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Factors and Practices Affecting Nutrient Management in Eastern Uganda

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Abstract – **In order to appreciate nutrient management in agricultural systems, there is need to investigate how they are managed and practices affecting their availability. This helps to make informed decisions on better nutrient management strategies among different farming systems. A survey was conducted in Bududa, Mbale, Namutumba and Budaka districts of Eastern Uganda to identify factors and practices affecting proper nutrient management in the region. Data was collected using structured questionnaires and focus group discussions. Results revealed that demographic characteristics such as Age, Gender, Education level, House hold size and marital status of respondents had great influence on how nutrients are managed across target districts. Results also showed that land size significantly influenced nutrient management practices, a case of Namutumba where a larger land size led to production of a lot of biomass that attracted burning of residuals by farmers on-farm as their means of disposal. This eventually causes risks for environmental degradation and soil health. Another factor was utilization of animal droppings by farmers; where results revealed that most of the animal droppings are just applied directly in the field without transforming it into manure form or disposed-off as waste. This was majorly observed in Mbale district. This also has environmental implications and on soil and crop health. Level of fertilizer use is another factor revealed under this study, where 10% of the farmers where using fertilizer but the problem here was that most of the farmers do not know which fertilizer combinations to use, which poses a risk for application of excess fertilizers a case of Nitrogen where most of the farmers in Bududa and Mbale were applying NPK + Urea as a combination. This may lead to eutrophication of aquifers. The method of application of the fertilizers was also not properly done. Generally, there is need for more sensitization on proper nutrient management in the region in order to reduce environmental degradation and boost farm productivity.**

Keywords – **Eastern Uganda: Nutrient management.**

I. Introduction

Studies in Africa have revealed that there is widespread nutrient mining leading to negative nutrient balance and increased threats of nutrient deficiencies in different ecological zones [5]; [6]. Annually, nutrients are taken away either through crop harvests or through other processes such as leaching and erosion in quantities that far exceed the nutrient inputs through fertilizer application, deposition and biological fixation. On average, 660 kg of nitrogen (N), 75 kg of phosphorus (P) and 450 kg of potassium (K) are estimated to have been mined per hectare per year during the last 30 years from about 200 million hectares of cultivated land in only 37 countries in Africa [10]; [6]. Losses of 130 kg N, 5 kg P and 25 kg K ha^{-1} per year have been reported in the East African highlands [4].

The concern for soil nutrient depletion and low soil fertility has led to the development of several integrated soil fertility management technologies that offer potential for improving soil fertility management in Africa [2]. These include improved soil and water conservation measures, growing of improved N-fixing crops, efficient use of manure and other locally available organic materials, planting cover crops [4]. However, there is a limited number of long - term studies monitoring the nutrient status of soils, nutrient balances, and crop productivity in Uganda [3]. It is therefore important to learn about the factors and practices leading to poor nutrient management so that strategies for soil fertility improvement are laid for sustainable agricultural producti--vity. By understanding factors and farmers' current practices pertaining nutrient management will help to design means of improvement in order to reverse the level of nutrient mining and depletion. Therefore, the objective of this study was to determine factors and practices affecting nutrient balances in different farming systems of Eastern Uganda.

II. Materials and Methods

2.1 *Location and Description of Study Area*

The study was conducted in three districts of Eastern Uganda namely Bududa, Namutumba, Mbale and Budaka. District is located between1.0030°N, 34°19'54''E with average annual rainfall of at least 1500 mm per year. The main source of income is farming. Mbale lies between 00°57'N and 34°20E, with annual rainfall of about 1180 mm while Budaka lies between 1.1016°N, 33.9304°E with average rainfall of above 12.08 mm annually. The soils in the two districts (Mbale and Bududa) are volcanic and rich in nutrients. Namutumba lies between 0.8493°N, 33.6623 °E with sandy clay loams that are susceptible to leaching. In in the four districts, Bududa Mbale, Namutumba and Budaka the studies were conducted in the sub-counties of Nabweya, Wanale, Bukenga and Lyama respectively. Nabweya and Wanale sub-counties are mountainous in nature and heavily cultivated with high susceptibility to erosion. While Bukenga and Lyama are flat land areas with sandy soils which are susceptible to leaching. The cropping system consists of perennials (banana-coffee either as pure stand or intercrop) in Wanale and Nabweya; while Bukenga nad Lyama sub-couties are mainly compo--sed of annual crops mainly beans (*Phaseolus_vulgaris*), maize (*Zea Mays* L) and Cassava (*Manihot esculenta*). Another emerging farming system especially in Mbale and Bududa is Horticulture which involves growth of crops like Onions, Carrots, Tomatoes, Spinach and Cabbages among others mostly in Mbale and Bududa districts. This study therefore focused on how nutrients are being managed on farmlands since the region's major activity is agriculture.

2.2. *Study Design*

Data was collected from various districts as mentioned above, using a survey approach. Face-to-face interviews with household heads or their spouses using a structured questionnaire, focus group discussions, interviewing key informants and conducting a stakeholders' workshop in each participating sub-county was used. In each sub-county, a total of 100 respondents randomly selected were interviewed. Field transect walks across farmers' fields were carried out to establish the most common practices for soil fertility management. The data collected included: socio-demographic characteristics and various soil nutrient management practices used by farmers.

2.3. *Data Analysis*

Data collected was analysed using descriptive statistics. Descriptive statistics were used to characterize selected farmers and other factors affecting nutrient management on farmers' fields. Statistical Package for Social Scientists (SPSS) Data Analysis Tool Version 16 was used to determine factors and practices affecting soil nutrient management reported by farmers. Outputs from the analysis tool were presented using graphs, tables and pie charts, generated using excel software.

III. Results and Discussion

3.1 *Demographic Characteristics of the Respondents*

The demographic characteristics of the respondents included: Gender, age distribution, size of household, education and marital status.

3.1.1 *Gender of Respondents*

Figure 1 shows the gender distribution of the responde--nts across the entire survey area. Male respondents at 57.63 % constituted the largest number of respondents as opposed to 42.37% women.

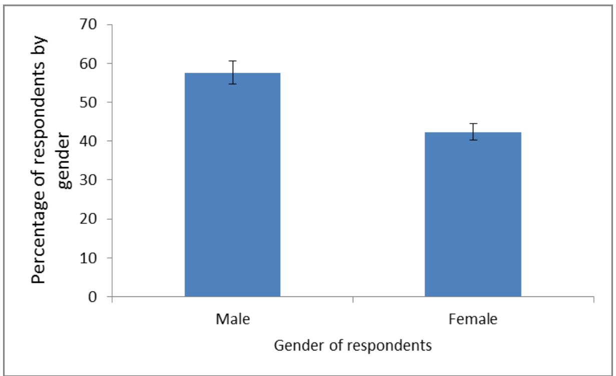

Fig. 1. Gender distribution of the respondents.

The variation in gender was mainly due to the cultural influence which dissuades women from talking on behalf of the household in the presence of her husband [8]; [13]. In many cases, men had much more free time to respond to the questions as women were busy involved in several domestic activities making them too busy [13]. This affects decision-making on how some nutrient sources can even be utilized since it's the women who are normally involved in production process. But you may find a man dictating whether to sale off the manure or not hence contribute to poor management of nutrients.

3.1.2 *Age of Respondents*

The age of the respondents was categorized into five namely: 18-27, 28-37, 38-47, 48-57 and ≥ 58 years. The age group between 28-38 years constituted the majority at approximately 39% closely followed by those under the category of 38-47 years at about 34 %. The least number of respondents were those above the age of 58 years at only 5% followed by those under 18-27 year category (Table 1). This was observed across districts.

Table 1. Age of respondents.

Age	Freq.	Percent
18-27	10	8.47
28-37	47	38.98
38-47	41	33.9
48-57	16	13.56
≥ 58 years	6	5.08
Total	**120**	**100**

The age group of 28-38 is considered to be the most active group in the production process. Unfortunately, this age group doesn't normally get involved in farming due to other factors but they rather prefer work which fetches quick income in cities [12]. This in a way also impacts on proper nutrient management.

3.1.3 *House Hold Size of Respondents*

Table 2 shows the three classes of household size were used (2-4, 5-9 and ≥ 10 members. The class with the highest number of respondents was that of 5-9 members at 61%. The least number of respondents were those having a household membership of 2-4 at 13% followed by those of ≥10 members.

Table 2. Household size of respondents

HH size	Mbale	Namutumba	Budaka	Bududa	**Total (%)**
2-4	5.56	1.85	3.7	1.85	**12.96**
5-9	27.78	5.56	9.26	18.52	**61.11**
>10	9.26	3.7	1.85	11.11	**25.92**
Total (%)	**42.59**	**11.11**	**14.81**	**31.48**	**100**

The larger numbers of people at home may mean more labor for production. Therefore this in away affects nutrient management since there is enough labour to transport residues in the field, apply fertilizer and practice improved farming methods (Matsumoto, 2006). Lower number of family members may imply less labour to manage nutrients for example transporting residuals back to the field, practicing improved farming methods such as conservation structures in the Farm which seem labour intensive.

3.1.4. *Marital Status of Respondents*

Out of 100 respondents, 86% were married and significantly different from the rest of the categories observed under the study. However, there were no significant differences observed among the rest of the categories under study. (Table 3).

Table 3. Marital status of the respondents.

Marital status	Freq.	Percent
Single	3	5.17
Married	50	86.21
Separated	2	3.45
Widowed	3	5.17
Total	58	100

Majority of the respondents in this survey were married (50%). Married couples are less mobile than singles and this gives them a reason to settle and work hard to cater for their families (Ajuruchukwu, 2011). Likewise, this gives implication that the couple will reserve some time to manage nutrients in their farm compared to unsettled group of singles.

3.1.5. *Education Level of Respondents*

The education attained by the correspondents is presented in Figure 2. Evidently, the majority of respondents in the districts of Mbale and Bududa only attained primary level education with 27.1% and 18.6% respectively. The number of respondents who completed secondary level is almost the same across all the four districts while only two districts of Mbale and Budaka had respondents with university education. Only 1.7% didn't give any response to this question.

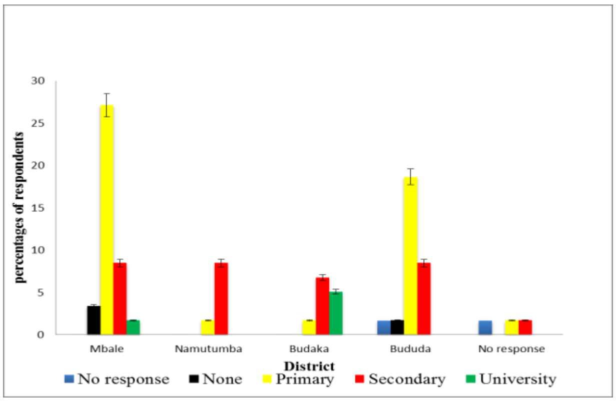

Fig. 2. Shows education level of respoindents across districts.

Generally, most of the respondents across districts had completed primary education and this is good enough to help them make informed decisions on how to better manage their resources (Ajuruchukwu, 2011). However, there may be other factors affecting better management of available resources such crop residues and manure. On the other hand, more educated people tend to leave farm activities to un-educated people who have less knowledge on good nutrient management practices and opt for better jobs which in most cases are non-farm.

3.2 *Physical Factors*

3.2.1 *Land Size under different Crops*

Table 4 shows the average acreage under legumes and root crops grown in the districts of Namutumba, Budaka, Bududa and Mbale. The land acreage under the two types of crops varied widely across the districts. Overall, more land is under legume crops than root legumes across districts. However, Namutumba district significantly grows more legumes compared to other districts followed by Budaka district.

Table 4. Summery statistics of acreage of crops grown in target districts

Enterprise	Namutumba			Budaka			Bududa			Mbale		
	O	M	S	O	M	S	O	M	S	O	M	S
Legumes (acres)	5	4.20	7.44	8	2.00	1.1	14	1.00	0.98	21	0.79	0.43
Root crops (acres)	4	2.00	1.03	5	1.20	0.76	7	0.72	0.67	15	1.00	1.27

Note: O = Number of observations, M = Mean, S = Standard Deviation

More land acreage, a case of Namutumba district means more production hence more production of residues to biomass on farm, that may become difficult for them to manage hence resort to Burning which may cause other environmental issues. More biomass production creates risk for nutrient mining. Therefore Namutumba has the highest number of acres under legume production for both crop types followed by Budaka. On the other hand this means more nitrogen fixation since more legumes are grown hence more inflows for nitrogen. Meaning there is also a balance of nutrients in a way that root crops recycle back leached nutrients which are utilized by short rooted crops like most legumes hence efficient nutrient re-cycling [9]. Since most of this normally intercrop.

3.2.2 *Level of Fertilizer use*

Results showed that Mbale is the only district which utilizes Urea singly compared to other districts with 2.6% (Table 5). However, DAP is equally utilized across districts under study while Budaka leads in utilization of Super glow (25%) followed by Namutumba district. However, Bududa leads in utilization of NPK (25%) followed by Mbale district. When it comes to combinati-ons, Namutumba leads in utilization of a combination of Urea and DAP (33.3%) followed by Budaka district. Results also revealed that Bududa leads in utilization of NPK and Urea (25%) compared to the rest of the districts followed by Mbale district.

Table 5. Shows level of fertilizer use in different districts.

District	Urea (%)	DAP (%)	Super glow (%)	Urea and DA (%)	NPK and Urea (%)	NPK (%)	Totals (%)
Mbale	2.60	50.00	5.30	15.80	15.80	10.50	100.00
Namutumba	0.00	50.00	16.70	33.30	0.00	0.00	100.00

District	Urea (%)	DAP (%)	Super glow (%)	Urea and DA (%)	NPK and Urea (%)	NPK (%)	Totals (%)
Budaka	0.00	50.00	25.00	25.00	0.00	0.00	100.00
Bududa	0.00	50.00	0.00	0.00	25.00	25.00	100.00

Most of farmers across districts use DAP only (50%) for soil fertility management. This contributes to nutrient imbalances since DAP alone majorly provides Phosphoro--us with little of Nitrogen. Mbale leads in utilization of Urea alone which is mainly a nitrogen source but this leaches or volatilizes very fast which creates Nitrogen imbalances in the system. Budaka leads in utilization of super glow which is not a fertilizer per say but an amendment which enhances moisture availability in the soil leading to nutrient availability for plant uptake, hence enhancing nutrient balances. Overall, a fertilizer combina--tion would be most advisable to increase level of nutrient balances in the system. However, this should be done wisely to avoid negative implications. For instance, Bududa district mostly utilizes a combination of Urea and DAP in their farming systems and this good combination since Urea provides Nitrogen while DAP provides mostly phosphorus hence improving nutrient balances. Mean--while, Namutumba utilizes a combination of Urea and NPK which is normally discouraged since this may cause a risk of eutrophication as the combination may cause application of excess nitrogen in the system that may be washed away into aquifers.

3.2.3. *Level of Crop Residual Utilization*

Figure 3. Shows how farmers in different districts utilize crop residuals. Namutumba and Bududa leave their crop residuals in the field while majority of Budaka Farmers stock them. Some Mbale farmers leave their crop residuals in the field, others stock them, and some are fed to animals.

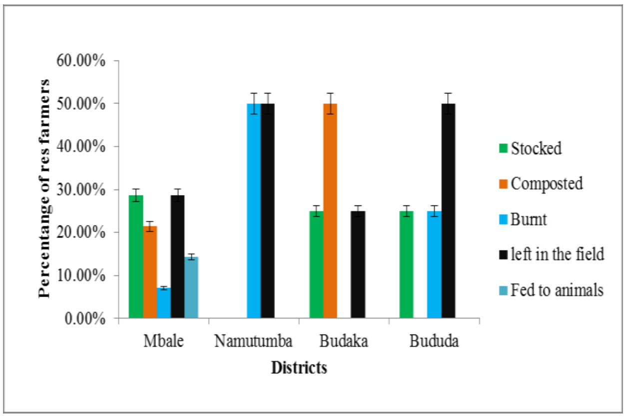

Fig. 3. Shows how crop residuels are utilised by farmers in different districts.

Generally, most of the farmers across districts either compost, stock, burn and leave residuals in the field. The percentage of residuals left in the field is to those farmers in respective districts who have been trained in smart agricultural technologies by different organisations like NARO, MAAIF and others. While a good number of farmers just burn off the residuals in some districts especially in Namutumba. Burning of residuals results in a significant loss of soil health and function. What farmers may see as being beneficial may eventually become long-term cost increases in soil nutrient and crop production management. The costs associated with the loss of organic matter and nutrients from burning crop residues exceed its benefits. Additionally, burning results into atmospheric degradation/ destruction of the ozone layer through emissions of trace gases like CO2.CO, N2O among others [11].

3.2.4 *Level of Animal Droppings Utilization*

Figure 4. How animal droppings are utilized in target districts

Overall, Mbale farmers significantly vary in utilization of animal droppings compared to other districts (Figure 4). Further still majority of farmers, further still Mbale has the highest number of farmers who use animal droppings directly in the garden with a percentage of 71.4%.

Most of the animal droppings is either disposed-off as waste or applied directly on crops as fertilizer across districts.

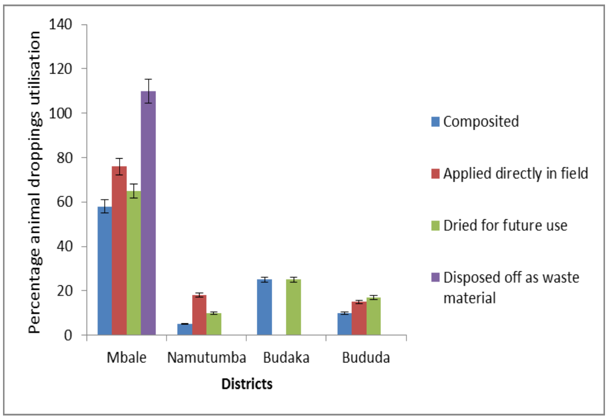

Fig. 4. Shows how animal droppings are ultilised by farmers in different districts.

The act of most of the farmers disposing off and applying animal droppings directly in the field is an implication that there is lack of awareness on how best they can utilize the droppings. This was majorly seen in Mbale district although other good practices also exhibited in the same district compared to the rest. Improper utilization may also imply laziness among farmers who just feel lazy to their compost the material into manure or dry it off for future use. It is unfortunate that comparing the graph above on how crop residuals are utilized, you will find that most of the residuals are fed to animals but the droppings which would provide good manure is just disposed off as waste, which may cause negative impact on crops and soil life, due to too much heat generated from the fecal material.

3.2.5. *Method of Fertilizer Application*

3.2.5.1 *Organic Fertilizer Application*

Figure 5 shows how organic fertilizers are applied in different locations, majority of farmers in Mbale, Namutumba, Budaka and Bududa practice deep applica--tion as a method of organic fertilizer application with 20.3%, 5.1%, 10.2% and 14.3% respectively.

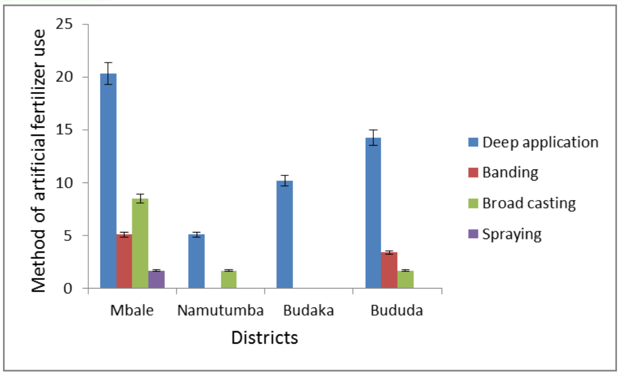

Fig. 5. Shows method of organic fertilizer application by farmers in different districts.

Due to many trainings from both Government and Non governmental organisations like Naional Agricultural Research organisation, Ministry of Agriculture, District local governments among others has equiped farmers with knowledge to apply manure deep into the soil, unlike previously when farmers would just broadcast manure hence causing environmental threats.

3.2.5.2 *Artificial Fertilizer Application*

Figure 6. shows method of application of artificial fertilizers. Of all farmers that were interviewed, all those who Practice broad casting as a method of artificial fertilizer application are in Mbale (100%). Majority (85.7%) who practice round application are also in Mbale district. Generally farmers in Mbale practice more artificial application methods of Banding and deep application.

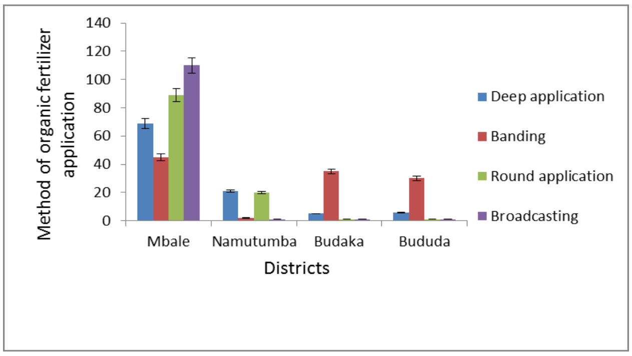

Fig. 6. Method of application of artificial fertilizersby farmers in target districts.

Mbale district using a variety of fertilizer application methods is because of the knowledge obtained through trainings from different organizations being a central place and vulnerable to a lot of declining soil fertility. Mbale also grows a variety of crops given nature of its terrain ranging from flat to hilly. The diversity of crops calls for different fertilizer application types and methods.

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Conclusion and Recommendations

Soil fertility decline is a major problem especially on smallholder farms in Eastern region. This is due to nutrient mining and poor farming practices which lead to depletion of nutrients from the soil. By training farmers and demonstrating to them how nutrients can better be managed in their cropping systems, will help to reduce soil degradation. Therefore, urgent intervention to promote awareness on proper nutrient management strategies in the region is needed, since the study brings out clearly, that most of the farmers have inadequate knowledge on proper nutrient management and recycling.

References

[1] A. Abebayehu, E. Eyasu, D. Jan, 2011, "Comparative analysis of soil nutrient balance at farm level: a case study in Jamma zone, Ethiopia". *International Journal of Soil Science, 6: 259-266.*

[2] A. Bationo, B. Waswa, J. Kihara, J. Kimetu. (eds). Advances in integrated soil fertility management in Sub-Saharan Africa, *in Scoones and Toulmin (1999). pg 26.*

[3] Bekunda, M., Nkonya, E., Mugendi, D., J.J.T. Msaky. (2002). Soil fertility status, management, and research in East Africa. *Eastern Africa journal of rural development 01/2002; 20(1). DOI: 10.4314/eajrd.v20i1.28362*

[4] C. Wortmann, C., and C.K. Kaizzi. (1998). Nutrient balances and expected effects of alternative practices in farming systems of Uganda. *Agriculture. Ecosystem Environment. 71:115–129.*

[5] E.M.A. Smaling, (eds), (1998). "Nutrient balances as indicators of productivity and sustainability inn Sub – Saharan Africa Agriculture". *Agriculture, Ecosystems and Environment, 71: 1-3.*

[6] E.M.A. Smaling, S.M. Nandwa, B.H. Janssen, (1997). "Soil fertility at stake. In Buresh, RJ, Sanchez, PA and Calhoum F (eds). Replenishing soil fertility in Africa". Special publication No. 51 Madison, Wisconsin: *American Society of Agronomy and Soil Science Society of America Pg 47-61.*

[7] E.N. Ogbodo. (2011). "Effect of crop residue on soil chemical properties and rice yield on an Ultisol at Abakaliki, Southeastern Nigeria". *World journal of agricultural sciences 7 (1): 13-18, 2011.*

[8] FAO, 2012. Gender and nutrition. Available on *http://www.fao.org/fileadmin/user_upload/wa_workshop/docs/Gender,Nutrition_FAO_IssuePaper_Draft.pdf. Accessed on 25th.2.2018*

[9] J. Lehmann, G. Schroth, (2003). Nutrient leaching. Chapter 7; © CAB International Trees, Crops and Soil Fertility *(eds G. Schroth and F.L. Sinclair).Pg 154.*

[10] J.J. Stoorvogel, E.M.A. Smaling (1990). "Assessment and soil nutrient depletion in Sub-Saharan Africa" 1983-2000.Winand staring Centre Report 28. *Winand staring Centre Wageningen, The Netherlands. Pp. 137.*

[11] K.G. Prabhat, S. Shivraj, S. Nahar, C.K. Dixit, D.P. Singh, C. Sharma, M.K. Tiwari, R.K. Gupta,, S.C. Garg. (2004). "Residue burning in rice wheat cropping system: Causes and Implications". *Current Science: 87; 12. (2004)-Research communications.*

[12] S. Schwarze (2017). "Determinants of income generating activities of rural households". *Gottingen University.*

[13] S.Heilter, (2012). "How gender differences make decision making difficulties". Available on *https://www.psychologytoday.com/blog/resolution-not-conflict/201202/how-gender-differences-make-decision-making-difficulties, Accessed on 25th. 10. 2017.*

[14] T.A. Gashaw, B.A. Zewdu, A.B. Assefa. (2017). "Effects of land fragmentation on productivity in North Western Ethiopia".

[15] 15. Van lauwe, J., Diels, N. Sanginga, S. Merckx (Eds). (2002). "Integrated plant nutrient management in Sub-Saharan Africa". From concept to practice. CABI, Publishing, New York, NY 10016 USA, CAB International Institute of Tropical Agriculture.

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