Household Survey on the Compost Use and its Constraints in Smallholder Farming of Malawi Northern Region

N. Matsui[1*] and C. Cornelius[2]

[1]Environment Department, Kanso, Osaka, Japan.
[2]Department of Agri. Res. and Service, Ministry of Agriculture and Food Security, Lunyangwa, Malawi.

Original Research Article

ABSTRACT

The household survey was conducted in the four northern districts of Malawi, Mzimba North (N), Mzimba South (S), Nkhatabay, and Rumphi in July 2012. Totally 432 households (9 villages, 148 households in Mzimba N, 7 villages, 123 households in Mzimba S, 5 villages, 85 households in Nkhatabay, 4 villages, 76 households in Rumphi) were studied with the aim of clarifying current status regarding land management practices and at identifying reasons refraining farmers from proactive use of compost. 47% of income comes from agriculture in smallholder farmers. Farmers are forced to engage in off-farm works to sustain the livelihood such as sales business, working abroad and migrant work within the country. This result indicates a necessity to make agriculture activity in the study region more sustainable and productive.
Among land management practices, soil fertilization highly relied on the use of chemical fertilizer. Compost use was still limited among farmers. Only 30 % of farmers applied to a half of the crop land. Effects of compost were recognized as 21% of farmers experienced an increase of yield by compost application. However, 26% of farmers just burn crop residue without any utilization. Compost material collection and transportation were two main obstacles in compost application as expressed by the equation; Application of compost = 0.41 x compost material collection + 0.33 x compost transportation - 0.14 (r^2=0.39, $p<0.05$). These would be solved to some extent if compost making is jointly done by farmer group since it plays a great role in rural activity in Malawi. Material availability for compost making was different among the districts so that strategy to promote compost application shall be planned according to the regional condition.

Keywords: household survey; smallholder farming; compost use; crop residue; Malawi.

1. INTRODUCTION

Continuous cropping without fallow and insufficient organic matter input have attributed to deterioration of soil fertility resulting in a low crop productivity in most of smallholders in sub-Saharan Africa countries [1,2,3]. A decline of soil fertility has been one of crucial problems for the agriculture in Malawi. Smallholder agricultural sector in Malawi is characterized by low

**Corresponding author: E-mail: nmatui19@gmail.com, matui_naohiro@kanso.co.jp;*

productivity. The national yields of maize have averaged 1.3 metric tons per hectare (t ha^{-1}) during the last 20 years [4] which are three to four times lower than the world average yield. Furthermore, enhancement of land productivity is becoming crucial issue because of an increased population pressure.

Annual population growth rate between 1998 and 2008 was 2.8% for the whole country and 3.3 % for the north region [5]. Soil fertility improvement thus has become one of the indispensable measures to alleviate poverty of smallholders.

A number of approaches has been conducted for soil fertility improvement. It includes wide ranged land management activities such as biomass transfer, mulching, compost, manure, agroforestry [6]. All of them are obviously important because single measure cannot solve soil fertility problem.

Low soil fertility in Malawi northern region is partly attributable to poor crop residue management. Matsui *et al*. [7] conducted soil fertility study in the study region, and which revealed that soils in the north region are lower fertility than those of central and south regions as shown by low organic matter content and a high sand content. These endows with low nutrient holding capacity so that effect of chemical fertilizer application is kept quite low.

Compost application shall be promising measure for enhancing soil fertility but organic matter based technologies has been minimal [1]. Compost use in Malawi is still limited comparing to other land management practices. Thus understanding an importance of compost use in the region and constraints against compost use, will be necessary. The household survey was conducted in 2012 at the initial stage of Sustainable Land Management Promotion Project (SLMP) in Malawi to understand smallholder's farming and management of agricultural activity. This study aims at clarifying current status regarding compost use and at identifying reasons which refrain from proactive use of compost.

2. MATERIALS AND METHODS

The study region is located in the four northern districts of Malawi, namely, Mzimba North (N), Mzimba South (S), Nkhatabay, and Rumphi (Fig. 1). The mean annual rainfall over a 22-year period between 1989 and 2011 was 1,129 mm in Mzimba N, 702 mm in Mzimba S, 612 mm in Rumphi, and 1,610 mm in Nkhatabay. Rainfall patterns of the four districts were almost identical: high rainfall from November to April and low rainfall from May to October. Nkhatabay had very high rainfall in April and May. Number of households as of 2008 were 142,980 in Mzimba, 36,037 in Rumphi, 42,269 in Nkhatabay [5].

The household survey was conducted in July 2012 for 432 households which are 9 villages, 148 households in Mzimba N, 7 villages, 123 households in Mzimba S, 5 villages, 85 households in Nkhatabay, and 4 villages, 76 households in Rumphi. Among a number of surveyed items, issues regarding compost making and use were examined for this study.

For collected information, statistical analysis was conducted using the software JMP 8.0.2 version for Windows [8]. In which correlation analysis and multivariate analysis were conducted for all reasons to obstacle compost making.

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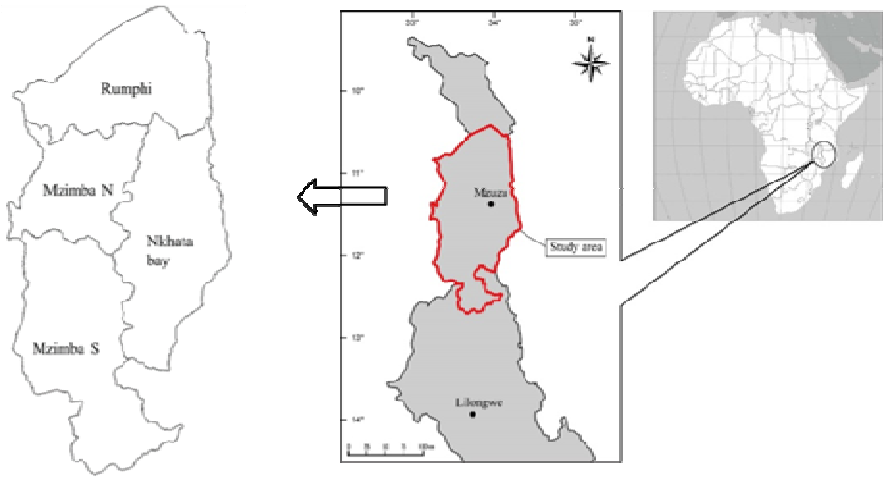

Fig. 1. Location of study site composed of four districts (Mzimba N, Mzimba S, Nkhatabay, and Rumphi).

3. RESULTS AND DISCUSSION

3.1 Basic characteristics of farming in the region

The household survey reports cropping activities for 14 different crops. The ten most frequently grown crops across the four districts are, in descending order, maize, groundnut, cassava, tobacco, S/potatoes, finger millet, soya, beans, i/potato, field beans, banana, vegetable, paprika, coffee. Average owned land area is 1.98 ha, the lowest in Nkhatabay with 1.66 ha and the highest in Rumphi with 2.19 ha (Fig. 2). Average cultivated area is 0.81 ha for all districts, which is around 40% of owned land area.

As regards with the income of households, 47% of income comes from agriculture while 20% from business (Fig. 3). Due to unstable and insufficient income from agriculture, farmers have to find another income. Business in Fig. 3 means extra work, for example farmers make local beer at home and sell, or buy fish, maize or cow at low

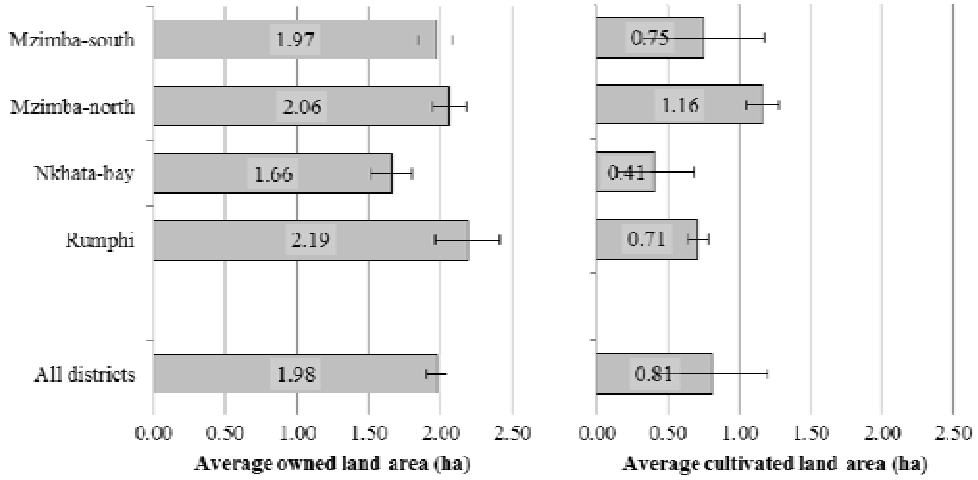

Fig. 2. Average land and cultivated area in the study region (Error bar indicates the standard deviation).

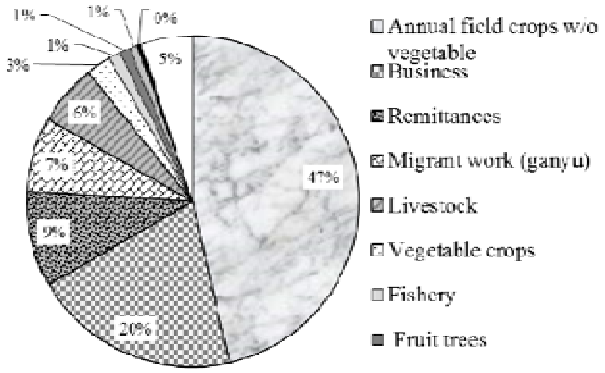

Fig. 3. Types of income and its proportion among the total.

price in one place and sell them at higher price in another place. Remittance means money transfer from working abroad, mostly from South Africa. Migrant work which is called *ganyu* in Malawi, means work within the country. Off-farm activities are increasing and which brings several problems in villages. Thus enforcement of agriculture sector is greatly needed for farmers' stable livelihood.

3.2 Land Management Practice

For sustainable land management, several technologies are believed to be useful. Maize cultivation with legume intercropping is one of the effective measures since N can be fixed and supplied from leguminous crops. Crop rotation is helpful to recover soil fertility by soil enrichment plants. Since continuous cropping often induces plant infection, changes of crops may prevent through diversification of microbial community. Non-tillage would be effective especially if soil is erodible where land is located in a high slope. Agroforestry is also effective if land use is not competitive between forestry use and agriculture use.

The household survey demonstrated that 30% of farmers practiced maize cultivation with legume intercropping and 36% did crop rotation (Fig. 4). Both non-tillage and agroforestry were not common land management in the region. In terms of soil fertilization, 95% used chemical fertilizer but not green manure. Compost/manure were used in 32% of farmers.

Soils in the study region are poor in soil organic carbon (SOC), only around 0.5% [7]. Increasing SOC is quite important in terms of soil fertility improvement, but which cannot be met by sole conservation practice like intercropping, therefore organic matter input such as compost application shall be required.

3.3 Compost Application in the Region

Use of compost/manure is not yet common in the northern districts. Except for one village (No. 17) in Mzimba N, compost use is quite low in most of villages (Fig. 5). Farmers who were utilizing manure, just had several years' experience. Very few farmers have more than five years use. Nkhatabay had a low % of compost user. This was partly related with animal husbandry activity. Compost is normally prepared using cattle dung, but cattle is scarce in Nkhatabay (Fig. 6). Also maize residue is mainly used for compost making, but cassava is more grown than maize in Nkhatabay. These matters have driven to lower motivation of farmers to make compost in Nkhatabay.

30% of farmers incorporate crop residues such as maize stalk into soils, but 26% of farmers just burn without any proper utilization (Fig. 7). 25% of farmers just leave residues above crop land and 14% of farmers use as animal feed. In the study region, incorporation of crop residues started in the late 90s, maize residue is buried with ridge. Its effect is not yet approved but decomposition of residues are quite high due to termite attack. Decomposition by termite also happens in crop residues used for mulching. Increment of organic carbon in soils is thus important for soil fertility improvement, but this is a hard task in the study region.

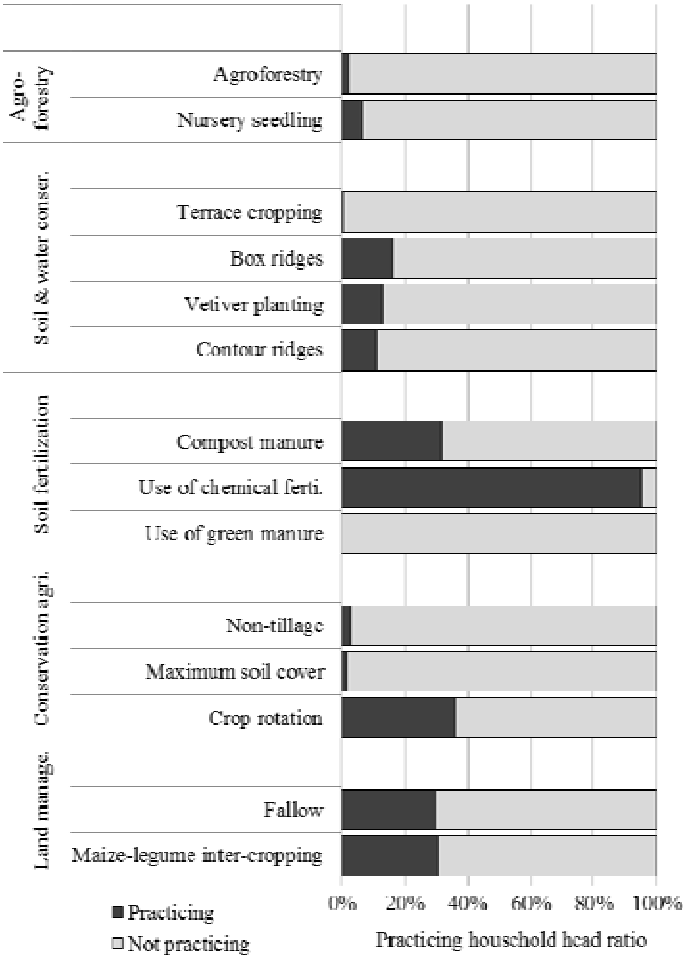

Fig. 4. Land management practice in the study region

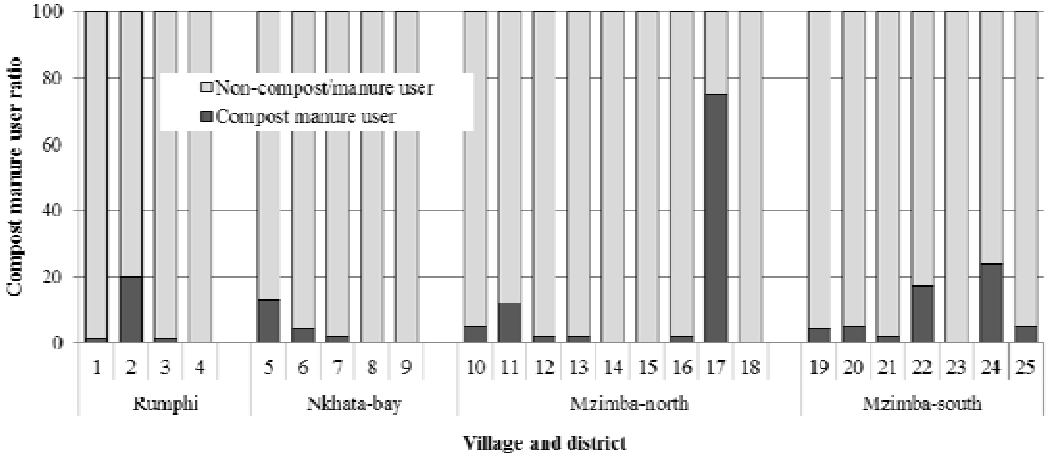

Fig. 5. Compost/manure use in the study region

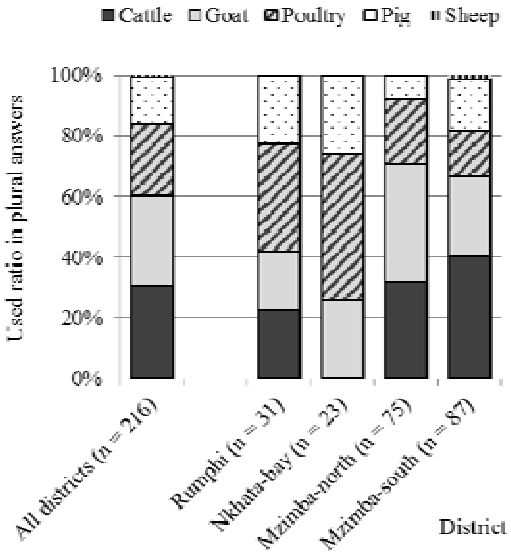

Fig. 6. Type of livestock owned by farmers in the study region

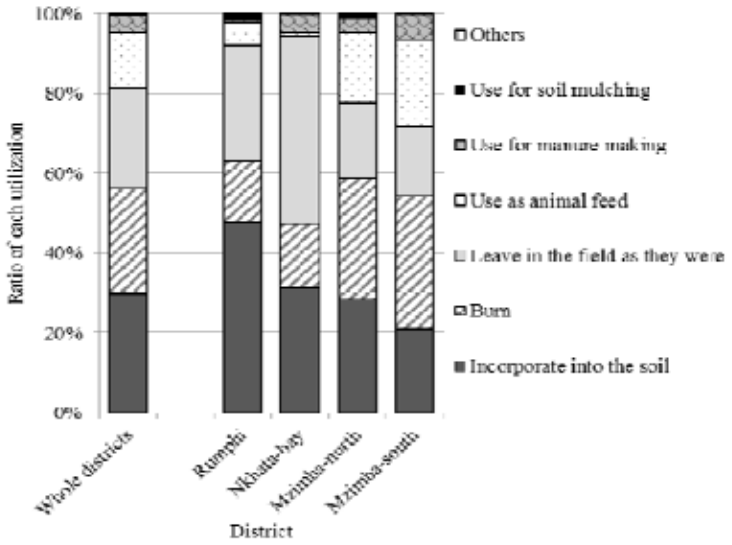

Fig. 7. Ways of crop residue use in the study region.

3.4 Recognition of Compost Application Effects

Farmers understand about positive effects of compost application through their experience (Fig. 8). 21% of farmers obtained an increase of yield by compost use. The combination of inorganic fertilizers and organic manures from cattle, compost, green manures, grain legume, is recognized as one of alternatives to reduce inorganic fertilizer consumption [2,9,10,11,12]. Mixed use of compost with chemical fertilizer increased efficiency of fertilizer use possibly because it lowered nutrient leaching and increased nutrient holding capacity [7]. Due to an increased price of chemical fertilizer, an efficient and economical use of chemical fertilizer is highly requested by farmers. Mixed use with compost will greatly attribute to solve this challenge.

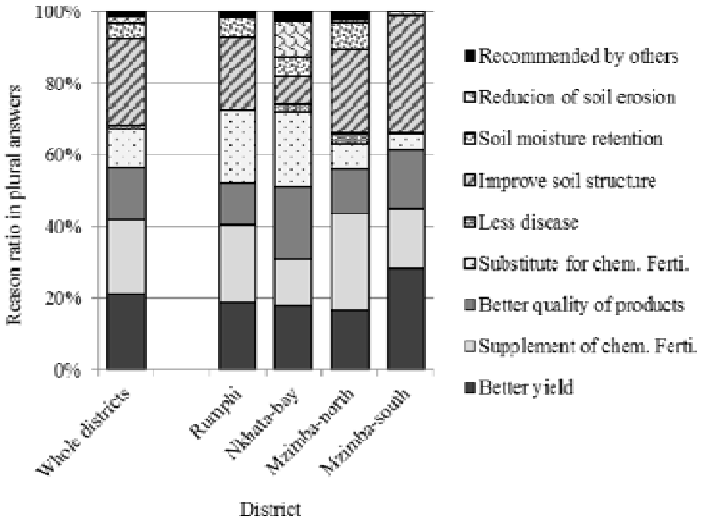

Fig. 8. Perceived effect of compost use by farmers.

Compost production mostly falls far short of annual needs. Average area of compost application in the northern three districts was 0.38 ha with the highest (0.55 ha) in Rumphi and the lowest (0.23 ha) in Nkhatabay. Compared with the average cultivated area (Fig. 2), merely a half of crop land has received compost.

3.5 Obstacles in Compost Making

Reasons to obstacle compost making were collected in the household survey and examined. Compost making is divided into three processes which are material collection, material preparation and compost transportation. Material collection is made for maize stalk, legume, gaga (maize bran) and animal manure. Material preparation consists of chopping, turning and watering.

Any single reason couldn't explain compost application as shown by no relevant significant correlation with compost application (Table 1). Collection of maize stalks and legume residues are highly correlated. Maize and legume are grown together as intercropping so that collection of these two residues are well correlated. Turning compost heap and chopping materials are also closely correlated. It is likely that these two operation are done at the same time.

Multivariate analysis was conducted to find variables to correlate with compost application and revealed that willingness for compost application was affected by compost material (maize residue) collection and its transportation, expressed by the following equation.

Application of compost = 0.41 x compost material collection + 0.33 x compost transportation - 0.14 (r^2=0.39, $p<0.05$)

The equation indicates that compost material collection and transportation are two main constraints in compost application. There is a room to increase compost application if these are improved.

Snapp *et al.* [13] pointed out reasons to obstacle farmers from applying green manure, which were high labor requirements, skillful management, delayed application effect. Chinangwa *et al.* [14] showed other challenges to application such as water, livestock manure shortage and lack of interest. Opportunity for farmers to access an information of compost making is still limited. Farmer training and knowledge on compost manure making are listed as barriers for its adoption in the southern Malawi [15]. As such conditions to enable farmers to apply compost differs according to the regions. Available compost materials, accessibility to water and labor condition are different among the districts in the northern region so that strategy to promote compost application shall be planned according to the regional condition.

Table 1. Correlation matrix of obstacle reasons in compost making

	Maize stalks collection	Legume residue collection	Animal manure collection	Gaga collection	Chopping materials	Turning compost heaps	Watering	Compost trans-portation
Legume residue collection	0.77**							
Animal manure collection	0.23	0.14						
Gaga collection	0.40*	0.36*	0.06					
Chopping materials	0.05	0.22	0.10	0.01				
Turning compost heaps	0.32	0.14	0.00	0.11	0.66**			
Watering	0.18	0.07	0.05	0.09	0.34	0.52*		
Compost transportation	0.08	0.08	0.14	0.07	0.09	0.05	0.09	
Compost application	0.28	0.14	0.17	0.18	0.00	0.13	0.17	0.40

** and * mean significance level at 0.01 and 0.05, respectively

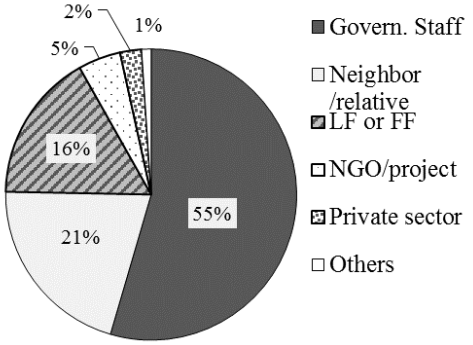

Fig. 9. Source of an information on land management technologies

An increase of farmer's participation in farmer's group helps to increase compost application through enhancement of knowledge and understanding on compost application [14]. Fig. 9 shows sources where farmers in the study region got an information on land management technologies. Around half of farmers have acquired an information and 55% of them got from governmental staff, 21% and 16% obtained from neighbor/relative and lead farmers (FF) or follower farmer (FF), respectively. Farmers group plays a great role in rural activity in Malawi, such the case that fertilizer loan is given through farmers group (called as "farmer club" in Malawi). For compost use more to be disseminated, farmer group also could be as important as NGO whose role is also increasing in the region. Compost making on site where farmer practice agriculture would also help to reduce laborious compost transportation.

4. CONCLUSION

Compost use was still limited in the northern region of Malawi. Effects of compost use had been recognized by farmers shown as an increased yield. However, still 26% of farmers just burn crop residues without utilizing for other purposes like compost making. Material collection and transportation stand for as the main limitation in compost use. Compost making by farmer group would solve problems to some extent and lead into dissemination of compost use.

ACKNOWLEDGMENTS

This research was conducted within the project " Sustainable land management promotion (SLMP) project" durated from 2011 to 2015 with the participation of the Ministry of Agriculture, Food security (MoAFS), Malawi and Japan International Cooperation Agency (JICA). The authors are deeply indebted to local farmers, for their valuable collaboration.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kumwenda JDT, Waddington SR, Snapp SS, Jones RB, Blackie MJ. Soil fertility management in southern Africa. In: Byerlee,

D, Eicher CK, editors. Africa's emerging maize revolution. Boulder, Colorado: Lynne Rienner Publishers;1997
2. Snapp SS, Mafongoya PL, Waddington S. Organic matter technologies to improve nutrient cycling in smallholder cropping systems of Southern Africa. Agriculture, Ecosystems and Environment 1998;71:187-202.
3. Wall PC. Tailoring Conservation Agriculture to the Needs of Small Farmers in Developing Countries : An Analysis of Issues. Journal of Crop Improvement 2007;19:137-155.
4. FAO. FAOSTAT database. Production: Crops. 2008: Available: http://faostat.fao.org/site/567/default.aspx.
5. National statistical office. 2008 population and housing census. Preliminary report. 2008.
6. Phiri AT, Mhango WG, Njoloma JP, Kanyama-Phiri GY, Lowole MW. Farmers' evaluation of integrated soil fertility management methods in Northern Kasungu Central Malawi. J. of Agricultural Extension and Rural Development 2012;4(1):340-346.
7. Matsui M, Nakata K, Cornelius C, Macdonald M. Improvement of maize yield and soil fertility by 2years compost application in Malawi's northern districts. African Journal of Agriculture Research 2016;11(30):2708-2719. DOI: 10.5897/AJAR2016.10884
8. SAS Institute Inc. SAS/STAT® 9.2User's Guide, Second Edition. 2009: Cary, NC: SAS Institute Inc.
9. Sakala WD, Ligowe I, Kayira D. Mucuna-maize rotations and short fallows to rehabilitate smallholder farms in Malawi. In: Waddington SR, editor. Grain Legumes and Green Manures for Soil Fertility in Southern Africa. Harare, Zimbabwe: Soil Fert Net and CIMMYT-Zimbabwe; 2003.
10. Tittonell P, Corbeels M, van Wijk MT, Vanlauwe B, Giller KE. Combining organic and mineral fertilizers for integrated soil fertility management in smallholder farming systems of Kenya – explorations using the crop-soil model FIELD. Agron. J., 2008;100:1511-1526.
11. Chivenge P, Vanlauwe B, Gentile R, Wangechi H, Mugendi D, van Kessel C, Six J. Organic and mineral input management to enhance crop productivity in Central Kenya. Agron J 2009;101:1266-1275.
12. Vanlauwe B, Descheemaeker K, Giller KE, Huising J, Merckx R, Nziguheba G, et al. Integrated soil fertility management in sub-Saharan Africa: unravelling local adaptation. SOIL 2015;1:491-508. doi:10.5194/soil-1-491-2015.
13. Snapp SS, Rohrbach D, Simtowe F, Thombozi J, Freeman HA. Sustainable soil management options for Malawi: can smallholder farmers grow more legumes? Agriculture, Ecosystems & Environment 2002;91:151–174.
14. Chinangwa L. Adoption of soil fertility improvement technologies among small holder farmers in southern Malawi. Norway. 2006. Available: http://www.umb.no/noragric
15. Mustafa-Msukwa AK, Mutimba JK, Masangano C, Edriss AK. An assessment of the adoption of compost manure by smallholder farmers in Balaka district, Malawi. S. Afr. J. Agric. Ext. 2011;39:1725.