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Smallholder Farmer Innovation and Contexts in Maize-Based Conservation Agriculture Systems in Central Malawi

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Abstract

The increased threat of food insecurity and climate change requires more sustainable ways of agriculture intensification in African smallholder farming systems. Ample evidence confirms that maize-based conservation agriculture (CA) systems lead to increased soil health and yield enhancement yet their overall uptake remains low in Africa. An array of studies on challenges and solutions to CA systems conducted in southern Africa principally focussed on the views of scientists, often neglecting the views of CA farmers. Therefore, this study assessed farmer decision making, innovation and contexts during implementation of maize-based CA systems in communities of central Malawi. A survey involving interviews with 226 CA farmers was deployed, triangulated with key informants comprising extension workers and policy makers. The study showed that about 58% of smallholder farmers did not adapt CA practices to their circumstances because they were strictly following change agents' recommendations. The major challenge noted was competition for crop residues due to mice hunters and grazing livestock. Local by-laws initiated by the communities have started to privatise the crop residues and its grazing. However, other innovations were often not documented by extension workers, consequently neglecting more than half of the potential solutions provided by farmers. The establishments of a National Conservation Agriculture Task Force and CA guidelines are positive developments for coordination of stakeholders and harmonisation of CA messages in Malawi. However, for greater adoption, non-linear interaction and learning must be encouraged in practice by fully embracing innovative farmers and the voices of the pool of stakeholders with varying experiences.

Keywords: adapting, adoption, agricultural innovation system, conservation agriculture, innovation, decision making

1. Introduction

The increased threat of food insecurity, climate variability and change requires more sustainable ways of agriculture intensification in African smallholder farming systems (Pretty et al., 2011). For instance, 2011-2013 food security assessment revealed that the developed regions had 15 million hungry people (<5%) while the sub-Saharan Africa (SSA) region alone had about 223 million hungry people (21%) (Food & Agriculture Organisation [FAO], 2013a). Despite the agricultural sector directly accounting for 34% of gross domestic product (GDP) and 64% of employment in the SSA, it performs poorer than other regions largely due to climate change and unsustainable agricultural practices (Barrios et al., 2008; Juma, 2011; Pretty et al., 2011). Malawi has experienced climate change in the past and has projected average temperature increase of about 2.9 ℃ and declining variable in precipitation by 2050 which may lead to maize (*Zea mays* L.) yield decline of approximately 25% in some parts of the country under business as usual scenario (McSweeney et al., 2010; Cairns et al., 2012; Saka et al., 2013).

CA adapts to the negative effects of climate change (Thierfelder et al., 2017), may sequester soil carbon if systems are diversified (Powlson et al. 2016), reduces to a certain extent the emission of greenhouse gases (Kimaro et al. 2016), and halts soil degradation while improving agriculture productivity and income (Barungi &

Maonga, 2011; Thierfelder et al., 2013; Reicosky, 2015; Mupangwa et al., 2016; Thierfelder et al., 2016). CA is not only associated with the climate-smart agriculture (CSA) framework but also sustainable production intensification (Lal, 2015; Kassie et al., 2015; Ward et al., 2016). CA is defined by the three principles of continuous minimum soil disturbance, permanent organic soil cover and diversification of crop species grown in sequences and/or associations (FAO, 2015). The three basic principles are supported by other improved agriculture practices and technologies to enhance agronomic and economic benefits (Thierfelder et al., 2015a).

1.1 CA Development in Malawi

CA was not introduced in Malawi until the advent of the Sassakawa Global 2000 (SG 2000) in 1998 (Ito et al., 2007). The programme promoted the CA technology package combined with herbicides and high fertiliser doses thereby reporting increased maize yields of between triple or six times the conventional yield while improving soil fertility (Ito et al., 2007). Nonetheless, the increases in the maize yield were not directly linked to the CA technologies but to the high-input package (Thierfelder et al., 2015a). Previous studies questioned the approach of SG 2000 due to its lack of sustainability and farmer involvement (Thierfelder et al., 2013).

In 2004, collaborative efforts between the International Maize and Wheat Improvement Centre (CIMMYT) and the Research and Extension Departments of the Malawi Government reintroduced CA in some targeted communities around Mzimba, Dowa and Balaka (Thierfelder et al., 2015a). CIMMYT later expanded to other districts in collaboration with Total LandCare (TLC), a non-governmental organisation (NGO) (Bunderson et al., 2015). Currently, there are many stakeholders promoting CA mainly comprising players from the Ministry of Agriculture, Irrigation and Water Development (MoAIWD) and NGOs to the extent that National Conservation Agriculture Task Force (NCATF) has been formed to promote coordination and lesson sharing.

CA is being promoted in the country to address soil degradation, declining soil and crop productivity and the need to adapt to climate variability and change after noting that the conventional tillage is not sustainable (Wall, 2007; Thierfelder & Wall, 2011; Thierfelder et al., 2013; Reicosky, 2015; Thierfelder et al., 2015b). Since introduction, CA promotion has largely been on maize because it is the most important food security crop in Malawi, occupying about 80% of the land area under cultivation, covering over 90% of land under cereal production and accounting for more than 80% of the population’s caloric intake (Ngwira et al. 2012a; Kaczan et al., 2013; Edelman et al., 2015).

1.2 Benefits and Uptake of CA

Currently, literature informs numerous stories both positive and negative, about stakeholder experiences with CA. There is empirical bio-physical evidence on the benefits of maize-based CA systems in Malawi particularly on increased and stable maize yield, improvements in soil health and overall, reducing risk of crop failure in comparison to conventional tillage practices (Bunderson et al., 2007; Ngwira et al., 2011; Thierfelder & Wall, 2011; Ngwira et al., 2012a; Kaczan et al., 2013; Thierfelder et al., 2013; Wall et al., 2013; Ngwira et al., 2014a; Ngwira et al., 2014b ; Thierfelder et al., 2015b). The positive evidence on yield gains after two to five cropping seasons has been questioned by some scholars, who argue that increased yields under CA might be more related to the provision of agricultural inputs (fertilizer and herbicides) than the system per se (Giller et al., 2009; Andersson and Souza, 2014).

In conventional ridge tillage systems, many farmers associate soil fertility with only mineral fertilisation, ignoring the bio-physical aspect of soil fertility (Thierfelder & Wall, 2011). The destruction of the soil through tillage leads to the breakdown of soil aggregates, compacted layers, reduced water infiltration and soil water-holding capacity, reduced root growth, and increased water run-off and soil erosion (Thierfelder & Wall, 2011) although tillage might lead to temporary mobilization and mineralization of organic carbon, which may provide short term yield gains (Giller et al., 2009).

Retention of crop residues under CA is expected to increase soil carbon unlike the tillage-based cropping since residues are either destroyed or taken away from the field (Ngwira et al., 2012a; Corbeels et. al., 2013; Thierfelder et al., 2013; Wendt et al., 2013; Lal, 2015; Cheesman et al., 2016). Some studies have informed that CA sequesters 0.2-0.7 C per hectare per year (Kaczan et al., 2013; Powlson et al., 2016), however, cereal-based CA system need to be diversified enough to be able to measure carbon sequestration.

Not only has CA been reported to improve the soil aspect and yields but also profitability and income (Wall et al., 2013; Asfaw et al., 2014; Thierfelder et al., 2015a; Mupangwa et al., 2016; Thierfelder et al., 2016). Comparing CA maize systems with conventional tillage systems, studies conducted across the country reported that the former has less labour costs, has higher gross margins and lowers risk of crop failure (Ngwira et al., 2011; Ngwira et al. 2012a; Ngwira et al., 2013; Wall et al., 2013; Ngwira et al., 2014a; Thierfelder et al., 2016).

Despite the benefits, CA uptake in Africa is still low and has been slower than in other regions (Derpsch et al., 2010; Kassam et al., 2014). As of 2014, worldwide CA adoption was approximately 155 million hectares (ha), about 11% of arable land. However, Africa had only 1.2 million ha under CA, about 0.8% of global total area under CA and 0.9% of total arable land on the continent (Kassam et al., 2014). Largest adoption is found in South America with 64 million ha translating to 60% of arable land area and 41% of global total (Kassam et al., 2014). The trend globally is that arable land under CA is rising at approximately 10 million ha per year. In Africa, it was 368 000 ha in 2008, 1.1 million ha in 2010 and 1.2 million ha in 2014 (Derpsch & Friedrich, 2009; Kassam et al., 2014).

Malawi had appreciable CA uptake in the last decade. It had 70 000 ha under CA in 2014, representing 2.8% of its total arable land (Kassam et al., 2014). In the same year, South Africa was the highest on the continent with 400 000 ha, representing 2.5% of its arable land (Figure 1). National uptake of CA practice is estimated to be below 2% of Malawian smallholder farmers (Phiri et al., 2012; Dougill et al., 2017).

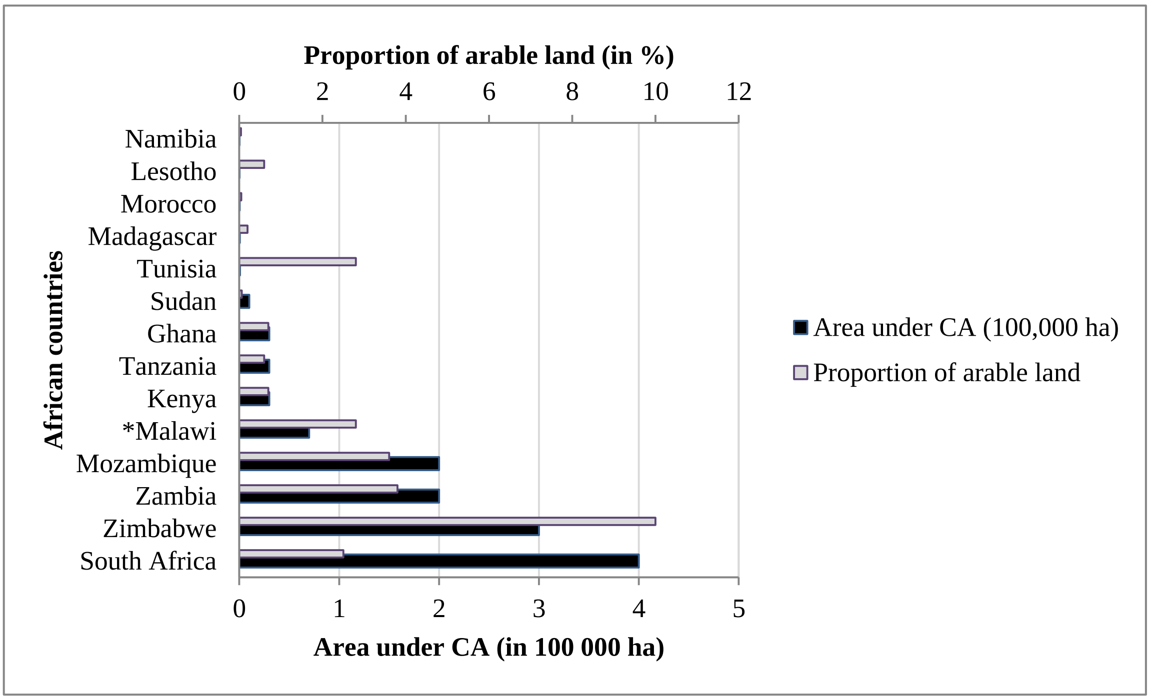

Figure 1. Adoption of CA in Africa (Kassam et al., 2014:8)

The variant figures from sub-Saharan Africa generally show very low adoption. According to Andersson and Souza (2014), adoption of the CA is overestimated in the southern Africa context because of different definitions across the region and the commonly reductionist embracing of the system as just minimum tillage or mulching. Furthermore, as noted by Giller et al. (2009), the methodologies used for assessment of CA adoption are weak since they concentrate on the beneficiaries of CA discrete interventions whose adoption is temporal and often incentivised by free inputs.

In the quest to better understand barriers and factors contributing to slow adoption and to offer solutions, a wide range of studies have been conducted in the SSA (Giller et al., 2009; Thierfelder & Wall, 2011; Baudron et al., 2013; Kaczan et al., 2013; Wall et al., 2013; Andersson and Souza, 2014; Ngwira et al., 2014a; Thierfelder et al., 2015a). Particularly, Baudron et al. (2013) acknowledged that crop residues trade-offs between livestock feeding and soil mulching is a major cause of the low and slow adoption in SSA yet mulching is considered a precursor to CA implementation. The experts agree that increasing crop productivity also increases crop residues to cater for both competing demands (Thierfelder & Wall, 2011; Baudron et al., 2013) otherwise territorial arrangements and by-laws over-riding free grazing may support better crop residue management (Corbeels et al., 2013). Other challenges observed in CA systems include: a) labour for weeding is expensive for resource poor farmers who cannot afford herbicides especially in the first years; b) the temporal need for more nitrogen in the first years of conversion due to slow organic matter decomposition and temporal nitrogen immobilisation; c) waterlogging in high rainfall areas; d) inadequate residues in very dry areas; e) land insecurity leading to unwillingness to invest in the CA; f) shifting of CA labour to women; g) lack of good markets for input purchase and sale of produce; h) tradition, believes and communal peer pressure (Wall, 2007; Thierfelder & Wall, 2011; Corbeels et al., 2013; Thierfelder et al., 2015b).

The larger part of the solution to these challenges seems to highlight the fact that CA is knowledge-intensive and that it requires changes in behaviours and mind-set besides a strong capacity in problem-solving amongst farmers, extension agents, researchers and other stakeholders if benefits are to be fully experienced (Wall, 2007). Furthermore, the adoption of a new technology does not happen overnight and requires a number of years of experimentation by and with the farmer until he/she starts to take it up (Bunderson, et al., 2015). Explicitly, the initial CA challenges can be overcome over time (Bolliger et al., 2006). For instance, long-term results from CA fields in Brasil showed that after 20 years of implementation, the maize fertiliser application rate was reduced by 50% while increasing the yield by 50% (Derpsch, 2005).

There is recognition that as much as CA principles are universal in their application, the implementation of the actual technologies are site and farmer-circumstance specific requiring more innovative ways of promotion than the linear extension approach used to disseminate component technologies such as crop varieties or a new type of fertilizer (Ekboir, 2002; Wall, 2007; FAO, 2013b; Thierfelder et al., 2016). Hence, it is proposed that multi-agent innovation networks should be used to extend CA systems in which complex interactions happen therein; innovative farmers, extension agents, researchers and other relevant stakeholders all work together to adjust the CA systems to the local environment and circumstances (Thierfelder & Wall, 2011).

1.3 Whose Perspective is Vocal on CA?

The foregoing section summarises literature that tried to delineate adoption, the context of CA implementation in Malawi and prescribing suggestions as solutions to overcome barriers of adoption from the perspective of CA scientists and experts. However, what remained unknown was what the CA challenges and solutions were from the perspective of the implementing farmer i.e. what do farmers consider as challenges, and are they adapting the system to their needs during adoption? How are they innovating to avoid, control or mitigate the challenges? What support (or the absence of it) do they get in the rural areas? It is important to assess innovation of the CA farmers and understand how they are enhanced or discouraged by the institutional environment. The voices of farmers should matter because it is reported that growth of CA in Americas, the highest in the world, was led by innovative farmers in 1970s (e.g. this is commonly referred to as “bottom-up” development). This attracted other stakeholders including fellow farmers, extension agents, researchers, machine manufacturers and input suppliers (Wall, 2007). It appears that CA promotion has been led by development experts and researchers, particularly in the eastern and southern Africa where the approach was introduced without adapting the practices (e.g. commonly referred to as “top-down” development approach) (Wall et al., 2013).

This study consequently argues that ignoring farmer voices on innovations for coping with CA challenges could be one of the reasons for the seemingly low adoption (Bragdon & Smith, 2015). The research is unique because it employed a positive approach to studying the challenges and local solutions of the CA systems and their extension, recognising the value of innovations and solutions that farmers are employing locally and which they perceive as right. This notion is consistent with the perspective enshrined in the agricultural innovation system (Spielman, 2005; Anandajayasekeram, 2011; Brooks and Loevinsohn, 2011). The purpose of the study was to provide information on where we are in promoting farmer CA innovations, matching farmer and scientist perceptive and demonstrate what is being missed by not pragmatically integrating them in the agricultural innovation system, and recommend scalable farmer innovations. Ultimately, the research was envisaged to encourage development of virtual innovation networks and systems.

The underlying objective of the study was therefore to assess farmer innovation and contexts during adoption and implementation of maize-based CA systems in central Malawi. Specific to this study was: a) to find out the proportion of farmers that modify CA practices within defined CA principles during the adoption process; b) to establish perceptions of farmers on the extent of benefit from the modification of the CA system practices; c) to identify CA challenges and innovations/solutions developed by the farmers against them; d) to identify pathways for sharing the local CA innovations; and e) to assess the environment for supporting development and nurturing of farmer CA innovations.

2. Methodology

2.1 Conceptual Framework

The study was founded on the agricultural innovations system (AIS) defined as a set of interrelated agents focussing on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect their behaviour and performance (Spielman, 2005; World Bank, 2006). Innovations emerge out of the interactions (cooperation, competition and learning) from within the group of actors (Brooks and Loevinsohn, 2011). The AIS is a shift from the highly linear national agriculture research system (NARS) and its upgrade, the agricultural knowledge and information system (AKIS) in the 1990s, that focused on linear links between research supply, education, extension and identifying farmer demand driven technologies while AIS adds interaction and application of innovations (World Bank, 2006; Anandajayasekeram, 2011; Brooks and Loevinsohn, 2011). The AIS perspective analyses actors (their motives and behaviour), how institutions shape the behaviour and motives, joint/complementary innovations and the dynamics of institutional learning and change. There is a wide spectrum of analytic dimensions with respect to AIS such as spatial (local, national, regional economic, geopolitical units etc.); sectoral; technological; material and many others (Spielman, 2005). The use of this approach, which also employs agrarian agents such as farmers and rural communities as not only users of knowledge but also, co-developers and diffusers, can help identify and analyse new ways of encouraging innovation because it has the ability to analyse processes often overlooked in the linear research and development approach (Spielman, 2005).

An AIS approach is operationalized in the CA promotion by the multi-agent/stakeholder innovation network framework as recommended by Thierfelder & Wall (2011) and Corbeels et al. (2013). The experts underlined that CA systems are more complex than the simple component technologies (e.g. seed and fertilizer) since the former involve multiple new aspects of the cropping systems. Thus, its successful promotion requires multi-agent interaction where particularly, smallholders appear in the network as innovative farmers (Ekboir, 2002; Thierfelder & Wall, 2011). As seen from Figure 2 representing the framework, farmers appear at the centre of the interaction as hosts of the technologies, co-developers and innovators, not passive recipients. This study largely looked at the farmer inclusiveness in the AIS at the subnational level by accounting for the level of farmer innovative behaviour, the concrete innovations and the institutions (World Bank, 2006; Brooks and Loevinsohn, 2011). In order to understand the environment of the farmer innovation, the study also extended its interest to extension workers in the study areas who were supposed to engage with researchers working in the area. However, researchers were reported to not working directly in the area on CA systems at the time of the research. Private sector actors were not prominent as far as the objectives of the study were concerned. Therefore, the study engaged a national CA policy maker who would provide a general picture of CA at national level including responsiveness of the researchers and private sector to farmer innovation.

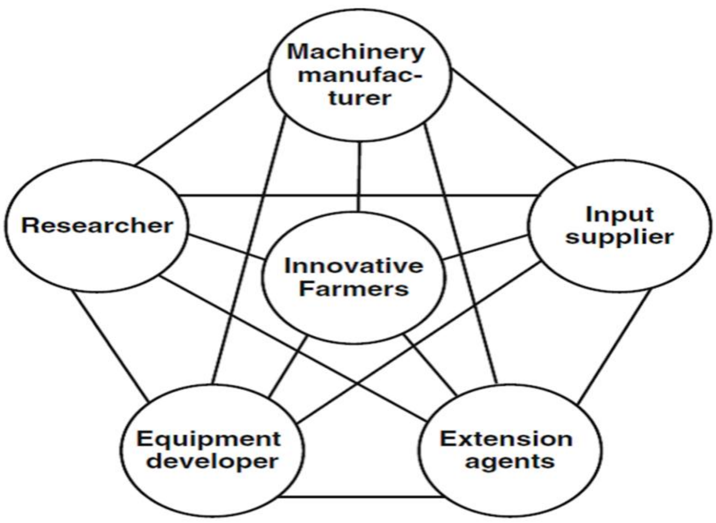

Figure 2. A representation of agricultural innovation network (Thierfelder & Wall, 2011:1275)

2.2 Study Area

Field data collection was conducted from the 11th to 17th of December, 2015 in central Malawi; the region where the dominant crop is maize, contributing over 55% to the country's food supply system (Edelman et al., 2015). Two Extension Planning Areas (EPAs), Chibvala and Chiwamba in Dowa and Lilongwe respectively, were purposefully selected from where the government and Trustees for Agricultural Promotion Programme (TAPP), a local non-governmental organisation (NGO), had been promoting the CA approach since 2006. Purposefully selected respondents were drawn from the selected EPAs. It was noted during data collection that some of the farmers from which the sample was drawn in Chibvala had also been working with Total LandCare (TLC). Thus, this area of study provided CA farmers who were varied and experienced enough to discuss challenges and innovations of the CA.

Maize is the major food crop grown in the area. Other crops include sweet potatoes (*Ipomea batatas* L.), cowpeas (*Vigna unguiculata* L. Walp.), pigeon peas (*Cajanus cajan* L. Millsp), and cassava (*Manihot escuelenta* Crantz). Tobacco (*Nicotiana tabacum* L.) is the most important cash crop with others being groundnuts (*Arachis hypogaea* L.) and soybean (*Glycine max* (L) Merr). Both study areas experience rainfall between 800 to 1000 mm, with Dowa having an average of approximately 900 mm and Lilongwe 860 mm annually. Both areas have generally ferric *Luvisols* which are soil types, characterised by tops soils with a sandy clay loam and clay topsoil texture. The *Luvisols* in the area are with *Lithosols* in Dowa. Farmers in the area have mostly crop-livestock mixed farming systems which combined in extensive system (Chintsanya et al., 2004). Common livestock, although not reared in large numbers, include mostly chickens and goats and to a lesser extent, cattle and pigs.

2.3 Data Collection Methods, Sampling and Data Analysis

Using a pre-tested semi-structured questionnaire, a survey was conducted with the help of trained enumerators to collect quantitative data by facilitating face to face individual interviews with 226 CA farmers (sample size was determined at 95% confidence level with a margin of error of 6%) drawn from a population of 10 000 CA farmers. All questions of the survey questionnaire were structured but the questions on challenges and innovations were left open ended to capture actual perspectives of the farmers as the core of the study. A survey research method is appropriate when the study involves collection of primary data from a large number of people (MacDonald & Headlam, 2008). It is the most economical method, crucial for measuring unobservable data and allows for execution of a wide range of statistical analysis (Bhattacherje, 2012). To ensure triangulation and collection of more details, the survey was augmented with ten key informant interviews (KIIs) consisting of extension workers, policy makers and experts on CA from government and the NGO sector, an approach also used by Ngwira et al. (2014b). The combination of both quantitative and qualitative data collection methods is gaining ground because it enhances validity of findings when combined with appropriate instrument development and training of enumerators (Kuma, 2011).

To ensure external validity, multistage (two stages) sampling procedure comprising simple random selection and cluster sampling (Kumar, 2011; Bhattacherje, 2012) was employed to select the 226 CA farmers. While simple random selection ensures that every unit in a population has an equal chance of being included in a survey sample for representativeness and generalisation, cluster sampling achieves the same, apart from being more cost-effective in achieving probability sampling when the area is relatively large (Kumar, 2011; Bhattacherje, 2012).

The first stage of the procedure involved simple random selection of 16 clusters or sections (a section is a sub-division of an EPA) from the EPAs using the fishbowl draw method. In the fishbowl method of drawing random sample, all the slips or pieces of names of sections were put into a box, mixed and picked out one by one without looking, until the number of slips selected equalled 16 (Kumar, 2011). The second stage then involved simple random sampling procedure with Probability Proportionate to Population Size (PPPS) to select, without bias, 226 interviewees for the study from the 16 sampled sections within the EPAs. Following the procedure, Chibvala contributed 130 farmers while Chiwamba contributed 96 farmers (Table 1). Furthermore, in a purposeful manner (non-probability sampling), interviews with a total of ten policy and technical staff KIIs were conducted to support the quantitative data from the structured interviews. Data were analysed using the Statistical Package for Social Scientists (SPSS), version 20 and Excel, which are widely used packages for data summarising and statistical analysis (MacDonald & Headlam, 2008). Variables were described based on the descriptive statistics namely frequency counts, percentages and graphs, an approach also employed by Ribeiro (2017).

Table 1. Sample size distribution across the districts and clusters

Dowa (Chibvala EPA)		Lilongwe (Chiwamba EPA)	
Section (Clusters)	**CA farmers**	**Section (Clusters)**	**CA farmers**
Chadza	12	Chibvundula	10
Chibvala Central	12	Malemia	10
Chibvala North	14	Gwazamaya A	12
Chibvala South	14	Gwazamaya B	28
Chitunda	12	Mkhupa	36
Funsani	14	-	-
Makande	4	-	-
Manondo	12	-	-
Mtengowanthenga	12	-	-
Sanjiko	12	-	-
Zidunge	12	-	-
TOTAL	**130**		**96**

3. Results

3.1 Respondent Demographical Characteristics

Demographic characteristics are displayed in Table 2. The sample comprised 52.2% females and 47.8% males. The average age was 42.6. Majority of the respondents (85.8%) were married while the minority were single (8%). Majority of the respondents were farmers that produced for both consumption and sale (69.9%) followed by those that produced for consumption only (around 27.4%). Most of the respondents (65%) had attended primary school of which about 35% had completed the primary school level. The average household size was 5.2 (Table 2).

Table 2. Demographics of the respondents

Demographics	**Dowa (N=130)**	**Lilongwe (N=96)**	**Total (N=226)**
Sex	51.5%M; 48.5%F	42.7%M; 57.3.%F	47.8%M; 52.2%F
Mean age	42.9	42.2	42.6
Marital status			
Married	90.8%	79.2%	85.8%
Widowed	4.6%	4.2%	4.4%
Divorced	3.1%	0.0%	1.8%
Single	1.5%	16.7%	8%
Education level			
Never went to school	13.8%	12.5%	13.3%
Informal schooling only	0.0%	2.1%	0.9%
Some primary schooling	20.0%	43.8%	30.1%
Primary school completed	44.6%	20.8%	34.5%
Some secondary/high schooling	10.8	8.3	9.7%
Secondary/high school completed	10.8%	12.5%	11.5%
Main occupation			
Farmer (home consumption only)	18.5%	39.6%	27.4%
Farmer (both home consumption and for sale)	80.0%	56.2%	69.9%
Farmer (produces mainly for sale)	0.0%	4.2%	2.8%
Supervisor/Foreman	1.5%	0.0	0.9%
Mean household size	5.4	5.6	5.2

3.2 Extent of Practice of CA

The farmers had been practicing CA for an average of three years. They possessed an average farm land of about 1.2 ha per farmer of which 0.3 ha was under CA in the 2015/2016 growing season, translating to approximately 25% of the total arable land area of the respondents. Chiwamba had slightly larger extent of CA adoption than Chibvala (30.7% and 27.2%, respectively).

3.3 Decision to Modify CA during Adoption

Modifying a pre-defined practice is one of the innovations (Rogers, 1998). In the process of adoption, 42.5% of farmers decided to modify CA practices to suit their farming environment while 57.5% never did. The reasons for modifying the practices were; to suit their farming environment/circumstances (79.2%) and that they did not have enough recommended inputs for CA (20.8%) (Figure 3). Key informant interviews (KIIs) with experts indicated that farmers are rational decision makers and tend to respond to the environment; for instance, the experts observed that a number of farmers spread mulch sparsely under waterlogged conditions in the field and maintain their recommended cover when water moisture is normal. Instead of using maize stalks for mulching as taught by the change agents, some farmers used grass from their houses' roofs or vetiver grass (*Chrysopogon zizanioides* (L.) Nash) planted as erosion control in the undulating land areas. The experts also supported the idea that the guiding principles of CA are to be observed but complementary practices may be changed to enhance the benefits of CA.

The majority of the sample did not modify the practices (Figure 3) and principally indicated to just following CA recommendations (61.5%), followed by those who indicated that there is no need to change CA practices because they are just fine (32.3%) and those that wanted to observe its performance first (4.6%). KIIs with extension workers pointed out that farmers in the area normally do not modify CA practices because they are confined to recommendations learnt during trainings at start. In some instances, farmers assess its performance first and adapt it later at least after the first growing season whenever a challenge occurs or the implementation of a project has stopped.

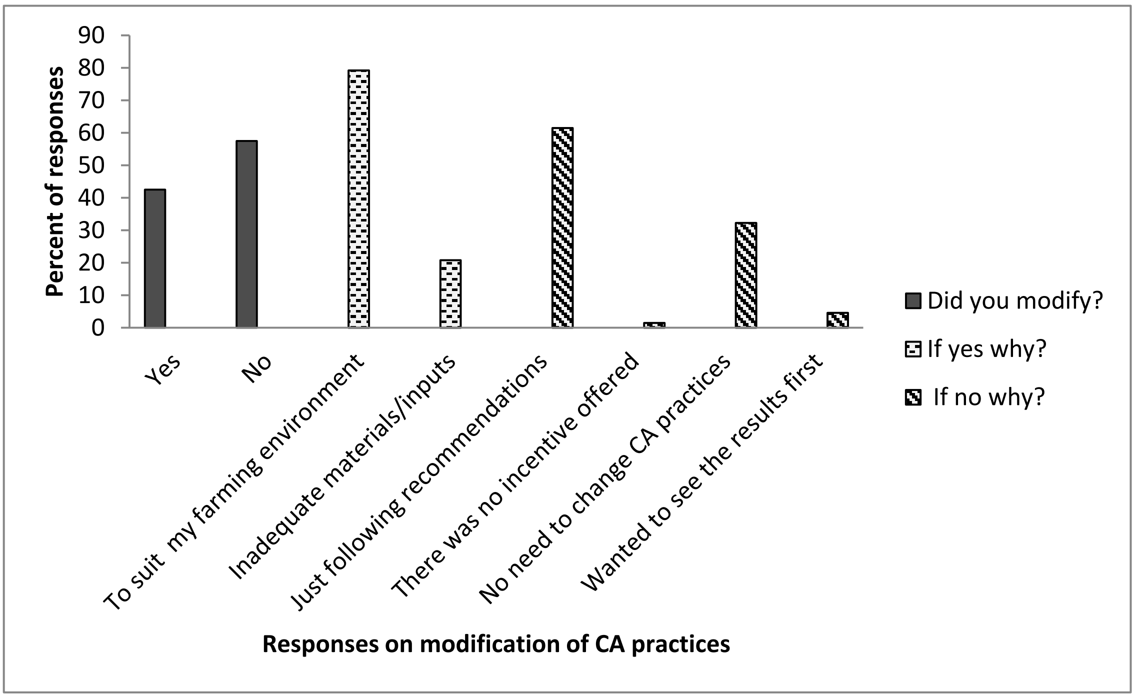

Figure 3. Modification of CA during adoption (N=226)

3.4 Perspective of Farmers on the Extent of Benefit of CA Modification

About 67% of those that modified the practices claimed that it was 'very beneficial' to their farming system followed by 27% who thought it was 'fairly beneficial' (Figure 4).

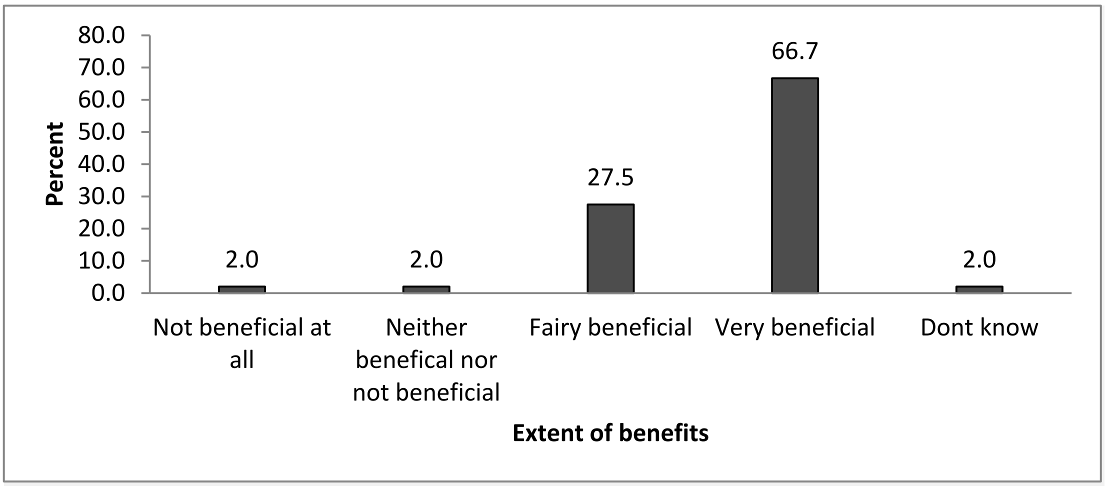

Figure 4. Extent of benefit from CA modification (N=102)

Thirty-seven percent of respondents thought that CA modification contributed to the enhancement of maize crop yields (Table 3). Other mentioned perspectives indicated that modification contributed to the following: a) reduced farming cost when farmers used alternatives to fertilisers (19.8%); b) improved soil fertility when compost manure and legumes were applied and planted respectively (18.5%); and c) improved soil and water conservation (17.3%).

Table 3. Perspective of CA farmers on CA modification benefits

Benefits of CA modification	Responses (Multiple responses)	
	N	**Percent**
Increase crop yields	60	37.0
Reduce farming cost	32	19.8
Conserved soil and water	28	17.3
Reduce fungal diseases	10	6.2
Ease of farming enhanced	2	1.2
Total	**162**	**100.0**

3.5 Challenges and Local Solutions

The majority of farmers (85%) indicated to face challenges with CA (Table 4). The challenges mostly mentioned were: a) burning and destruction of mulching materials by mice hunters (75% of farmers); b) livestock grazing on and destruction of mulch (55.5%); c) limited access to recommended agro-inputs such as herbicides, certified seeds and fertiliser (22.1%); d) water-logging in planting pits causing fungal diseases and maize blight (21.2%); e) inadequate amounts of mulching material available (20.2%); f) enhancement of pests such as stalk borer & white grubs (larvae of *Phyllophaga* ssp. and *Heteronychus* spp.) (20.2%); g) theft of maize stalks which are used as fuel for cooking (15.4%); and h) CA activities are laborious & costly (13.5%) (Table 4). Most of the challenges mentioned by significant number of farmers were also mentioned by the experts indicating that they are notable problems of the CA system and its implementation in Malawi. However, the experts knew less than what farmers reported.

Table 4. CA challenges as indicated by respondents

CA Challenges (Post implementation)	
Views from CA farmers	**Related observations from KIs (experts)**
Burning and destroying of mulch (75% of cases). The common type of mulch is maize stalks that are burned by mice hunters. Furthermore, bush fires also affect mulch	Mice hunters cause fire and also widen pits when digging the for the mice
Livestock grazing on and destroying mulch (55.8%)	There is a competition for mulch (maize stalks) between livestock and CA. For instance, livestock of fellow farmers graze on mulch.
Limited access to recommended agro-inputs (e.g. herbicides, certified seeds & fertiliser) undermining potential CA benefits (22.1%)	Weeding increases the cost of CA in the first years if a farmer cannot afford herbicides mainly due to high demand for casual labour.
Water-logging in planting basins cause fungal diseases and maize blight (21.2%)	Maize is not growing very well especially under water logged conditions
Inadequate quantities of mulch (20.2%). The popular mulching material is maize stalks	There is scarcity of maize stalks coupled with competition with livestock and its other alternative uses
Enhancement of pests such as stalk borer & white grubs (20.2%) on CA fields	CA is associated with pests like white grubs (i.e. the larvae of the black maize beetle, *Phyllophaga* ssp. and *Heteronychus* spp.) which attack late planted maize
Theft of maize stalks to be used as fuel for cooking (15.4%)	Some women steal maize stalks from farms to be used as fuel for cooking because of lack of firewood
CA activities are laborious & costly (13.5%)	CA is laborious with poor planning. Mulching, digging, (if planting basins are used) and weeding demand much labour especially in the early years of adoption
Mulch attracting termites in the field (7.7%)	Not mentioned
Mice hiding under mulch and destroying crops (6.7%)	Maize is eaten by rodents such as mice which enjoy the mulching environment
Limited knowledge & skills (6.7%). The farmers indicted to be in need of regular interaction with extension workers.	There is limited mobility of extension workers. The government extension workers who are more common than NGO field coordinators lack resources for instance: use own salaries to pay transport to do an extension activity.
Lack of transport for ferrying bulky manure to farms (3.8%).	Not mentioned
Snakes and sharp objects under mulch threaten or injure farmers (2.9%)	Not mentioned
Poor germination percentage (1.9%).	There is low maize seed germination because rodents eat the seeds
No protective clothing when spraying herbicides (1.9%)	Not mentioned
Pressure from fellow farmers to dis-adopt CA (1.9%)	Not mentioned
Lack of mental power to contribute thoughts on CA (1%)	Not mentioned
Limited land (1%)	Not mentioned
Cricket hunters till & widen planting basins (1%)	Not mentioned
Untilled soil becomes hardened (1%)	Not mentioned

It was also noted that CA farmers are developing local solutions to most of the aforementioned challenges (Table 5). As highlighted, the major challenge of CA adoption is communal free grazing rights and utilisation of crop residues, a common practice in SSA (Valbuena et al., 2012). The most mentioned solution (44.7%) was the privatisation of the mulch through by-laws by the local authorities (e.g. chiefs) whereby every community member is to respect the CA farmers' field groundcover. The by-laws illegalise: a) the fire outbreaks caused by mice hunters or general bush fires; b) cricket hunters; c) theft of mulch; and d) grazing one's livestock on other people's CA farms. If one is caught, he/she is asked to replace the mulch or even pay a fine depending on situation. Another solution being used is early collection and storing of maize stalks at home or under a tree to avoid damage by livestock, fire or termites and returning them later when the rainy season has stopped (25.5%).

Table 5. Innovations/solutions against CA challenges

Innovations/solutions	
Views from CA farmers	**Related observations from KIs**
Development and enforcement of by-laws (47.7%)	Chiefs enforce by-laws developed by communities following sensitization
Early collection and storing maize stalks at home or under a tree to avoid damage by livestock, fire or termites and returning them later (25.5%)	Early collection of mulching material for safe keeping under a tree or home
Manure application to compensate lack of fertilizer (21.3%)	Apply manure
Buying or collecting residues from fellow farmers or finding alternative organic cover to mitigate scarcity of residues (18.1%)	Use grass used for roofing houses including vetiver grass (*Chrysopogon zizanioides*)
Guarding for maize stalks in field against theft and fire outbreaks (17.0%)	Some farmer put charms in his farm to scarce away intruders. Whosoever sees fire outbreak should put it off or risk being be suspected to have caused it. Establish firebreaks
Removing mulch around planting basins to control waterlogged condition (11.7%)	Remove mulch surrounding the maize for proper drainage in high rainfall times
Follow recommended cultural practices such as early planting to control stalk borer, white grub etc (8.5%)	Apply manure early and timely planting to control stalk borer
Advising the owner to watch over their livestock (8.5%)	Not mentioned
Early land preparation against laboriousness and scarcity of materials (8.5%)	Proper planning, buy wheelbarrow/ox-cart in clubs for ferrying manure
Relying on farmer to farmer extension against lack of adequate extension support (5.3%)	Not mentioned
Getting support from friends to ease labour intensive digging of planting basins (4.3%)	Not mentioned
Setting up traps such as maize bran to control mice (4.3%)	Apply maize bran to control mice
Putting on farmer shoes to be protected from sharp remains of cut stalks and snakes (3.2%)	Not mentioned
Apply soil/sand on the apex of maize plant to suffocate stalk borer (3.2%)	Not mentioned
Planting resistant varieties to control pests & diseases (2.1%)	
Applying dried fish soup to control termites attacked by maize stalks (2.1%)	Not mentioned
Do casual labour to raise capital for herbicides and chemical fertilizers (2.1%)	Not mentioned
Plenty of crop residues (2.1%)	Not mentioned
Making manure at the farm to reduce transport costs (1.1%)	Not mentioned
Buying an oxy-cart at club level for ferrying bulky manure (1.1%)	Not mentioned
Use of herbicides to control weeds (1.1%)	Not mentioned
Planting local maize due to lack of hybrid (1.1%)	Not mentioned
Establishing firebreaks (1.1%)	Not mentioned
Plant *Euphorbia tirucalli* (or milk bush/pencil tree/Indian tree spurge or locally called *nkhadze) to* repel termites (1.1%)	Not mentioned
Apply pounded and soaked *Tephrosia vogelii* leaves to control termites (1.1%)	Not mentioned
Borrowing wheelbarrows for ferrying manure (1.1%)	Not mentioned
Sowing more maize for replanting against poor seed germination attributed to maize stalk mulch (1.1%)	Not mentioned
Ignore detractors/laggards of CA adoption (1.1%)	Not mentioned
Change sites for tilling pit planting to reduce hardening of untilled areas (1.1%)	Not mentioned

3.6 Pathways for Sharing the Local CA Innovations

Follow up questions were made to understand the dissemination of the local innovations. Nearly 96% shared the innovations whether at adoption or post adoption stage (Figure 5). The four percent of farmers that did not share the innovations gave the following reasons: 'I cannot explain CA system to someone else in the way an extension agent does'; 'fellow farmers are not interested'; 'there is lack of an appropriate forum for dissemination', 'I am in my second year of practice hence know very little to share'; 'I feared questions'; and 'it is not beneficial to share'.

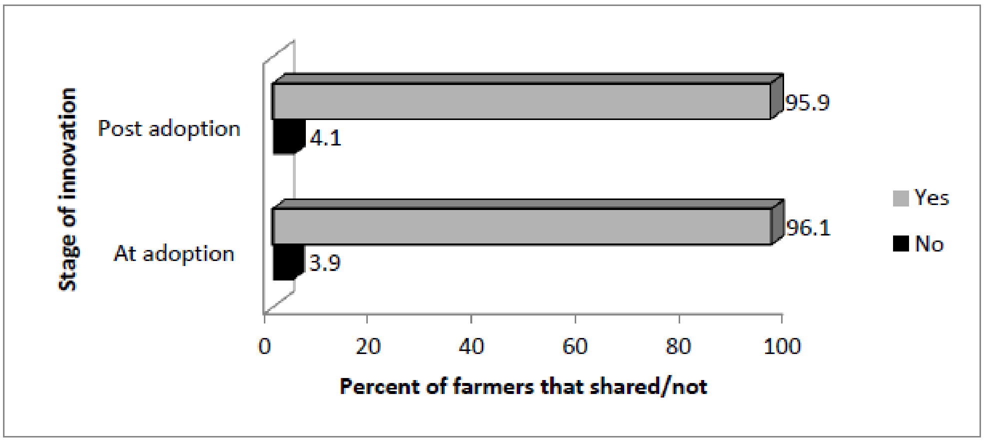

Figure 5. Sharing of innovations (N=226)

The majority of the farmers (90.2%) shared or discussed the local innovations with fellow farmers followed by slightly above quarter (26.1%) that shared to government extension workers. Nearly 21% and 14% shared to NGO extension workers and lead farmers respectively (Table 6).

Table 6. To whom were CA innovations shared to?

Category	Responses N	Percent of Cases (multiple responses)
Fellow farmer	166	90.2
Government extension worker	48	26.1
NGO extension worker	38	20.7
Lead farmer	26	14.1
Relatives	2	1.1

Furthermore, the formal presence of forums for disseminating the innovations was also looked at (Figure 6). Approximately 96% indicated the presence of forums in their communities. The most mentioned forum was the field day (31.7%) followed by an ordinary farmer group/club (27.9%) and then agriculture show (26.9%). In addition, KIIs indicated presence of the platforms as follows: a) market places through a plant clinic extension approach; b) during farmer meetings; c) during follow-ups and farmer visits; and d) during trainings. In a plant clinic approach, extension workers are trained to diagnose pests and plant diseases and to recommend solutions to farmers who take an initiative to approach them.

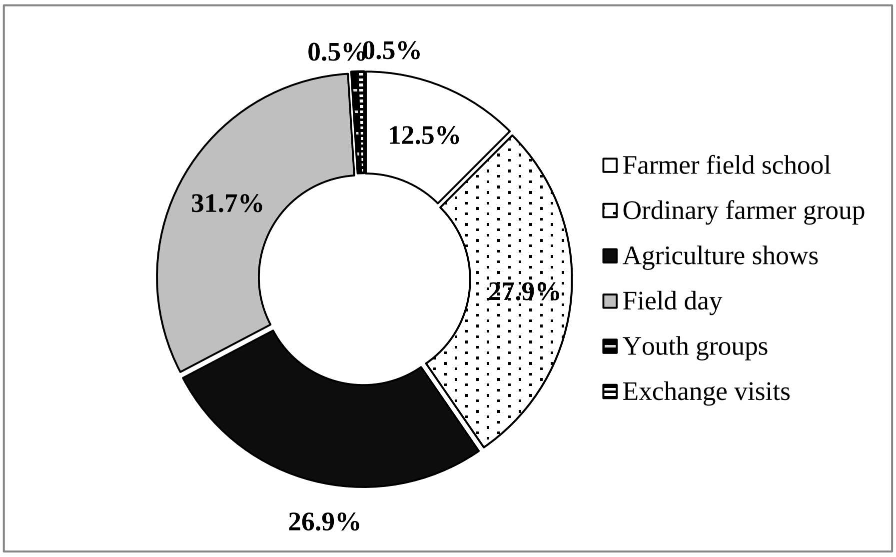

Figure 6. Forums for disseminating innovations (N=226)

3.7 Environment for CA Innovations (Institutions)

As noted from results on innovations, by-laws remains the most prevalent (over 90%) traditional institution (norm) regulating the biggest problem of communal grazing and rights of way in the study area. The study further looked at the context in which the agrarian agents share innovations. About 35% and 32% of the responses from the CA farmers indicated that when they shared CA solutions to fellow farmers, they tried and adopted them respectively (Figure 7). Very few discouraged them (5%).

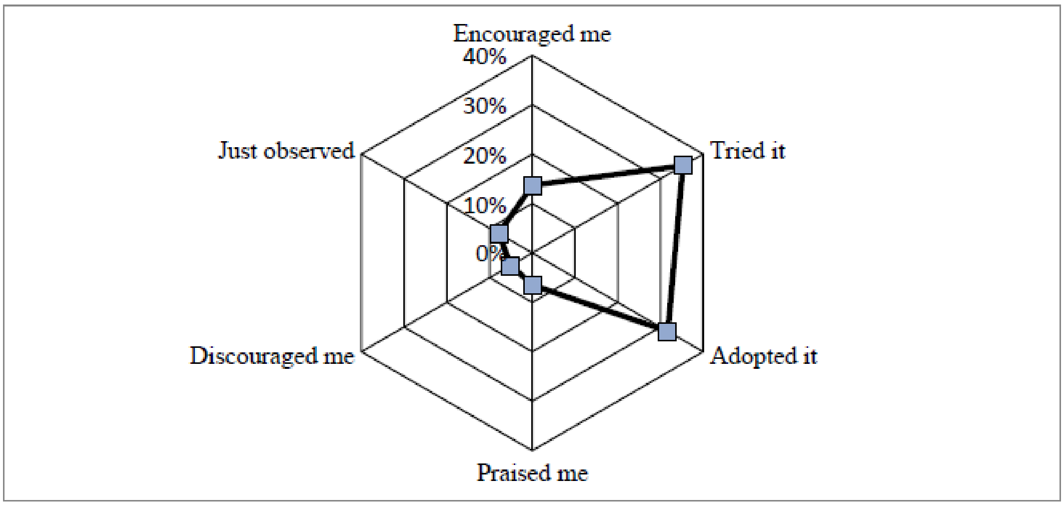

Figure 7. Reaction to sharing of innovations (N=226)

KIIs indicated that extension workers positively react to farmer-driven innovations and tend to encourage them. Encouragements to innovate were shared in meetings, field or farmer visits, and demonstrations. However, it was also revealed that the extension workers did not document these innovations for sharing with other stakeholders particularly scientists, the reason being that they were locked in the extension workers' minds as they perceived they should not be shared before being scientifically proven.

A positive interaction (cooperation and learning) existed between the government extension workers, NGOs, farmers and local leaders. The government agricultural staff work collaboratively with lead farmers and NGOs in the area on CA. Particularly, government staff have limited resources and thus take advantage of the resources availed by the NGOs to be active in their work area. On the other hand, NGOs have limited extension workers and thus take advantage of the availability of the government staff endowed with community mobilisation skills despite that this is overstretching the already insufficient staff. Furthermore, it was noted that there are harmonisation problems with regard to CA technical messages on soil organic cover and dimensions of planting basins.

Nationally, the Land Resources Department of the Ministry of Agriculture, Irrigation and Water Development (MoAIWD) provides policy direction in terms of implementation of conservation agriculture. This is done in collaboration with stakeholders through the NCATF. NCATF was founded in 2002 and re-launched in 2007 with a call from the Conservation Agriculture Regional Working Group (CARWG) for southern African states (Dougill et al., 2017). The task force aims to advocate and influence agricultural and other policies related to conservation agriculture, facilitate capacity building amongst stakeholders and develop strategies for the roll out and adoption of conservation agriculture. National Guidelines on CA have been developed and launched in 2016 to harmonize the approach in the scaling-up efforts.

The Department of Agriculture Research in Malawi together with CIMMYT and TLC played an important role of assisting stakeholders involved in promotion of CA by providing research evidence to finally clear the technology by the Agriculture Technology Clearing Committee (ATCC) in 2013 (Ligowe et al., 2013). Apart from this, researchers were noted to be engaged with participatory approaches on CA in funded projects only.

4. Discussion

4.1 Modification of CA at Adoption

Farmers are heterogeneous and so are their farming environments hence the call for CA practices to be site and circumstantial specific is critical (Thierfelder et al., 2016; Dougill et al., 2017). The finding that about 42% of farmers decided to modify CA practices confirms that there is a considerable proportion of farmers with a positive rudimentary attitude of creating new knowledge embodied in the technologies which could be fed into the Agriculture Innovation Systems (AIS). The most prevalent perspective of 37% of farmers that modification of CA practices led to increased yields makes common sense. This is because when one modifies the CA practices, it is expected that they will suit the environment thereby making the system more efficient. The CA system then performs better on the usual reported bio-physical benefits (Ngwira et al., 2011; Ngwira, et al., 2012; Kaczan et al., 2013; Thierfelder et al., 2013; Ngwira et al. 2014a; Thierfelder et al., 2015c; Thierfelder et al., 2016). However, such anecdotal benefit need to be confirmed by controlled experiments to ascertain its attribution.

The fact that about 58% indicated to not modifying CA systems because they were “simply following recommendations” from promoters is an indicator of a presence of passiveness among the farmers against the assumptions on the role of farmers in innovation networks within an active AIS (Spielman, 2005; Thierfelder & Wall, 2011). The assertion confirms that the majority of farmers consider CA promoted by some change agents as a rigid and sometimes ‘religious approach’ (i.e. one size fits all) with little need to adapt the system to their environment and socio-economic circumstances (Giller et al., 2009). This could be one of the reasons for the slow uptake, dis-adoption and/or non-adoption.

4.2 Challenges and Solutions from Farmer Perspective

The wide range of challenges and solutions provided by informants, with the majority having low percentages of responses of as little as below ten, means that farmers in the study area are facing many different challenges and employing different solutions in accordance to their contexts. This agrees with recommendations for CA to be site and farmer circumstance specific (Wall, 2007; Thierfelder & Wall, 2011; Corbeels et al., 2013).

The majority of communities in SSA have free access to utilisation of residues for grazing and other purposes (Valbuena et al., 2012; Mupangwa & Thierfelder, 2014). The combined effects of low agricultural production, high population growth and decrease of communal resources lead to dependency on crop residues for not only livestock but also many household activities such as cooking and construction (Valbuena et al., 2012). In such communities, it is regarded normal if the one intending to use the residues does not seek permission from the owner. This explains why the findings unveiled two major challenges which related to free access to and utilisation of particularly maize stalks and farm for livestock grazing, mice and cricket hunting. The mice and cricket hunters dig (till) the fields, breaching one of the key principles of CA (FAO, 2013a), and at times widening the already dug planting basins. Mice hunters were even reported to set residues on fire so that mice storm out of the mulch for their catch. It is acknowledged by Chintsanya et al. (2004) that most smallholder farmers operate mixed crop-livestock systems under conditions of extensive management of the livestock. Apart from grazing, the livestock (especially cattle) also disrupt the layout of mulch as they trample on the farmers’ fields. In a nutshell, competition for crop residues between livestock feeding and soil mulching could be a major cause of slow adoption of full conservation agriculture (CA) in SSA (Valbuena et al., 2012; Baudron et al., 2013).

CA particularly works well in conditions that are dry but not too dry and not waterlogged (Wall, 2007). In Malawi, including the study area, rainfall has been variable, both inadequate and heavy in different seasons. The annual rainfall of 900 mm a^{-1} may seem to not be too high but in-season rainfall variability may at times lead to waterlogging. This explains why 21% of respondents mentioned that water-logging in planting basins caused fungal diseases and maize blight which strongly calls for different CA systems (e.g. planting with a dibble stick) in high rainfall areas (Thierfelder et al., 2016).

As a major solution to their key challenge, the communities in the study area instituted by-laws to control free access to grazing and other purposes (48%). The territorial arrangement is that if one is found contravening, they are to be reported to chiefs who order the guilty to replace the residues or pay a monetary fine. However, it will take time before this solution becomes wholly effective as a considerable proportion of community members in the study area still has the mentality of free access to stover and neighbouring farmers' fields. This is evidenced by 26% of respondents said to collect stover, bind and put them under a tree or home soon after harvest and returning them in the field at the on-set of rainy season. Such a solution seems temporal and contradictory to permanent soil cover principle (Baudron et al., 2013) and labour intensive, which could be an impediment to adoption. At farm level, some farmers are using residues other than maize stover such as vetiver grass or even buying from external sources (18.1%) thereby widening mulching sources and probably reducing the competition at farm level. This coupled with increased productivity would reduce this pressure as more residues could be available to serve both competing demands.

Another significant challenge mentioned by farmers was limited access to agro-inputs such as chemical fertilisers, certified seeds and herbicides (22%). The three principles of CA are supposed to be augmented with good agricultural practices to enhance agronomic and economic benefits (Bunderson et al., 2015; Lal, 2015; Thierfelder et al., 2015b). But due to cash constraints, farmers end up applying less than recommended chemical fertilisers (it is less than 10 kg N ha^{-1} a^{-1} across Africa), yet comparably higher nitrogen (N) doses are needed in the first years of CA adoption because most cereal stover consists of wide C:N ratios (>20-30%) and low N fertilization may lead to increased N immobilisation, due to increased biological activity in the soil (Mueller et al., 2001; Wichelns, 2006; Morris, 2007; Thierfelder & Wall, 2011). Limited affordability of herbicides to the small-scale farmers makes the labour saving advantage less significant since weeding is done manually often using family labour (Wall, 2007; Thierfelder & Wall, 2011). To mitigate the chemical fertiliser problem, the farmers (21%) rely on manure application but for the seeds and herbicides, they use recycled or local seed varieties and manual labour, respectively, according to KIs. It takes time before weed pressure diminishes and soil fertility is permanently restored in a CA system (Muoni et al., 2014). Thus, despite CA promoters being criticised for accompanying CA with agro-inputs (e.g. Giller et al. 2009; Andersson & Souza, 2014; Dougill et al., 2017), it is still important to make these inputs available. This is particularly relevant to CA farmers in the SSA who are largely small-scale unlike their counterparts in the Americas who are large commercials and can afford these inputs without external support (Wall, 2007; Derpsch & Friedrich, 2009; Kassam et al., 2014; Vanlauwe et al., 2014).

4.3 Sharing Innovations

It was not a surprise that many farmers (over 90%) share and discuss innovations with fellow farmers because they interact often with their peers in the communities. However, in an appropriate and functional AIS or innovation platform for CA promotion as previously postulated (e.g. Ekboir, 2002; Spielman, 2005; World Bank, 2006; Wall, 2007; Anandajayasekeram, 2011; Brooks and Loevinsohn, 2011; Thierfelder & Wall, 2011) it was expected that far more farmers than what was reported (46%) would be sharing innovations to extension workers. The fact that no researcher was mentioned to have been shared new innovations indicates that one-way linear approaches are still existent and often the norm where an extension worker is a link between a researcher and a farmer. One of the major reasons for those that did not share was that they just followed recommendations as trained by extension workers. The right of a smallholder farmer in an active AIS approach, to be innovative and adapt farming practices to their needs (Ekboir, 2002; Spielman, 2005; Wall, 2007; Thierfelder & Wall, 2011) is not yet inherent among the farmers themselves. Other responses for not sharing innovations were that farmers felt not competent enough to articulate their innovations and answer questions from interested participants. Such expressions just confirm that CA systems are knowledge-intensive and thus farmers need to be trained to understand what it involves, why and its objectives (Wall, 2007).

Furthermore, the extension techniques for sharing challenges and experiences mentioned such as agriculture show, field day, plant clinic and farmer group meeting are chiefly linear and hardly allow interactive learning yet innovation platforms/networks are increasingly being prescribed to be appropriate for promoting more knowledge-intensive systems like CA. A successful example of an innovation platform from southern Africa is called farmer learning centre (Ngwira et al., 2012b; Mapfumo et al., 2013). In such a system, farmers are organised into research networks (with regular participation of researchers and extension workers) to assess and adopt technologies to overcome their farming constraints. Such platforms have been praised for being responsive to farmers' needs in Zimbabwe, Ghana and Malawi (Ngwira et al., 2012b; Mapfumo et al., 2013).

4.4 Environment for CA Innovations

Institutions as part of the AIS affect how innovations are developed and delivered, hence defining efficiency (Spielman, 2005). These are the laws, regulations, conventions, traditions, routines, and norms of society that determine how different agents interact with and learn from each other, and how they produce, disseminate and utilize knowledge. The highlighted by-laws indicated presence of a local environment or a social norm which, as theorized by Spielman (2005), fall under the traditional institution of a society. It was noted that when farmers shared innovations to fellow farmers, many tried and adopted them (35% and 32% respectively) while few (5%) numbers discouraged them indicating positive reception. However, the setback on the traditional institution is that by-laws, already noted, are not yet fully implemented in the study areas.

Two major milestones on the national CA environment are the formation of NCATF and the guidelines for CA implementation. The NCATF aims to advocate and influence agricultural and other policies related to conservation agriculture and facilitate capacity building. Currently, NCATF effectiveness may not be confirmed especially with frequent meetings being impeded by funding challenges such that some stakeholders recently complained of meeting only once since its re-launch in 2007 (Dougill et al., 2017). The CA guidelines just launched at the end of year 2016, have come at a right time when CA messages in the field were lacking harmonisation. The development is also consistent with the need to harmonise the pluralistic extension services as highlighted in the Malawi's Extension Policy 2000. However, how to truly harmonise such guidelines and take into consideration the context-specific nature of CA by taking views of numerous CA stakeholders working across the country, may be an issue. Confirming this, Dougill et al., (2017) criticised that although the formation of the guidelines is a welcome development, key stakeholders of the NCATF were rigid in their recommendations which were largely driven by few vocal key stakeholders. This highlights the need to find a pragmatic middle way between the need for harmonization of extension messages and avoiding top-down inflexible extension systems that would suffocate agriculture innovations that could enhance adoption.

Another welcome development; CA is now incorporated in district plans (Dougill et al., 2017). This just confirms that CA is noted to work in a wide range of environments (Wall, 2007). As from this study, extension workers were reported to show a positive reaction to farmers' innovations. However, the problem is that the extension workers do not document such farmer innovations because they are said to be "kept in their minds". They only document and share reports to their superiors on the technologies that come from 'above'. This behaviour is rooted in the linear top-down thinking which does not recognize bottom-up innovation. Interestingly, the extension workers managed to only mention less than half of the innovations farmers perceived in the study area. This implies that the extension workers are not aware of the many innovations that farmers are employing on CA. Such innovations could be both beneficial or not or requiring further investigations. Therefore, innovative farmers are still not being recognised as such, thus contravening the principles of AIS. Perhaps this could partly be explained why there is little evidence on the solutions from the application of AIS in developing countries (Spielman, 2005). Furthermore, as noted from the newly launched [2016] National Agriculture Policy for Malawi, one of the ten policy objectives is to increase, the number of new agricultural technologies by 60%, developed and demonstrated to farmers by 2020. While the objective is measurable and ambitious, it reveals a connotation that farmers are on the receiving end only. One would expect the objective to be more inclusive, taking all farmers, extension workers and researchers on board to co-develop and try out technologies together as partners. In such a case, any of the partners is free to develop technologies as in AIS (Spielman, 2005). In fact, Malawi has witnessed a lot of innovations in agriculture developed by farmers which have proven to be useful, such as the *Phiri Lino* Frame used for making contour ridges developed by Jeremiah Phiri, the *Mbeya* fertiliser (a mixture of mineral fertiliser and manure) invented by Fwasani Binwel Mbeya, (Nyirenda, 2015) and *Chikunisapuni* (a cup for applying fertiliser for the 1x1 maize planting technology) by Luciano Chikuni. ATCC is not responsive to such innovations. For instance, despite rapid, silent and non-sponsored diffusion of *Mbeya* manure across the country since around 2014, the ATCC had not cleared it yet by early 2017 because it was waiting for scientific results.

5. Conclusions and Implications

The majority of farmers still consider CA as a rigid approach with clear instructions that cannot be modified to suit their circumstances. Nevertheless, farmers who modified CA practices perceived benefits namely increased yields and soil health enhancement necessitating a need to encourage farmers to contextualise the CA practices.

The study further delineated a wide range of challenges that farmers are facing with CA, the predominant ones being the free access and utilisation of crop residues at community level, and the mixed crop-livestock systems at farm level. Despite reporting a wide range of challenges, farmers have developed a number of solutions such as the traditional institution of by-laws that privatise the crop residues, which have not been adequately documented by extension workers for sharing with stakeholders. Extension workers should be encouraged to document such solutions for dissemination beyond local communities and encouraging further research by scientists.

On the other hand, most of the current forums being used to disseminate the CA innovations are often linear, top-down and incompatible with modern ideas of participatory interactions and innovations in AISs. Therefore, contemporary interactive innovation platforms such as learning centres should be encouraged.

Furthermore, the establishments of NCAFT and CA guidelines are positive developments for coordination of stakeholders and harmonisation of CA messages in Malawi. For greater adoption, however, non-linear interaction and learning must be encouraged in practice by fully embracing innovative farmers and the voices of the pool of stakeholders with varying experiences.

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