

Full Length Research Paper

Assessment of smallholder farmers' perceptions and degree of adoption of *Tithonia diversifolia* compost in addressing declining soil fertility in Ming'ongo Extension Planning Areas, Lilongwe, Malawi

MLANGENI Noel Jekemu Thembachako Angstone

Basics Programme, NR Department, Natural Resources College, P. O. Box 143, Lilongwe, Malawi.

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A study was conducted to assess smallholder farmers' perceptions and degree of adoption of *Tithonia diversifolia* chimato compost among the smallholder farmers in *Ming'ongo* Extension Planning Areas in Lilongwe. Primary data regarding smallholder farmers' knowledge, perception and adoptions levels on making and using *T. diversifolia* chimato compost were collected through a questionnaire interview with household heads and their spouses. Descriptive and inferential statistics as well as regression analysis were used to analyse the data. Results indicated that 87% of the smallholder farmers have limited knowledge of *T. diversifolia* potential in improving soil fertility whereas 92% lacked knowledge of recommended blending composition of nitrogen rich and nitrogen poor organic natural resources. The results further indicated that adoption of making and supplementing *T. diversifolia* composts positively correlated with good education of household heads ($P=0.12$, $\alpha=0.001$), low vulnerability levels of households ($P=0.207$, $\alpha=0.001$), larger household size and labour force ($P=0.47$, $\alpha=0.001$), knowledge of nutrient richness of *T. diversifolia* ($P=0.01$, 0.001) and available extension services in the area ($P=0.27$, $\alpha=0.05$). A strong negative correlation was observed between households' decisions to make and use composts and double poor education levels of household heads ($P=0.12$, $\alpha=0.001$), high vulnerability levels of households ($P=0.207$, $\alpha=0.001$), low household labour force ($P=0.47$, $\alpha=0.001$), lack of knowledge of richness of *T. diversifolia* ($P=0.01$, 0.001) and inadequate extension services in the area ($P=0.27$, $\alpha=0.05$). Smallholder farmers should be sensitised on benefits of *T. diversifolia* chimato composts in soil enrichment.

Key words: Compost, adoption, households, compost supplementation.

INTRODUCTION

Composting is comeback technology that has recently been advocated as a viable option of improving soil fertility (Enger and Smith, 2002) and enhancing soil carbon sequestration in sub Saharan Africa (Ganunga et al., 1998). In Malawi, the Department of Agricultural

Extension under the Ministry of Agriculture has in recent times advocated for chimato composting as a possible option of addressing declining soil fertility in several extension planning areas (EPA) (DAREST, 2012) including Ming'ongo EPA. Smallholder farmers are

trained to make chimato composts using maize stalks and grass. Chimato compost is a type of compost made by conically piling ingredients in layers on a circular base measuring 1.5 to 2 m in diameter and 1.5 m in height (Mlangeni et al., 2013; Nalivata, 2008). The pile is plastered with mud and each layer is supplied with manure and water to hasten decomposition (Nalivata, 2008).

Traditionally, the main organic resources used are maize stalks and grass which are of poor quality (C:N>60:1; Nalivata, 2008; Ngeze, 1993; ICRAF, 2007). This limits the availability of the much needed nitrogen in soils, since soil nitrogen is central in controlling soil microbial activities and controlling growth and yield of crops. Furthermore, chimato composts made using maize stalks and grass take a longer duration to mature and yield composts with higher C:N ratios (C:N>30:1) which characterise immature compost (Ngeze, 1993; WSU, 2010).

Carbon compounds in such immature composts continue to break down once incorporated into the soil and the microorganisms draw on soil nitrogen to assist in the process (Tsutsuki, 2009; Joern and Brichford 2006). This leaves the root zone temporarily nitrogen deficient thereby inversely inducing N-immobilization process (Tani, 2009). Limited soil nitrogen meant for the crops is then used up by microbial decomposers that further tie up the much-needed nitrogen (Ngeze, 1993; Nalivata, 2007). Sole application of chimato composts made using low quality organic resources is likely to induce N-immobilization and become limited in overcoming nitrogen demand by microbial decomposers (Tani, 2009; Tsutsuki, 2009).

Oxygen demand increases in soils supplemented with immature compost due to high level of microbial activities (OFCH, 2010). As a result the microbes draw the oxygen from the surrounding soils that further suffocate plant roots (Tsutsuki, 2009; Joern and Brichford 2006). Supplementation of well-matured composts supply nitrogen and other nutrients in ready form and do not require further microbial processes (WSU, 2010; OFCH, 2010). Well-matured compost may contain nitrogen weighing up to 7.5 to 15 kg per one tone of composts (OFCH, 2010).

In Malawi, smallholder farmers are advised to use groundnuts and soy bean clovers to produce nitrogen rich chimato composts with low C:N ratios. However, the clovers are in short supply. Farmers use groundnuts and soy bean clovers as livestock feed and are unwilling to compost them at the expense of feeding them to livestock (Jama et al., 2000; Olabode, 2007). Sometimes, they are grazed by livestock in the field. Due to these limitations, Nalivata (2007) recommended that maize stalks should

be blended groundnuts and soy bean clovers in order to produce relatively nitrogen rich and well matured chimato composts. Similar studies by Mlangeni et al. (2013) recommended use of *Tithonia diversifolia* to substitute groundnuts or soy bean clovers. *T. diversifolia* biomass possesses relatively high

concentration of nitrogen (3.5% N), phosphorus (0.82% P) and potassium (3.92% K) (Jama et al., 2000; Olabode et al., 2007) which are essential soil nutrients.

Chimato composts produced by blending *T. diversifolia* with maize stalks or grass in the ratios of 50:50 and 60:40 are reported to possess significant quantities of nitrogen of about 2.32 and 2.42%, respectively and optimum C:N ratio of about 10:1 and 12:1, respectively (Mlangeni et al., 2013). These characterise high quality composts and highly correlate with high maize yield (Mlangeni et al., 2014). Studies have shown that composted *T. diversifolia* significantly reduces transportation costs, increases compost nitrogen concentrations, improves C:N ratio of composite ingredients (Mlangeni et al., 2013; Jama et al., 2000). In contrast to supplementation of raw *T. diversifolia* biomass, supplementation of composted *T. diversifolia* significantly reduces bulk of plant matter by approximately two-thirds of the biomass mass which significantly reduces transportation costs by the same ratio (two-thirds) in transporting equivalent amounts of nutrients.

In Malawi, smallholder farmers are advised by extension staff to make chimato composts to supplement crop fields with poor soils in order to: 1) mitigate the declining soil fertility to improve productivity of farming land (OFCH, 2010); and 2) optimize crop production of small parcel of land smallholder farmers hold thereby mitigating impacts of limited farming land (Muzari et al., 2012). Farming land is becoming increasingly limited to smallholder farmers due to: increasing population growth currently rated at 2.8% per annum (MIE, 1998); problems associated with land grabbing; urbanization and other environmental factors (MIE, 1998). As a result, over 30% of the smallholder farmers cultivate a piece of land that is less than one acre, which is insufficient to produce enough food that could ensure food security at household level (GOM, 2010; MIE, 1998). Loss of soil fertility and soil degradation are exacerbated by poor farming methods and over reliance on chemical fertilizers (OFCH, 2010; Sakira, 2000). Over reliance on chemical fertilizers does not replenish farm land with organic matter whereas composts supply the soil organic matter in addition to soil nutrients (Akanbi et al., 2007). Organic matter forms soil nutrients anchorages that give soils capability for self building (Akanbi et al., 2007; OFCH, 2010).

Therefore, compost supplementation has been identified to improve both soil fertility and soil organic

matter (Enger and Smith, 2002; OFCH, 2010; Mlangeni, 2013).

Shortage of farming land has exerted pressure on the available land through intensive farming which has further led to depletion of soil fertility thereby limiting increased agricultural production (Ledbetter, 2006; Nalivata, 2008). Low utilization of some technologies aimed at replenishing soil fertility, such as supplementation of compost to farming land, has also worsened soil nutrient holding capacity (Enger and Smith, 2002; OFCH; Muzari et al., 2012). Compost supplementation also improves root penetration, permeability, water retention that ultimately reduces leaching of nutrients, and improves resistance to erosion, which also reduces nutrient loss through run-off (Nalivata, 2008).

Thus, composts help the soil-air-water relationship by improving soil drainage and the plant-available water and water-holding capacity of the soil (Fandika et al., 2007; Ledbetter, 2006). The poor yield has been associated with the declining soil fertility of most fields that are failing to support plant growth even with recommended chemical fertilizer application (Enger and Smith, 2002; OFCH, Mlangeni et al., 2014). Therefore, this study was carried out to assess smallholder farmers' perceptions and degree of adoption of *T. diversifolia* chimato compost among the smallholder farmers in *Ming'ongo* Extension Planning Area, in Lilongwe, Malawi.

METHODS

Description of the study area

The study was carried out in Group Village Headman Mdzooole area which is within *Ming'ongo* Extension Planning Area (EPA) in Lilongwe. The study targeted the GVH Mdzooole area because majority of the smallholder farmers experience persistent food insecurity due to poor yields despite supplementing their fields with satisfactory quantities of chemical fertilizers of the FISP programme. The targeted villages were Mdzooole, Mandindi, Mtembe, Kambewu, Mndewere, Dambo Lion, Dambo Bernard and Kamatira village which are within Group Village Headman Mdzooole area in *Ming'ongo* Extension Planning Area (EPA) in Lilongwe district, Malawi. *Ming'ongo* EPA is situated in the western part of Lilongwe district covering the plane land of the district that borders Mchinji District.

The area receives low and erratic rainfall ranging from 830 to 1200 mm per annum and is characterized by moderate temperatures ranging from 18 to 33°C. It has about 41,377 farming households of which about 17,100 are female headed. The smallholder farmers practice subsistence farming that involves growing of crops such as maize, tobacco, groundnuts, soy bean, and sweet potato. Due to poor farming methods and deteriorating soil fertility, maize yields the main staple food with low average less than 3 bags (of 50 kg) per acre per cropping season in most years. Over 75% of the households do not harvest adequate maize despite farming large portion of land.

The soils have lost fertility where maize is grown without chemical and organic manure; maize plants are less than 30 cm high and do not fruit any cob. As a result, a large number of households are food insecure and in dire need of food aid (Agriculture Advisors, personal communication).

Sample size, sampling of interviewees and data collection

Ten villages (Msampha, Mdzooole, Mandindi, Mtembe, Kambewu, Mndewere, Mbala, Dambo Lion, Dambo Bernard and Kamatira village) from Group Village Headman Mdzooole in *Ming'ongo* Extension Planning Area (EPA), Lilongwe, Malawi were purposely selected because they perpetually experience severe food shortages due to poor maize yields in most years. A questionnaire was developed and administered randomly to selected 240 households' heads and key informants in the selected villages between September 2012 and February 2013.

Data analysis

The captured primary data were analyzed using descriptive and inferential statistics in order to establish: 1) smallholder farmers' perceptions of *T. diversifolia* composts; 2) smallholder farmers' knowledge of the importance of supplementing crop fields with composts, and 3) adoption levels of supplementing crop fields with composts or manure in the sampled villages in *Ming'ongo* Extension Planning Area (EPA). Adoption levels were measured as proportion of households (heads) that made and used compost against those interviewed in each category. Survey data were further analyzed to establish whether households' adoption of composts supplementation was influenced by education of households' heads, education of households' heads spouses, vulnerability of households, gender of households' heads, and size and labour force that a household has.

RESULTS AND DISCUSSION

Profile of smallholder farmers

Average age of the population under study was 45.5 years. The educational status of the farmers was low. Fifty-six percent of the household heads had at most junior primary school education of standard 1 to 5 of which 14.5% were illiterate, thirty-seven percent attained senior primary education of standard 6 to 8, nine percentage attended secondary education. Based on gender, 68% of the respondents were males while 32% were females. None of the female household heads attained senior primary school education and let alone secondary school education in the study area. The average farm size per household varied from 1.0 acres to 2.5 acres, with about 0.5 acres to 1.0 allocated to maize production. The farm size is more than the national average of 1 ha per household (GOM, 2010). Thus, households were expected to produce enough maize and be food secure. However, due to declining soil fertility and poor land husbandry practices, most households produce insufficient maize and are perpetually food insecure.

Farmers' knowledge of *T. diversifolia* potential in enhancing soil fertility

Out of 240 smallholder farmers sampled, only 13 households (5.4%) were aware that *T. diversifolia* possess enormous nitrogen and phosphorus nutrients

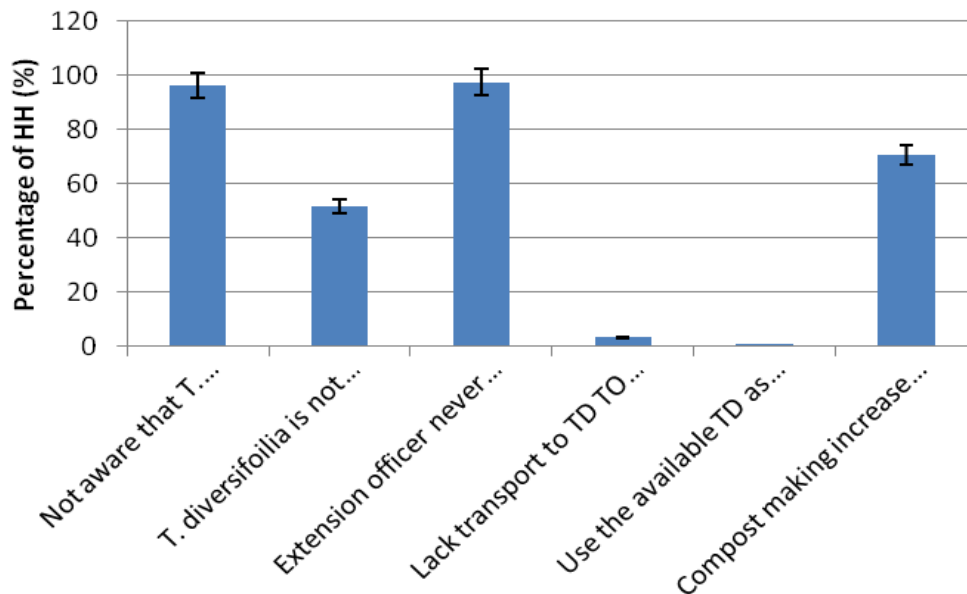


Figure 1. Farmers knowledge about *Tithonia diversifolia* potential in enhancing soil fertility.

that could be made available to crops. They had an idea that fields colonized with *T. diversifolia* shrub, once cleared for cultivation, produce good crop that suggests farmers possess some indigenous knowledge about richness of *T. diversifolia* in essential crop nutrients. However, they were not aware that *T. diversifolia* leaves, *T. diversifolia* tea or *T. diversifolia* composts could be supplemented with crop fields (Figure 1). Majority of the household heads (96%) indicated lack of knowledge of how rich *T. diversifolia* organic resources are despite having the *T. diversifolia* shrubs growing in abundance. Ignorance of how rich *T. diversifolia* organic resources negatively affected households' decision to use *T. diversifolia* organic resource in making composts; hence, the organic resource is underutilized in the study area despite the organic resource being found in abundance. *T. diversifolia* shrubs are found growing as hedges (Akanbi et al., 2007) in most dambo farm land commonly called 'Dimba'. Majority of the smallholder farmers still prefer to use fully grown *T. diversifolia* for domestic activities such as poles for drying burley tobacco and poles for constructing roofs for tobacco shades. Some households harvest fully grown *T. diversifolia* (woody *T. diversifolia*) for firewood that negatively affects carbon and nitrogen emissions. No farmer was identified supplementing his or her crop field with *T. diversifolia* compost or *T. diversifolia* tea or *T. diversifolia* biomass despite *T. diversifolia* growing in abundance in the area confirming smallholders farmers' lack knowledge of how rich *T. diversifolia* organic resource is.

Out of the twenty-three households that were aware that *T. diversifolia* is rich in nitrogen, six were female headed household (26%) and seventeen were male headed households (74%), indicating that male heads of

households were relatively more knowledgeable about richness of *T. diversifolia* organic resource. The difference could be explained by relatively higher education achievement of male members of the society in contrast to female members (Howley et al., 2012). More male members attained senior primary school education while majority of the female members were married off and dropped out of school before reaching standard five primary school such that majority of female members could hardly read or write. In addition, it was reported that majority of households members that attend extension services demonstration sessions were female members even though they were not heads. In some cases both husband and wives attend the extension demonstrations (personal communication, agricultural advisor). The finding increased likelihood of male households of the society of understanding and interpreting agricultural extension messages since they shared and discussed the acquired information with their spouses that further increased likelihood of meaningful learning of compost making related messages.

Farmers' knowledge of optimum blending composition of organic resources

Majority of the smallholder farmers (87.92%) were not aware that nitrogen rich organic resources such as soy bean clovers, groundnuts clovers and *T. diversifolia* are supposed to be blended with nitrogen poor organic resources such as maize stalks, grasses, millet chuffs and others in specific ratios to produce optimum composite ingredients for compost making as suggested by Mlangeni, 2013; WSU, 2010). Poor knowledge of

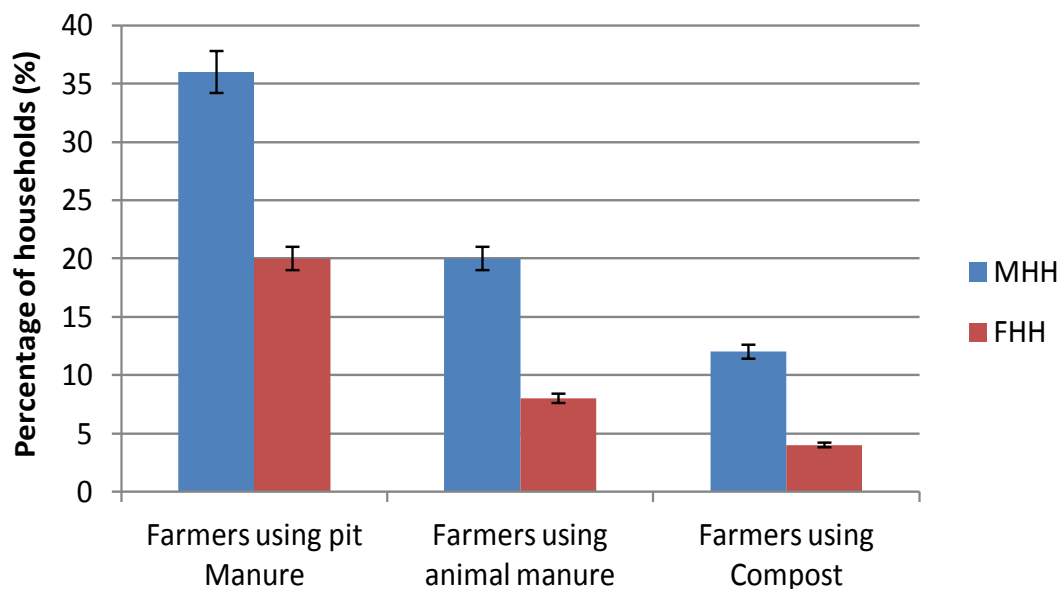


Figure 2. Variation of making and using composts among households (MHH = Male Headed Households, FHH = Female Headed Households).

qualities of organic resources for making composts was more pronounced and significant ($P < 0.01$, $\alpha = 0.05$) among all smallholder farmers. Thus, farmers' lack of knowledge or poor knowledge of qualities of organic resources negatively affected farmers' decision of making and using composts in their crop fields in the study area. They might have used such poor quality organic resources and never got the expected increase in crop yield in their fields. Poor quality resultant composts never gave immediate improvements in crop production. Lack of such knowledge is attributable to absence of effective extension services in the area. Farmers acknowledged having knowledge sharing crop husbandry practices, one by one maize planting, fumigation of maize, etc but denied having being taught "how to prepare chimato composts using maize stalks and *T. diversifolia*" using recommended ratios of 40:60, 50:50 or 60:40 (Mlangeni et al., 2013) which yield high quality compost. Even though, smallholder farmers were aware that groundnuts and soy bean clovers were rich in nitrogen, the most limiting soil nutrients in Malawi, such as clover are rarely used in making composts. They are usually grazed by free range livestock. Since free range livestock do not yield significant khola manure (Sakira, 2000), smallholder farmers seem not to utilise or maximise usage of groundnut and soy bean clovers nitrogen for soil enrichment. Therefore, smallholder farmers' ignorance about *T. diversifolia* soil nutrient richness further limits farmers' alternatives, hence use the usual low quality ingredients such as grass and maize stalks which yield poor and late maturing composts that fail to realise the expected increase in crop production.

Results have also shown that 97% of the smallholder

farmers lacked knowledge of the effects of chimato composts on soil PH, availability of soil nutrients and other chemical and physical properties of soil. Thus, compost was applied without knowledge of its buffering capacity. Smallholder farmers' decision to make and use *T. diversifolia* composts was negatively affected by limited knowledge of *T. diversifolia* composts soil buffering capacity ($\text{pH} > 8.0$) (Mlangeni et al., 2013) and limited knowledge of relatively high concentration of nitrogen (3.5% N), phosphorus (0.82% P) and potassium (3.92% K) (Jama et al., 2000; Olabode et al., 2007) of *T. diversifolia* shrub which could have been utilized in mitigating impacts of acidic soil conditions and declining soil nutrients on crop production.

Households that make and use compost by type and gender

As shown in Figure 2, among the few households that make and use manure and compost in the study area, sixty-eight percent were male headed households and thirty-two were female headed households. Further analysis showed that fifty-six percent, twenty-eight percent and sixteen percent made and used pit manure, khola (animal) manure and compost, respectively. Degree of adoption of making composts of any type was generally low on both MHH (12%) and FHH (4%). Making of compost, though using poor quality organic resources was significantly higher among male headed households ($P = 0.01$, $\alpha = 0.05$, wilcoxon) than those of female households. Low adoption rate among female headed households could be attributable to high levels of

vulnerability since majority of female headed households encountered in this study were either divorced women (50%) or widowed women (20%) or women caring sick and/or aged husbands (10%) which were more vulnerable to food insecurity, harsh economic hardships, general poverty, and other hardships. These factors and many others disadvantaged and prohibited female headed households from participating in long term household level development such as compost supplementation since they were probably too occupied with sorting recurring household food security problems in support of the findings by Howley et al. (2012), Hassan and Nhemachena (2008), Kipkemei et al. (2012) and Womiak (1984).

The relatively higher adoption rate observed among male headed households could be attributable to relatively low levels of households' vulnerability such as food security, household economic hardships etc, which free them to actively participate in long term household level development (Howley et al., 2012). Within the community, since male members of the households easily access finances (Womiak, 1984) through cash transfer programme, mostly male members also easily access significantly higher amounts of loans from village banks (commonly called Bank Mkhonde in Malawi) than female members. This further disadvantages female heads. In addition, mostly male members are generally accepted to hire ox carts or wagons to transport manure and composts to their fields on credit to be paid after sale of farm produce, a condition that increases likelihood of male headed households to easily adopt making and use of *T. diversifolia* composts. The loan and available oxcarts and wagons male headed households may provide male heads an opportunity to hire labour and transport *T. diversifolia* composts to the crop fields with minimal difficulties.

Furthermore, the task of transporting composts using oxcarts, wagons and wheel barrows is stereotyped for men whereas carrying the same on one's head is stereotyped for women. The gender stereotyping of compost transportation put female heads at a disadvantage thereby increasing vulnerability of female headed households (Hassan and Nhemachena, 2008; Howley et al., 2012). Hence, majority of male household heads are likely to afford supplement fields with *T. diversifolia* composts, if available.

The observed relatively high degree of adoption rate among male headed households could be explained by relatively higher literacy levels among men in the area of study (Muzari, 2012; Hassan and Nhemachena, 2008). Most male headed households (60%) were educated up to senior primary school (Standard 6 to 8), implying that they were advantaged to read and write the procedures and process involved in compost making; easily understood and assimilated principles of making compost from the extension officers; and used the principles later when preparing compost. Therefore, most male

household heads were able to translate the demonstration and theories into practice in their fields without problems to produce well-matured chimato composts.

As shown in Figure 1, majority of female households (78%) who did not adopt making and using compost in the study area possessed very low education (were educated up to or less than Standard 2). Therefore, the observed low adoption rate among female headed households could probably be attributed to low education levels of majority of the female households heads. Almost eight-seven percent of the female households' heads possessed no formal education or were educated up to Standard 2 and could hardly read or write. A similar study done by Aneani et al. (2014) and Womiak (1984) showed that low education levels negatively affected interpretation of recommendations and guidelines of modern technology. Therefore, poor education of women in the area might have impaired their perceptions and adoption of *T. diversifolia* compost making technology. The low adoption level among female headed households could also be attributed to nature of the job of making compost which is stereotyped for male members of the community. It is culturally perceived to be more laboring such that ordinary women resent themselves in taking such tasks. It was further observed that female headed households (14%) made and used composts hired men to prepare ingredients and construct compost piles at a cost, since this would require hiring cost in the case of vulnerable female headed households. Vulnerable households could not afford as they live below poverty line of 1US\$ a day. Therefore, the study results suggest that gender of household head played a significant role in adopting compost making and utilization in the study area.

Effect of education levels on compost making and use

As shown in Figure 3, number of households not making and using compost was inversely proportional to education levels of household heads and adoption of compost making was directly proportional to education levels of household heads up to senior primary beyond with a slight decrease in adoption. Thus, number of households not making and not using compost decreased with increase of education levels of household heads. On the other hand, number of households making and using composts increased with increase in education levels of household heads from lower primary school classes of Standard 1 to senior primary school classes of Standard 6 to 8. Households' heads without formal education or with primary school education of lower than Standard two were lowest adopters. The increase in adoption with increase of education is attributable to agriculture knowledge (Womiak, 1984; Kipkemei et al.,

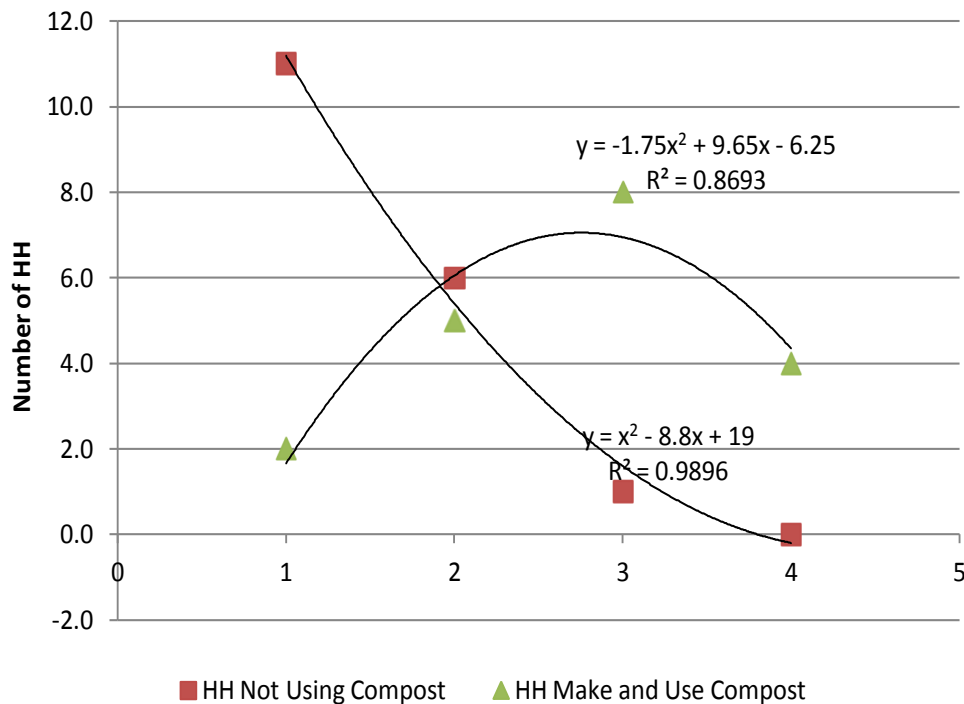


Figure 3. Use of compost and levels of education. (1-stands for Household Head with no formal education and with formal primary school education of lower than standard 2; 2- stands for Household Head with Primary school education of standard 3-5; 3- stands for Household Head with primary school education of standard 6-8; and 4- stands for Household Head with secondary school education).

2012) the households obtained at senior primary education. Thus, households that attained senior primary school agriculture education acquired deeper understanding of agricultural skills and practices and were more likely to appreciate the importance of adopting agricultural technologies such as compost supplementation, which supports the findings of Kipkemei et al. (2012) and Womiak (1984). On the other hand, the observed decrease in number of households adopting composting technology with increase of education levels of household head with lowest adoption levels observed whose household head with education of secondary education (Form 2) is attributed to same reasoning of acquiring good background understanding of agricultural practices at that level (Kipkemei et al., 2012; Womiak, 1984). The low adoption in household with poor education could be attributed to poor preparation to appreciate and accommodate such practices at an early stage hence attached less values to extension messages regarding the same. Thus, the study found a positive correlation between low education levels and low levels of adoption of making and using compost by households in Ming'ongo Extension Planning Area.

The findings confirm that an education level plays a vital role in adoption of technology. Households' heads that attained up to Standard eight of primary school education demonstrated satisfactory know how of how to

make chimato composts with minor departure from the standard procedure. on the contrary, household heads with lower than standard three of the primary school education demonstrated enormous erratic knowledge of how to make chimato compost and could not produce well matured compost. Others never appreciated that composts could improve soil fertility hence just ignored the technology. Education also plays significant role in the adoption of manure utilization as evidenced by the results of the research which is in agreement with the findings of Chinangwa (2006) and Muzari (2012). It is revealed that 83% of 22% (households that adopted making and using compost) studied up to senior primary school whereas 17% did not attend senior primary school. .

The number of households adopting making and using composts in their fields was observed to decrease as education of households heads exceeded senior primary school education (Standards 5 to 8). This indicates a negative correlation of education and adoption which is a departure from findings that education accelerates adoption of new technology. The findings could be explained by absence of adequate numbers of households in that category. Only three households whose heads possessed secondary school education whose living was not dependent on farming hence farming was not anything to invest in. Only one household was making and using compost while the

Table 1. Why households do not make composts.

S/No	Reasons for not making composts (N=240)	MHH	FHH	TT	%	RANK
1	Not aware that <i>Tithonia diversifolia</i> is rich in N and P	136	95	231	96	2
2	<i>Tithonia diversifolia</i> is not available	91	33	124	52	6
3	Extension officers never communicated that <i>Tithonia diversifolia</i> could be composted to produce nitrogen rich compost	152	82	234	98	1
4	Lack transport to carry <i>Tithonia diversifolia</i> to the farm/gardens	1	7	8	3	10
5	Use the available <i>Tithonia diversifolia</i> to feed animals	2	0	2	1	11
6	Compost making increase cost with no returns	115	55	170	71	5
7	Lack financial resources to source ingredients and make compost piles	19	60	79	33	8
8	Lack knowledge of preparing mature composts	165	31	196	82	4
9	It is labour intensive and could not manage to make <i>Tithonia diversifolia</i> composts	69	61	130	54	6
10	Shortage of materials to make well matured composts	21	3	24	10	9
11	Lack knowledge of positive effects of <i>Tithonia diversifolia</i> composts on soil pH, N and P)	165	65	230	95	3

Note: MHH = Male headed households, FHH = Female headed households and TH = Total households.

remaining two were not practicing farming which made households with heads of up to secondary school head to seem to lag behind in adopting making of making of compost. Reasons for not making compost were that 1) they were too occupied with other activities such that they could not afford to make compost, 2) they had no farm that required manure or compost application since soils in their fields were relatively nitrogen and in good condition and 3) they were not interested in compost application farming since it is labour intensive. The reasons could possibly be valid since they were working for an NGO that paid them healthy salary and life was smooth with taking substance farming as complementary source of living.

Education of the spouse or both positively correlated with both perception of compost application and the degree of adoption of a household. Households' heads whose spouses

possessed at least Standard 8 qualifications were outstanding farmers and ably articulated the importance of using compost, besides being limited in actual use. The p-value for spouse education indicated a more significant influence on the outcome with female spouses' education of at least Standard 6 of primary school ($P=0.015$, $\alpha=0.05$, Wilcoxon) male headed households. Impact of male spouse' education was not significant ($P=0.47$, $\alpha=0.05$, wilcoxon) in female headed households.

Effects of constraints on making and using well-matured composts

The other reason is that making and using composts is laborious culturally categorised as a masculine task that required men. As shown in Table 1, there are a number of constraints

affecting households to adopt compost making technology in mitole extension planning area, in Chikhwawa district. Majority of the households (47%) stated that that they do not use and apply ccomposts in their fields because the compost they apply does not offer the expected pompo-pompo benefits of improving soil fertility and producing high crop yields in the current season just as it is with chemical fertilizers. This could be attributed to immature state of compost they make that could not bring the expected pompo-pompo benefits. Smallholder farmers made immature composts because they lack knowledge of blending nitrogen rich and nitrogen poor ingredients; they only used low quality ingredients such as maize stalks and grass which usually yield immature and nutrient poor composts. Their knowledge of blending feedstock is limited and was not aware of using *T. diversifolia* as ingredient in making good composts. Others stated that they

could not make composts because, even they could make enough well-matured compost, they could fail to transport the composts to their fields due to lack means of transporting the compost to their fields. This suggests that the major problem is lack of transport not inability to make compost. About 33% of the households (of which 79% were female headed households; 21% were male headed households) cited lack of labour force to make compost for them as one hindrance to making compost. Female headed households lacked finances to hire out labourer to make compost and transport it to their fields. Ten percent of the households stated that they lack knowledge of how good compost is made. They tried to make compost before and it did not show any difference in plant growth. This implied the compost they made did not mature. The farmers suggested the need for training on feedstock and steps of how to make good compost including the importance and benefits of composting manure as well as its supplementation in crop production. Thus, household farmers should be sensitized to make and apply composts or composted manure to reduce fertilizer requirements in their fields.

CONCLUSION AND RECOMMENDATION

Majority of the household heads lack knowledge of richness of *T. diversifolia* organic resource despite having the *T. diversifolia* shrubs grow in abundance in the area. The study has also shown that adoption of making and using chimato compost is dependent on level of education and gender of household heads. Households whose heads possessed little or no formal education were characterized with low adoption rate of compost application. Lowest adoption rate was observed in households with double low education levels in which both the household head and his or her spouse had no formal education. Individuals with relatively better education become relatively better lead farmers likely to adopt new agricultural technologies. The research has also shown that inadequate household's labour force negatively affects making and transporting *T. diversifolia* compost to crop fields among aged farmers and female headed households since both compost making and transportation exercises are labor demanding processes. Hence, aged farmers and female headed house with no in-house labour force struggle to make and apply compost. Agriculture education should be encouraged in primary schools as it prepares those that drop out early for agriculture occupation. Furthermore, smallholder farmers should be trained on the benefits of supplementing their fields with well-matured compost by conducting on farm demonstrations, trainings, tours and field days concerning use of *T. diversifolia* composts.

Conflict of Interest

The authors have not declared any conflict of interest.

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