rural household size which can infer poor family planning practice. Rather, the average age dependency ratio is below the country's average (which is 0.92) which means most family members in each rural households of the Woreda are at their working age.

Farm Land, livestock, irrigation and livelihood diversification trend are important economic pillars in rural life. Taking this in mind, the survey attempts to examine the status of households in the study area regarding these parameters. The survey found that the average rural land holding in the study area is 1.4 hectares per household, which is slightly higher in the *Qolla* agroecology of the study area with an average land holding of 1.5 per household. It is higher in the *Qolla* agroecology because forest areas in the *Qolla* agroecology of the study area are not protected and dwellers unresponsively deforested it and changed it in to farm land. Generally, average landholding status of rural households in the study area is consistent with the country's average which is 1.4 hectares but below Amhara region's average which is 1.8 hectares as reported by CSA (2013). Regarding livestock ownership, the study depicted rural households in the study area owns 6.5 TLU on average.

The study also found that rural households in the study area have very limited access to irrigation and have poor livelihood diversification trend. From the total rural households the study depicts that only 20% have access to irrigation and only 24.7% of households have income source other than farming. This result indicates that the study area has no access to irrigation infrastructure. Similarly, the finding also implies as rural households in the study area are not well taught on the importance of livelihood diversification.

Rural household poverty profile of the study area

Fixing the objective poverty line of the study area at 15.4 birr per day per adult equivalent through the cost of basic needs approach. The survey proved that 26.3%of rural households in the area are living under rampant consumption poverty with 0.4 poverty depth and 0.001 poverty intensity was recorded. The poverty is even worst in the *Qolla* agroecology which shares 16.7% out of the total of 26.3%. In 2015, rural poverty prevalence of Ethiopia was estimated 35 % (Addisu and Sundara, 2015). Similarly, in 2012 the rural poverty prevalence of Ethiopia was estimated 30.4 % (MoFED, 2010). Compared with these two previous research findings the rural consumption poverty prevalence of the area found below the countries overall in the cross sectional survey time regardless of the time dynamism between the three surveys. Even if the prevalence estimate is below the countries average, still poverty in the study area is in its higher rate.

Apart from the consumption poverty, multidimensional poverty is getting currency these days since the research community well recognized the importance of measuring poverty using end parameters like health, education and living standard. Accordingly, this study measured multidimensional poverty and the result depicts that the prevalence, average

deprivation rate and adjusted multidimensional deprivation rate of rural households in the study area are 64%, 44.8% and 28.6% respectively.

In comparison of the national multidimensional poverty prevalence rate and adjusted deprivation rate which is estimated 46% and 22% respectively by Bruk and Sindu (2013) regardless of time variation, the study area is under abject multidimensional poverty.

Deep diving in to dimension specific multidimensional poverty condition, multidimensional poverty is worst in the living standard dimension with the prevalence rate of 79.6% and lower in the health dimension with a prevalence rate of 0.5%. This is because in the last two decades there were intensive interventions to improve the health and the education sector while less is done in the living standard aspect. Even out of the living standard indicators (which includes potable water, sanitation, housing roof, key assets ownership, road, access light and improved fuel) 99.5% of rural households in the study area has no access to improved fuel source in the cross sectional survey time. This indicates that relative to the education and the health sector, almost nothing is done yet to improve access to improved fuel, light, potable water, sanitation, access to road and other components of the living

standard dimension. This result could be also generalized to all rural households of Ethiopia with a very similar context.

Across literatures rural poverty is attributed to different factors. These factors vary from situation to situation and from context to context. In the context of rural Basoliben Woreda, as the regression result from binary logit depicted, consumption poverty status of rural households is attributed to household size, market distance, access to irrigation, livestock ownership in TLU, intensity of agricultural extension service and crop diversification trend. To be more specific and clear, the survey assures that larger household size, longer market distance and having no access to irrigation increases household's probability to be consumption poor. While, more livestock ownership in TLU, more frequent agriculture extension service and additional crop types cultivated annually decreases households probability to be poor in the study area. This result more or less matches with Addisu and Sundara's (2015) and Melaku's (2016) finding from their analysis of determinants of rural poverty in a similar rural contexts. Besides, the study also found that age of household heads, household size, livestock ownership, access to irrigation and market distance affects poverty depth or level of consumption shortfall of poor households in the study area.

An increase of years of age of rural household heads decreases the level of household consumption shortfall or the poverty gap among poor households. In this case when age increases asset holding status of households increase in this typical rural context which in turn tends to decrease the consumption shortfall level and this is consistent with the findings of Ahmed (2013). Similarly, increased livestock ownership also tends to decrease the consumption poverty depth. But, larger household size, having access to irrigation and longer market distance is found to increase consumption poverty depth or gap

Apart from determinants of rural household consumption poverty discussed above, indicators in the multidimensional poverty are self-standing and self-explanatory. So that, from the survey result it can be stipulated that higher adult literacy rate, lack of electricity, limited access to improved cooking energy source, poor access to safe drinking water, limited access to road, lack of key assets ownership, fragile house roofing and poor access to toilet are contributing factors for the acute multidimensional poverty prevalence of the study area.

Reference

Abrham, S. T., and Bauer, S. (2012). Poverty dynamics and vulnerability: Empirical evidence from Smallholders in northern highlands of Ethiopia. Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, August 18-24, 2012, Foz do Iguaçu, Brazil.

Addisu, B., and Sundara, M.(2015). Modeling the determinants of rural household poverty: Evidence from Ethiopia.

Ahemd, M. (2013). Determinants of poverty in rural Ethiopia: A household level analysis (Master thesis).

Alkire, S.; and Santos, E. (2010). Acute Multidimensional Poverty: A New Index for Developing Countries. OPHI working paper NO. 38. UK: University of Oxford.

Asmamaw, E. (2004). Understanding poverty; the Ethiopian context. A paper presented at the Gambia AAPAM Roundtable Conference held on April 19 - 23, 2004. Banjul, Gambia.

Basoliben Woreda Finance and Economic Development Office.(2016). Annual statistical report. Basoliben , Ethiopia.

Central Statistics Agency (2013). Ethiopian rural socioeconomic survey (ERSS).Addis Ababa, Ethiopia.

D. Israel, G. (2013). Determining sample size.USA: University of Florida.

Ministry of Finance and Economic Development.(2012). Annual report. Addis Ababa, Ethiopia

Morazes, J. and Pintak, I. (2007). Theories of Global Poverty Comparing Developed World and Developing World Frameworks. *Journal of Human Behavior in the Social Environment,* **16(1–2),** 105–21.

Ravallion, M. and Chen, S. (2007). Absolute poverty measures for the developing world, 1981-2004. Washington DC, USA : World Bank.

Sen, A. (1985).Commodities and capabilities. Amsterdam, North Holland.

United Nation Development Program. (2006). Poverty in focus: What is poverty? Concepts and measures. Brasil: Roberto Astorino& Lucas Moll.

United Nation Development Program. (2013). The rise of the south: Human progress in a diverse world. New York, USA.

World Bank .(2005).Introduction to poverty analysis. Poverty manual.

World Bank.(2000). Handbook on poverty and inequality.

Field Evaluation of Major Tomato and Onion Insect Pests and Management Practices, In Rib Irrigation Site, Libo Kemkem District, South Gondar Zone, Ethiopia

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Abstract

Huge amount of losses due to herbivorous insects in different vegetable crops have been recorded worldwide. Tomato and onion are predominantly grown vegetables in the irrigation area of the present study site and damaged by insects. The main objective of the present study was to evaluate major insect pests that cause economic losses on tomato and onion and management practices in the study area. Data were recorded weekly starting from transplantation to plots of land on randomly selected tomato and onion plants. Numbers of insect were recorded per plant. Flying insects were trapped using sweeping net. Insect identification was carried out morphologically using standard identification keys. Insect pest

density of well managed and poorly managed fields was compared. Cutworm, moths, aphids, Africa bollworm, and onion thrips were the most common insect pests. There were 33.09 mean/plant onion thrips recorded on onion per m^2 of the plot. The analysis of well managed and poorly managed plots showed that 30.78% and 39.45% tomato fruits were damaged by insects respectively. Thrips caused 33.18% of yield loss on onion. Number of thrips per plant also varied with growth stage ($p<0.05$). Onion growth stages of 9 to 11 weeks after transplanting were the most critical stage for thrips management where by suitable control measures needed.

Keywords: tomato, onion, insect pest, pest damage, management practice

Introduction

Herbivorous insects are said to be responsible for destroying one fifth of the world's total crop production annually and the severity increased in the tropics and tropics and sub-tropics (Kessler and Baldwin, 2002). According to CSA (2012), about 2,710 million tons of vegetables, root and tubers were produced on 541,000 ha, creating means of livelihood for more than 1 million households in 2010/2011. The production of vegetable crops is expanding with the expansion of irrigation schemes in the country (MOA, 2002). The average

productivity of tomatoes and onions in the year 2010-2011 was about 10.5 tons/ha and 10.8 tons/ha respectively (CSA, 2011). However, production of vegetables is low and insufficient due to insect pest attacks in the country. Shallot, garlic, potatoes, and chills are mainly produced under rain fed practices while tomatoes, carrots, lettuce beetroot, cabbage and onion are usually restricted to areas where irrigation water is available in Ethiopia (EIA, 2012).

Because of insect pests, huge amount of losses in different vegetable crops have been recorded in Ethiopia. *Thrips tabaci isone* of the major insect pests of onion crop recorded in the country. Africa bollworm was themajor pest of tomato fruits both in irrigated and rain fed conditions this range occupied by the species includes tropical, dry, and temperate climate (Gashawbeza, 2006). For example, 36-39% loss occurred due to African bollworm in cabbage (Gashawbeza, 2006), and 26-57% loss in onion due to Thrips (Yeshtila, 2005). Shiberu (2013) indicated that *T. tabaci* is an important onion insect pest that destroys onion fields, especially in the dry seasons.

In Ethiopia, the economic threshold level of onion thrips was reported 5 to 10 thrips in one plant (Tadele, 2014). When vegetable crops infested early in the season, they remain small and never produce crop and if get infected later in the season,

they remain small and never produce crop and if get infected later in the season, fruits become unmarketable. In Toke Kutaye district, West Shoa, Ethiopia the yield losses due to onion thrips ranged from 0 to 36.44% (Shiberu, 2013).

Rib irrigation in Libo kemkem district is one of the areas growing vegetables affected by insects of different species. Many of the farmers in the Rib irrigation do not have detail information about field evaluation of tomato and onion insect pests attacking vegetables at different growth stages and management practices. Moreover, growers in the study site have no scientific justifications about the dynamics of the devastating insect pests across the seasons.

Therefore, in the present study, field evaluation of major tomato *(Lycopersicon esculentum Mill)* and onion *(Allium cepa* L.) insect pests and management practices were carried out.

Materials and Methods

Description of the study area

Libo Kemkem is one of the districts in South Gondar Zone of Amhara Regional State (fig. 1). The town of the district is Adis Zemen, which is located 645 kilometers from Addis Ababa

and 85 kilometer from Bahir Dar. It is located at 37015'36'' E to 38006'36'' E of longitude and 11054'36'' N to 12022'48'' N of latitude. The dominant crops growing in the study area include wheat *(Triticum sp.)*, potato *(Solanum tuberosum)*, barley *(Hordeum sp.)*, teff *(Eragrostis sp.)*, sorghum *(Sorghum bicolor)*, bean *(Vicia fabia)*, peas *(Pisum sativa)*, Onion *(Allium cepa)*, Tomato *(Solanum lycopersicum)* and maize *(Zea mays)*.

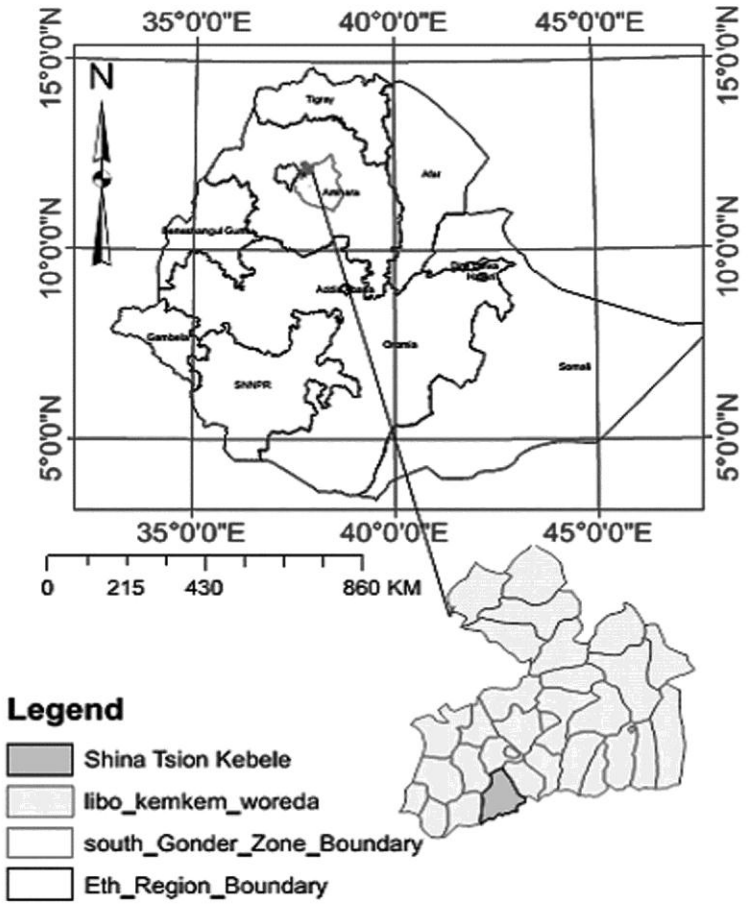

Figure 1: Map of the study area.

Woreda refer district and Kebele refers village

Experimental design

A longitudinal study was carried out to assess impact of insect pests and their management practices on onion and tomato fields from November 2016 to March 2017 in the study area.

Sample size and sampling technique

In the study area, 86 farmers were widely used irrigation for the production of tomato and onion crops. Among 86 farmers 38 farmers growing only tomato and 48 were growing onion during the study period. Based on the same transplanting date of onion and tomato, 20 farmers were selected purposefully. For data collection 1m by 1m plots of treated and untreated were arranged. Insect pest densities and degree of damage along with its effect on the crop were undertaken during each observation. All counts were performed in the morning at 12:00 up to 6:00. Sampling was done from November 2016 to March 2017 and was carried out weekly until harvest.

Assessment of insects' number and damage

Insect pests were evaluated at different growth stages of the crops starting from transplanting till harvesting. Leaves, stems, pods and fruits were examined from randomly selected ten plants per plot on the diagonal crosses method. The

The moving insects were collected using sweeping net. Insect population on the tomato and onion vegetable crops, damage inflicted to plants and insect developmental stages were surveyed on each plot. The difference between incidence and the damage in each plot at maturity stage was recorded. The collected insect pests were preserved with 70% ethanol in 20 ml vials and plastic bottles and also dead insects were collected packed individually for identification purposes.

Insect identification

Insects were identified morphologically by the identification keys of Gullan and Cranston (2000) using 10x magnifying hand lens.

Percent Fruit damage

Percent fruit damage was calculated by dividing number of fruits by the total number of fruits (Nasiruddin *et al.,* 2002).

% fruit damage=(B)x100/A

Where A=total fruits (damaged + undamaged), and B=damaged fruits

Weight loss

Weight of damaged and undamaged tomato and onion were recorded for each plant of each picking in the study plots. The fruits damaged by insects were separated from healthy once and weighted and counted following Gwinner *et al.* (1996) and percent weight loss was calculated as weight of infested fruits multiplied by hundred and divided by total weight of fruits.

Total yield (kg ha^{-1})

The weight of each picking was recorded individually for each sample and the total yield was calculated by adding the yield from all pickings. The yield was converted into per hectare basis with the following formula:-

$$\text{Yield (kg ha-1)} = \frac{(yield/plot)X10000}{Plot\ size}$$

Incidence of onion thrips damage was determined by counting the number of damaged plants over the total number of plant per plot. Damage severity by Thrips was determined sampling ten plants randomly from the inner rows of each plot. The percentage of leaf surface showing thrips damage was assessed based on a scale of 1-5 (Smith *et al.,* 1994) where 1= no damage 2 = damaged up to 25%, 3 = damaged up to 26-50%, 4 = damaged up to 51-75% and 5 = damaged up to 75%.

According to HCDA (1991), harvesting was done by most farmers when 50-80% of the foliage had fallen over and the tops roots were cut off. Unmarketable bulbs includes decayed, diseased, physiologically disordered were identified from the total bulb yield.

Yield loss was calculated as the difference between mean yield of damaged and undamaged crop:-

$$\%\ \text{yield loss} = \frac{(Yield\ of\ undamaged - damaged\ crop)x100}{Yield\ of\ undamaged\ crop}$$

Methods for evaluating farmers' management practices

In order to evaluate farmers' management practices, well-structured open and close ended questionnaire was prepared. The questionnaire was developed based on Lekei *et al.* (2014). Questions were translated into Amharic language for ease understanding by the respondents. The questionnaire was distributed to 20 farmers who transplanted tomato and onion on the same date.

Data analysis

Data analysis was done using SPSS version 16 statistical software. Percentage of damaged vegetables due to insects was analyzed using descriptive statistics. For socio-demographic data, descriptive statistics was used. Prevalence of insect pests collected at different weeks, damaged and undamaged fruits subjected to one way analysis of variance (ANOVA) and for the means separation the values of $P < 0.05$ were considered to be significant.

Results and Discussion

Occurrence of cutworm in immature stages of onion

Cutworm count per m^2 of the plot did not significantly different between week 1and 5 growth stages presented in table 1.

Table 1. Occurrence of cutworm on onion per plot at different weeks after transplanting

Weeks after transplanting	Mean ±SE
Week 1	0.5±0.17
Week 2	0.7±0.21
Week 3	0.9±0.23
Week 4	0.8±0.20
Week 5	0.5±0.17

Albarrak (2009) and Sarwar (2012) also reported that a mean number of cutworms per plant on the immature stages of onion were 0.33. After 5 weeks transplanting, cutworms were not observed. This might be due to the change of larvae into pupae. Researchers reported that larvae of cutworms' development lasted for 19.36 days (Vander Walt, 2008)

Onion thrips

Onion thrips has been observed after a month of transplanting of the target plant. Adult onion thrips count per plant was significantly different between managed and unmanaged plots *(P=0.0001)* and also among growth stages *(P=0.000)*. On managed plots, a mean of 26.62 onion thrips/plant and unmanaged plots a mean of 39.56 onion thrips per plant were recorded.

At vegetative stage (table 2a), specifically at 6 weeks after transplanting, infestation of thrips was gradually increased with the growth of onion plants. The large number of thrips was recorded in the 13 weeks (table 2b), which is at the maturity stage of the onion.

Table 5 Occurrence of onion thrips on onion per plot at different weeks after transplanting

a) Vegetative stage

Weeks after transplanting	Mean±SE
Week 5	20±1.40
Week 6	40±1.40
Week 7	41±1.44
Week 8	58±0.87
Week 9	62±1.52
Week 10	78±1.8
Week 11	79±2.99

b) Maturity stage

Weeks after transplanting	Mean±SE
Week 12	33±1.09
Week 13	56±0.87
Week 14	27±1.48
Week 15	18±1.29

This result is in agreement with the work of Yeshitla (2005), which indicated that thrips population was low during the immature stages of onion and the maturity stages of the onions. Liu (2004) also reported that thrips infestation in the onion fields start to increase gradually with the growth of onion plants, and reach peak abundance in about 13 weeks of the onion plant.

Grasshopper

Another insect observed in the study site was grasshoppers. It was not found at the seedling/immature stages of onion plants. A few grasshoppers were found at the vegetative stage which tended to decline at crop maturity stage. This might be due to the plants become less and less attractive to the grasshoppers. Grasshopper mean density did not significantly difference between management *(P=0.3632)* and unmanaged vegetative stages of the onion plant *(P=0.1304)*. In the managed plot, a mean of 0.2 grasshoppers per plant was recorded and on unmanaged plot a mean of 0.4 grasshoppers per plant were observed. Similar findings were reported by Andaloro and Shelton (2007) in onion fields during the vegetative stages.

Table 6. Occurrence of grasshopper on onion per plot at different weeks after transplanting

a) Vegetative stage

Weeks after transplanting	Mean±SE
Week 4	0.3±0.15
Week 5	0.3±0.16
Week 6	0.4±0.16
Week 7	0.3±0.16
Week 8	0.4±0.16

b) Maturity stage

Weeks after transplanting	Mean ± SE
Week 9	0.4±0.16
Week 10	0.5±0.16
Week 11	0.5±0.16
Week 12	0.3±0.15

Major tomato insect pests

A number of insect pests' species were recorded (table 7) on tomatoes in the study plots. The most serious pests include cutworm *(Agrotis ipsilon)* attacking seedlings, tomato fruit borer which is known as Africa boll worm *(Helicoverpa armigera Hubner)* that attacks fruits, and moths *(phthorimaea spp.)* also attacked fruits.

Table 3 Major insect pests recorded per plant on tomato at the study sites.

Common name	Scientific Name	Order/Family
Cutworm	*Agrotis ipsilon*	Lepidoptera/Noctuidae
moths	*phthorimaea spp.*	Lepidoptera/Gelechiidae
Onion thrips	*Thrips tabaci*	Thysanoptera/Thripidae
African boll worm	*Helicoverpa armigera*	Lepidoptera/Noctuidae

Cutworm

Cutworm count per m^2 plant was not significantly different ($P > 0.05$) between managed and unmanaged *(P=0.686),* and unmanaged *(P=0.0248)* tomato plants. A mean of 0.36 cutworms per m^2 was recorded on the unmanaged plot and 0.35 per m^2 on managed ones (table 4). Cutworm density was higher at the seedling stage of 2-3 weeks after transplanting, which later declined as plants grew older. Similar findings were reported by Bessin (2007) that two to three black cutworms were counted per m^2 on tomato fields.

Table 4 Occurrence of cutworm on tomato per plot at different weeks after transplanting

Weeks after transplanting	Mean±SE
Week 1	0.5±0.16
Week 2	0.7±0.15
Week 3	0.7±0.15
Week 4	0.4±0.16

Potato tuber moths (PTM)

Potato tuber moths larvae density per plant was significantly different between managed *(P=0.000)* and unmanaged plots of tomato plants. In the managed plots a mean of 4.54 moths per plot were recorded and a mean of 5.71 moths per plot was recorded in the unmanaged plots. No moths were observed at the seedling stage until 4 weeks after transplanting, but progressively increased at the vegetative stage and eventually decline in number at maturity (table 5). Maximum mean numbers of moths were counted at 9 and 10 weeks after transplanting.

Table 5. Occurrence of potato tuber moth larvae on tomato per plot at different weeks after transplanting per plot

a) Vegetative stage

Weeks after transplanting	Mean±SE
Week 5	4.3±0.153
Week 6	6.3±0.152
Week 7	8.2±0.13
Week 8	10.1±0.10
Week 9	11.9±0.10

b) Maturity stage

Weeks after transplanting	Mean±SE
Week 10	9.6±0.163
Week 11	4.8±0.133

Onion thrips

Number of onion thrips per plant was significantly different between managed and unmanaged *(P=0.000)* and also among growth stages *(P=0.0001)*. Managed plots contained a mean of 4.99 onion thrips per tomato plant and unmanaged ones contained a mean of 6.21 onion thrips per plant ($P<0.05$). Thrips were not found at the seedling stages of tomato. Thrips infestation increased at vegetative and maturity stages (table 6

a and b). The current result was slightly different studied by Umeh and Manga (2002) who counted 8.3 thrips per plant at the seedling stage and none at maturity stages of the tomato plant.

Table 6 Prevalence of onion thrips on tomato per plot at different weeks after transplanting

a) Vegetative stage

Weeks after transplanting	Mean±SE
Week 8	2.4±0.163
Week 9	5.4±0.16
Week 10	8.2±0.133
Week 11	6±0.000

b) Maturity stage

Weeks after transplanting	Mean±SE
Week 12	9.6±0.163
Week 13	5.9±0.10

African boll worm (Tomato fruit borer)

Count of tomato fruit borer density per plant was not significantly different between managed and unmanaged plots. In the managed plots a mean of 0.7 fruit borers per plant

and 0.74 fruit borers per plant on unmanaged plots. The infestation of fruit borers gradually increased when tomato plants flowered and produced fruits (table 7 a and b). Similarly, Van Der Walt (2008) reported that feeding by larvae of the American bollworm on tomato increased when fruits produced after the end of flowering stage.

Table 7. Occurrence of fruit borer on tomato per plot at different weeks after transplanting

a) Vegetative stage

Weeks after transplanting	Mean±SE
Week 7	0.9±0.10
Week 8	1.9±0.10
Week 9	2.7±0.15

b) Maturity stage

Weeks after transplanting	Mean±SE
Week 10	2.6±0.163
Week 11	4.1±0.10
Week 12	4.1±0.10
Week 13	3.1±0.10

Similarly, Albarrak (2009) found that no fruit borers at seedling and vegetative stages, but counted a mean of 3.3 per plant at maturity stage. Likewise, Umeh and Manga (2002), a survey of some tomato producing areas of Nigeria indicated that the major insects attacking tomato included the fruit borer, grasshopper, aphids, and white fly were recorded at different growth period. Moreover, Gashawbeza Ayalew and Lemma Dessalegn (2004) also reported the severity of African bollworm on vegetable including tomato and onions.

Damage caused by major insect pests on onion

Cutworms

The larvae feed close to the base of a plant or under the soil level and cut the plant at the stems. When the stems fall, the worms consume more of the plant. Climbing species of cutworms can move to the leaves and buds of plants, where they sustain even more damage by chewing holes. Most destruction to plants occurs in the early growing season, when the seedlings are small and tender. The damaged caused by cutworm was 11% in managed and 15% in unmanaged plots in fields. Similar findings were reported by Nielsen (1999) in which shoot damage varied between the loss of 12% and 17% on managed field and 19% on unmanaged plants.

Leaf damaged by Onion thrips

A mean of 4.3 (51-75%) of the leaves were damaged on unmanaged fields and mean of 2 (25%) leaves were damaged on managed fields onion by onion thrips. Thrips use their rasping and sucking mouthpart to scrape the leaf surface and suck up the exuding plant juices. During the feeding practice, silvery-white, mottled lesions on the leaf surface produced.

The present study further illustrated that changes in abundance of thrips were occurred when changes in crop phenology occurred. In all cases, thrips population were first observed on onion plants four weeks after transplanting and increased at 7-8 weeks. This might be because of the fact that leaves at eight-leaf growth stage are succulent and thrips preferred to feed on such leaves. The maximum increment was observed 13 WAT per plant and eventually decreased when the crop maturity increased. When the crop maturity increased, the leaf nutritional value decline and becomes tougher and lignified such that it cannot be rasped by thrips so that adult thrips are forced to move towards newly developing leaves or other potential alternative hosts. This is in agreement with the result of previous study on onion, which indicated that at the final growth stage of onion, number of thrips is reduced because of a decline in nutritional value of the onion leaves (Workman and Martin, 2002).

The present study indicated that, higher numbers of thrips (33.09 mean/plant) were observed in the inner leaves of onion. This is in agreement with Soni and Ellis (1990) who stated that the area between the newest leaves concealed majority of juvenile and adult thrips. Reuda and Shelton (2000) also explained that thrips prefer to feed on young plant tissues in the newest emerged leaves. Feeding damage to onion plants were caused by both adult and larval thrips. Damage to photosynthetic areas occurs when tissues are ripped apart and depleted of plant juices. The removal of fluids results in the death of attacked cells. Moreover, Alson and Drost (2008) reported that thrips prefer to feed on the newly emerged leaves in the center of the onion necks and the majority of thrips would be at the base of the youngest leaves in the lower center of the neck.

Yield loss due to insect pest on onion

Onion bulb yield significantly varied between managed and unmanaged onion plant and unmarketable yield 39 q/ha and 56 q/ha, respectively (Table 8).

Table 8 Mean marketable and unmarketable onion yield in $1m^2$ farm plot at Rib irrigation site in 2017

Type of plot	Marketable yield kg/m^2	Unmarketable yield kg/m^2
managed	2.17	0.39
unmanaged	1.45	0.56
t-value	8.76	-12.9
p-value	0.0001	0.000
Std error	0.3600	0.085

In the present study, the damage occurred by thrips caused on onion bulb yield loss of 72 q/ha (33.18%). This is in agreement with Yeshitla (2005) who recorded high yield loss when there is no management practice of thrips during different stages resulting in a total bulb yield loss of 35-45%, and marketable onion bulb yield loss of 44-53%. Moreover, Tsedeke (2001) indicated that onion bulb yield loss of 33.5% reported in the Awash Valley onion growing areas. Reuda and Shelton (2000) have also reported damages as high as 60% in tropical countries.

Damage caused by dominant insect pests on tomato in the study area

The plant damage incidence among managed and unmanaged plots recorded minimum percentage of infestation (13.3%) on managed plot an 15.7% on unmanaged plot. The damage effects of cutworms were relatively higher when plants are small, seedlings were often cutoff at ground level and if the soil around the plants were dug up to a depth of 5 cm, the characteristics of cutworm larvae could be found.

Cutworm hides during day time in cracks in the soil, become active at dusk, feed on leaves and also cut the tender stems of young and growing plants. It might be due to the absence of worm eating birds at night time. Then, they emerge at night and destroy vegetables and as a result farmers' loss one-third to one-half of their vegetables from cutworm ravages alone. Fowler and Lakin (2001) also reported that cutworms attacking vegetable in the night.

Larvae of cutworms hide under clods and in cracks in the soil in day time and appear at night, cutting off young plants near the ground. One larva often damages numerous plants in a row during a single night (Jim Chaput, 2005).Nielsen (1999) indicated that cutworms feed on plants by chewing, they vary as to damage done and host plants preferred.

Damage caused by tomato fruit borers *(Helicoverpa armigera)*

Fruit infestation

In the managed and unmanaged tomato fields there was significantly varied in mean number of fruits harvested and percentage fruit infestation by fruit borer *(Helicoverpa armigera)*. In managed plots a mean of 11.6 fruits reordered per plant and in unmanaged plots a mean of 9.1 fruits per plant was counted and fruit infestation by fruit borer was 30.78% and 39.45% respectively (table 8).

Table 8 Mean tomato fruits recorded per plant with in two different (managed and unmanaged) conditions at Rib irrigation area in 2017

Type of plot	Mean number of fruits per plant	Mean number of infested fruits per plant	% infestation
managed	11.6	3.57	30.78
unmanaged	9.1	3.59	39.45
t-value	5.1	-0.10	-5.1
p-value	<0.0001	0.9204	<0.0001
Std. Error	1.25	0.10	

According to Singh (2009), 30% loss of fruits was reported due to fruit worm infestation. Similar to the current finding, Sajjad (2011) indicated that the minimum larval population of the fruit borer was recorded to be 0.41 per plant on tomato fields. In addition, the maximum infestation was recorded to be 27.4% and minimum infestation of tomato fruit 26.3%.

Marketable and unmarketable yield of tomato fruit

There was significant differences (P=0.0025) between managed and unmanaged marketable yield. But there was no significant differences (P=0.1743) between managed and unmanaged marketable yield of tomatoes (table 9).

Table 9 Mean of tomato marketable and unmarketable yield in kg per plant

Type of plot	Marketable yield in kg per plant	Unmarketable yield in kg per plant
managed	6.2	2.5
unmanaged	4.9	2.3
t-value	3.74	1.42
p-value	0.0025	0.1743
Std error	0.6500	0.1000

In the present study, a maximum yield of 6.2 kg/plants was recorded while; minimum yield was 4.9 kg/plant. The percentage of weight loss of managed plot of tomato yield was 28.7% and unmanaged weight loss of tomato yield was 31.94%. Strinivasan and Sundara (2000) reported that 40 to 50% of fruits are damaged by this pest.

Farmers' management practices on tomato and onion vegetables

Table 10 presents the socio-economic characteristics of the respondents. Among the respondents, 75% of them were males while 25% were females. A good number of farmers (65%) in the study site are in their economic active stage. About 45% of the respondents had between 6 and 10 years of farming experience. When we look at the educational status, 50% of the farmers had no formal education. The management practices on tomato and onion reported by respondents in the study area (table 2) include more than half (55%) who lacks of training and do not participate in crop management practice by experts. About 70% of the respondent did regular monitor in controlling tomato and onion insect pests. More than half (60%) of the respondents were used a pesticide branded as Diazinon 50% E.C and 70% of the respondent have good management practices for the majority of insect pest occurred in the study site. Traditional management practice has been

observed including hand picking of larvae, uprooting and removing infested plants.

Table 10. Socio-economic characteristic of respondents

(N=20)

Variables		Percentage
Sex	Male	75
	Female	25
Age	<30	25
	31-35	40
	36-40	25
	>41	10
Marital status	Single	20
	Married	40
	Divorced	25
	Widowed	45
Educational status	No Formal Education	50
	Primary	25
	Secondary	10
	University graduate	5
Farming Experience	0-5	30
	6-10	45
	>11	25
Farm size in hectare	0.26-0.5	10
	0.6-1	25
	1.1-1.5	65

Table 11 management practices of respondents

variable		Percentage
Training on crop management experts	participant	45
	Not participant	55
Monitoring of pest	regularly monitor	70
	Not regularly monitor	30
Kind of pesticides used	Diazinon	60
	Dursben 48%	25
	Fentratayon 50%	45
Cause of insect pest occurrence	poor management practices	70
	Good management practices	30
Present status of pests	less damaged	60
	More damaged	40

The management practices of vegetable growers in the study area showed that people used pesticides to control insect pests. Geremew (2004) also reported that for management of cutworm control is currently based on heavy use of many insecticides. However, there is a need of integrated management options to reducing the risk of pesticide resistance development, reduce the impacts of the insecticide to environment, non-targeted organisms, beneficial insects such as natural enemies and human hazards.

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References

Albarrak, A.S. (2009). Occurrence and distribution of insect pests attacking some vegetable Plants at localities of el-Qassim province, Saudi Arabia. *Entomology*. Vol.31, no.2

Alson, D.G. and Drost, D. (2008).Onion thrips *(Thrips tabaci)*, [pest Fact sheet, Utah State University Extension and Utah pest Diagnostic Laboratory, p.7.

Andaloro, J.T. and Shelton, A.M. (2007). Insects of onion and cabbage: Onion thrips, New York state Agriculture Experimental station Geneva publ. P.750-752.

Bessin, R.(2007). Cutworm Management in Corn Extension, Entomologist University of Kentuky college of Agriculture. *Journal of Insect Science* **5**:84-85.

CSA (Central Statistical Agency) (2012):Crop Production Statistics of respective years, Addis Ababa

Ethiopia Investment Agency, (2012). Investment Opportunity Profile for the production of Fruits and Vegetables in Ethiopia, Addis Ababa.

Gashawbeza Ayalew (2006). Comparison of yield loss on cabbage from diamond back moth, *Plutella xylostella* L.(Lepidoptera:Plutellidae) using two insecticide. *Plant Protection* 25:915-99-19.

Gashawbeza Ayalew and Lemma Dessalegn (2004). African bollworm on vegetable crops in Ethiopia: Research status and needs.p.7-17. In:M. Dawd, S. Sithanantham and Tadesse Gebremedhin (eds.).Africa Bollworm management in Ethiopia:Status and Needs. Proceedings of the National Workshop at the plant protection Research Center, 17-19 April 2002, PPRC, Ambo, Ethiopia.

Gullan, P.J. and Cranston, P.S. (2000). The insect: An outline of Entomology. Blackwell Science, USA.470pp.

Gwinner, J. R., Harnisch. and Muck, O. (1996). Manual on the prevention of post-harvest grain Losses, GTZ, Germany.19 pp.

HCDA (Horticultural Crops Development Authority) (1991) Annual report Horticultural Crops Development Authority, Nairobi, Kenya.

Jim Chaput (2005). Post harvest Science. Crop Science Department. *University of Ghana, Legon,* October, 1998.71pp.

Kessler, A. and Baldwin, T.I. (2002). Plant responses to insect herbivory: The emerging Molecular analysis. *Annual Review of Plant Biology.* (53), 299-328.

Lekei, E.E., Ngowi, A.V. and London, L. (2014). Farmers' Knowledge, Practices and Injuries Associated with Pesticide Exposure in Rural Farming Villages in Tanzania. BMC *Public Health,* 14, 389.

Liu, T. X. (2004). Seasonal population dynamics life stage composition of *Thrips tabaci* and Predaceous natural enemies on onion in South Texas A and M University. Vol. 29 No.2

MOA. (2002): Agricultural production statics for the year 2002.Addis Ababa, Ethiopia

Nasiruddin, M., Alam, S, N., Khorsheduzzaman, M., Jasmine. H, S., Karim, A.N.M.R. and Rajotte, E. (2002).Management of cucurbit fruit fly, *Bactrocera cucurbitae,* in bitter gourd by using Pheromone and indigenous bait traps and its effect on year-round incidence of fruit fly, Banglade publisher.

Nielsen, G.R. (1999). Cutworm management on corn. University with Vermont Extension, Island.

Reuda, A. and Shelton, A.M. (2000). Development of bioassay systems for monitoring Susceptibility in *Thrips tabaci. Pest Manage.***59 (5)**:553-558

Sajjad, M. (2011). Insecticide resistance management of tomato fruit borer, *Helicoverpa armigea* (Hubner) (Lepidoptera: Noctuidae) employing a bio intensive integrated pest management. Faculty of agriculture University of Agriculture, Faisalabad Pakistan.

Sarwar, M. (2012). Frequency of insect and mite Fauna in Chilies *Capsicum annum* L., onion *Allium cepa* L. and Garlic, *Allium sativum* L. Cultivated Areas, and their integrated Management. *International journal of Agronomy and plant production.* Vol., 3. 173-178

Shiberu Tadele (2013). In vitro Evaluation of Aqua Extracts of Some Botanicals against Maize Stem Borer, Busseola fusca F. (Lepidoptera: Noctuidae). J Plant Pathol Microb 2013; 4:179.

Singh, S. (2009). Fruit culture in India. Indian council of Agriculture Research, New Delhi, P.412.

Smith, C. M., Khan, Z. R. and Pathak, M. D. (1994). Techniques for evaluating insect resistance in Crop Plants. CRC press, Boca Raton, Florida, USA.

Soni, S.K. and Ellis, P.R. (1990). Insect pests. In: Onions and Allied Crops, vol.2. Agronomy, Biotic interaction, pathology, and Crop protection, Rabino Witch, H.D. and Florida, USA pp. 213-271.

Strinivasan, G. and Sundara, B. P.C. (2000). Management of brinjal shoot and fruit borer, *Leucinodes orbonalis (Lepidoptera: Pyralidae) using neem products and insecticides. In: Proceedings of national symposium on Integrated Pest Management* (IPM) in Horti. Crops.

Tadele Shiberu and Amin Mohammed (2014).The importance and management option of onion thrips, *Thrips tabaci* L. *(Thysanoptera: thripidae)* in Ethiopia. A Review; Entomology and Applied Science, 1(3): 95-102.

Tsedeke Abate (2001). Source of Resistance in tomato against fruit worms. Pest Management Journal of Ethiopia 1:1-7

Umeh, V.C. and Manga, A.A. (2002). A survey of the insect pests and Farmers practices in the Cropping of Tomato in Nigeria. Tropicutura 4:181-186

Van Der Walt, S.J. (2008). Feeding by larvae of the American bollworm, *Heliothis armigera (Hubner)* (Lepidoptera: Noctudie) on cotton plants. M.Sc.Rhodes University Grahams Town: p. 1-100.

Workman, P. J. and Martin, N. A. (2002). Towards integrated management of *Thrips tabaci* in Onion. *New Zealand plant protection.* **55**:188-192.

Yeshitla Merene (2005). Study on population ecology and yield loss of onion thrips *(Thrips tabaci)* on onion in Shewarobit district of Amhara region. M. Sc Thesis, A.A University.