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Why do smallholder farmers dis-adopt conservation agriculture? Insights from Malawi

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Abstract

International donors and advisory bodies, governments and non-governmental organisations (NGOs) are actively promoting conservation agriculture (CA) to improve agricultural productivity and resilience to climate change impacts. However, many smallholder farmers continue to dis-adopt (abandon) the technology. Reasons for dis-adoption are not well known. This article examines farmers' lived experiences and perceptions of CA to understand why smallholder farmers dis-adopt CA in Malawi. Improving understanding of dis-adoption of this seemingly appropriate intervention is important to achieve sustained adoption and for ensuring long-lasting impacts of agricultural development project interventions. A mixed methods approach was used, involving household questionnaire survey and focus group discussions with smallholder farmers. Findings reveal that while drivers of dis-adoption are multi-dimensional and multi-layered, they are rooted in shortfalls of CA promoters' implementation arrangements. While CA proponents market CA as a time-saving, labour-saving and yield-improving technology, respondents report contrary experiences. Our findings show that farmers lack sufficient technical support and encounter technological, social, institutional and economic challenges. These, coupled with unfulfilled expectations, undermine ownership of CA projects and lead to dis-adoption. This highlights a need to: (1) collaboratively design projects to better suit local needs and context with inclusive implementation arrangements; (2) emphasise climate resilience benefits of CA rather than economic benefits to manage farmers' expectations; (3) intensify multi-disciplinary research that incorporates farmers'

knowledge and experiences to develop suitable, flexible and low-input CA packages; (4) provide regular hands-on technical extension support to farmers.

Key words: adoption; farmers' perceptions; sustainable land management; technology transfer; sub-Saharan Africa.

1. Introduction

International donors and advisory bodies, national governments and non-governmental organisations (NGOs) are actively promoting conservation agriculture (CA) as a route to sustainable land management and agricultural development across sub-Saharan Africa. In Malawi, agriculture remains the main source of livelihood, driving economic growth as it contributes 30% of the national Gross Domestic Product (GDP), 80% of national export earnings and employing 64% of the labour force (Malawi Government, 2016). CA is advocated on the basis of improving crop yields, income and/or profits, reducing production costs and conserving soil and water (Kassam *et al*., 2014; Knott *et al*., 2014). It is based on three fundamental principles: (1) minimum soil disturbance, which entails eliminating tillage practices (i.e. no-till) or reducing mechanical ploughing or minimising digging of the soil (i.e. minimum tillage); (2) continuous soil cover, which involves either mulching the soil with crop residues/biomass or use of cover crops as live mulch; (3) crop associations in space and time, which is achieved either by planting more than one type of crop on the same piece of land simultaneously (intercropping) or as a relay crop, or in rotations (FAO, 2015; Lahmah *et al*., 2012). To obtain optimal results from CA, it is advisable that farmers observe all three principles simultaneously, in addition to other good agronomic practices (FAO, 2010). Contestations exist surrounding performance of CA under smallholder farming conditions (Baudron *et al*., 2011; Giller *et al*., 2009 & 2015; Pittelkow *et al*., 2015). In addition, lack of consensus regarding universal definition of CA (Glover *et al*., 2016; Whitfield *et al.*, 2015) has led to diverse interpretations and promotion of disparate practices in different countries (Kassam *et al*., 2012; Andersson & D'Souza, 2014; Kirkegaard *et al*., 2014; Grabowski & Kerr, 2014; Bwalya Umar, 2017).

In Malawi, different combinations of practices promoted under the banner of CA include: no-till, planting basins, mulching, intercropping, organic manure, agroforestry, inorganic fertilisers, hybrid seed, herbicides, soil and water conservation measures, specialised planting equipment and direct seeding (NCATF, 2016). Unlike other countries, crop rotation is less emphasised (Mloza-Banda & Nanthambwe, 2010); perhaps considering that smallholder farmers' land holding size averages 0.61 hectares (Malawi Government, 2016), and coupled with the smallholders' tradition of growing maize (Thierfelder *et al*., 2016b).

Though widely considered one of the most appropriate climate-smart agricultural technologies for smallholder farmers in sub-Saharan Africa (e.g. Michler *et al*., 2016; African Conservation Tillage Network, 2016), smallholder implementation of CA is often short-lived. Evidence from literature and practice points to a growing problem of dis-adoption (Andersson & Giller, 2012; Arslan *et al*., 2014; Twomlow & Delve, 2016). This confounding situation drew attention of this study to investigate why smallholders dis-adopt CA. Dis-adoption is defined here as the decision to abandon an agricultural practice after initially adopting it (Kiptot, *et al*., 2007). While acknowledging debates surrounding definition of CA adopter/dis-adopter (Pannell *et al*., 2006; Kiptot *et al*., 2007), this research draws from the adopter/dis-adopter definition set by Malawi's CA guidelines to make the findings more relevant, meaningful and acceptable to CA promoters in the country. According to Malawi's National Conservation Agriculture Task Force guidelines, a farmer is regarded as an adopter if he/she has continuously utilised CA practices for at least 2 years (NCATF, 2016). CA dis-adoption occurs when an adopter discontinues CA and reverts to conventional tillage practices. While the concept of adoption of CA has been studied extensively (e.g. Knowler & Bradshaw, 2007; Mlamba, 2010; Ngwira *et al*., 2014), dis-adoption has rarely been studied (Pedzisa *et al*., 2015; Glover *et al*., 2016), and reasons for its occurrence are far less known.

Since agricultural technology disseminators are mostly interested in determining the rate of adoption/diffusion (Rogers, 2003), potential impact (Glover *et al*., 2016) or beneficiary-targeting (Chinseu *et al*., 2018), much of the existing agricultural

technology adoption studies emphasise linking farm and household characteristics to adoption decisions (e.g. Pedzisa *et al*., 2015; Nyanga, 2012; Wendland & Sills, 2008). This however provides a poor understanding of how smallholder farming households and their production systems function (Andersson & D'Souza, 2014). By focusing on farm-household characteristics, researchers "look at adoption in a static state and fail to see it as a process" (Lalani *et al*., 2017, p104) therefore fail to uncover motivations underpinning (dis)adoption decisions (Sietz and Van Dijk, 2015). Regardless of household/farm attributes, individuals derive different experiences, interpretations and perceptions from the same phenomenon, ultimately triggering different decisions and/or behaviour (Hay, 2010). This paper investigates CA farmers' lived experiences and perceptions to gain insights into underlying drivers of CA dis-adoption in two districts of Malawi.

The aim of this study is to investigate smallholder farmers' perceptions of why they dis-adopt CA in Malawi. Specific objectives are to: (1) investigate smallholder farmers' motivations for starting CA; (2) examine farmers' experiences of CA to illuminate challenges encountered during implementation; and (3) analyse smallholders' perceptions of CA and their implications for dis-adoption.

2. Methodological approach

Study sites

The study was conducted in Lilongwe district (latitudes 13^0 30'S and 14^0 45'S and longitudes 33^0 15'E and 33^0 30'E) and Dowa district ($13^0$20'S and $13^0$40'S and 33^0 20'E and $34^0$10'E), Malawi. The districts were purposively chosen because: (1) CA has been implemented for >5 years therefore would provide rich information on CA; and (2) have challenges sustaining smallholder farmers' continued CA implementation. Both Lilongwe and Dowa have a unimodal rainfall pattern, with mean annual rainfall of 900mm and 1250mm, annual temperature range of 20^0-28^0C and 15^0-30^0C respectively. In Dowa, 36.6% of the people in the district are poor[1]. Over 90% of the

[1] Live below $1/day

population rely on agriculture for their livelihood, maize being the staple food crop, tobacco and legumes as the main cash crops (Malawi Government, 2008). In Lilongwe district, 37.5% of the population are poor. Over 90% of the population derive their livelihood from agriculture, with tobacco as the main cash crop and maize as the staple food. For both Dowa and Lilongwe districts, the predominant tribe is Chewa (Malawi Government, 2008).

Theoretical framework

The study was informed by Diffusion of Innovations (DoI) theory, specifically the Innovation Decision Process framework (Rogers, 2003). The Innovation Decision Process distinguishes five stages through which the decision maker adopting an innovation passes: (1) knowledge stage; (2) persuasion stage; (3) decision stage; (4) implementation stage; and (5) confirmation stage (Rogers, 2003, p170). This study focused on implementation and confirmation stages; where perceived new ideas are essentially put into practise, and it is also where challenges may emerge on how to utilise the innovation or how to resolve the challenges (Rogers, 2003, p179). As individuals utilise the innovation, real experiences and perceptions emerge, a process out of which discontinuance (dis-adoption) is a possible outcome (Rogers, 2003). Though the implementation stage is very important in conceptualising dis-adoption decisions, analyses of this stage are generally lacking in the adoption literature.

According to Rogers, the most critical type of knowledge to a decision-maker is 'how-to' knowledge, which is useful during implementation particulary for perceived complex technologies such as CA. 'How-to' knowledge is a critical determinant of whether an individual can continue utilising the innovation or not (Sahin, 2006). The Innovation Decision Process is relevant for analysing CA dis-adoption as it extensively engages with farmers' decision-making during implementation and confirmation stages. The dis-adoption decision-making process is largely informed by personal experiences; perceived attributes of the technology such as: perceived complexity (technical capacity limitations); relative advantage; compatibility with values, beliefs, felt needs or existing (farm) management system; and nature of the social system (Rogers, 2003; Pannell *et al*., 2006), described by Ndah *et al*. (2012) as 'frame

conditions' of adoption decisions. The methodological approach herein was guided by these themes.

Despite wide applications of Rogers' theory, several authors have drawn attention to its limitations, mainly pro-innovation and individual-blame biases (Botha and Atkins, 2005; Vanclay and Lawrence, 1994; Pannell *et al*., 2006). The Innovation Decision Process is arguably entrenched in the traditional linear agricultural extension model of knowledge generation and dissemination, which suggests that innovations developed by agricultural scientists are 'improvements' to be disseminated to farmers without questioning their suitability under actual farm conditions (Vanclay and Lawrence, 1994). Nonetheless, we considered the DoI theory, particularly the Innovation Decision Process, most suitable in conceptualising (dis)adoption decisions of smallholder farmers in developing-country agriculture (Ndah *et al*., 2014), and it has been specifically recommended for studies on CA (Corbeels *et al*., 2014).

Methods

A mixed methods approach (Tashakkori & Teddlie, 2010) involving household questionnaire survey and focus group discussions (FGDs) was used to gain understanding on why farmers dis-adopt CA. Two Extension Planning Areas (EPA) per district were purposively selected in consultation with the Department of Land Resources and Conservation. Using purposive sampling (Bryman, 2016), farmers still practising or previously practised CA for at least two[2] years were targeted to obtain rich and relevant data. Purposive sampling was employed to target survey respondents who were still practising CA for a minimum of two years at the time of data collection or those who had practised CA for at least two years but dis-adopted. It was discovered during exploratory visits that many CA promoters in the study districts perceived the research aim on dis-adoption to be sensitive; they did not want their projects to be associated with dis-adoption, expressing concern about possible

[2] Two years is the definition of adoption set by Malawi's National Conservation Agriculture Task Force (NCATF). We use this so as to make our research more relevant to the NCATF with the hope it will enable our recommendations to be more easily taken up.

negative implications on continuity of funding for CA activities from international donors, their main sponsors. To address these fears, and in line with ethical approvals, it was agreed that the study would recruit equal numbers of, and engaged mixed focus group discussions comprising farmers still practising CA and those who dis-adopted. Anonymity of respondents and their CA projects was guaranteed to enable participating respondents to freely express their opinions.

Data collection was done during the 2015/2016 cropping season, which began with exploratory visits and community meetings to build rapport, establish social context and verify study sites. A structured questionnaire, comprising closed and open-ended questions, was designed and pre-tested. The questionnaire included questions on CA practices implemented, agricultural extension and advisory support. It was administered face-to-face to 300 CA farmers whose attributes are presented in Figure 1. Apart from defining respondents' attributes and scope of responses (Bryman, 2016), the questionnaire survey enabled selection of suitable FGD participants and pertinent group discussion topics.

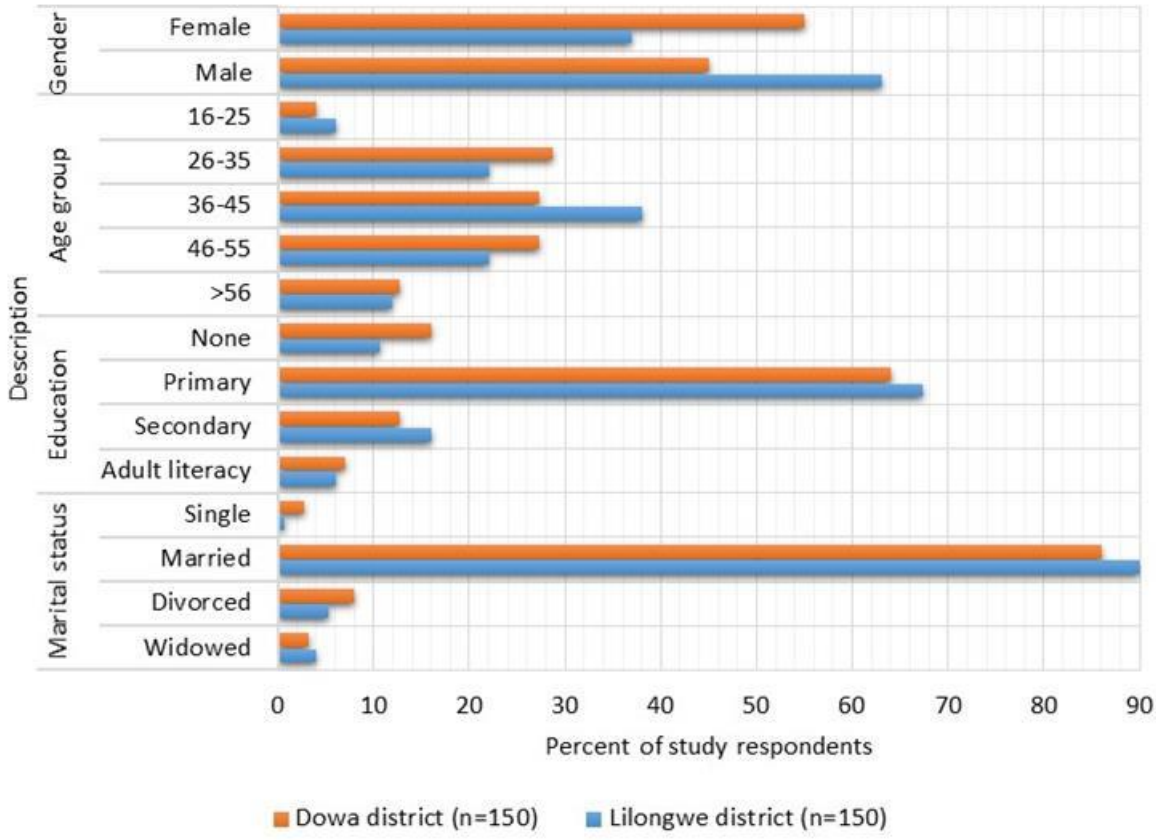

Figure 1: Description of questionnaire respondents

Since qualitative research methods are ideal to answer why a social phenomenon occurs (Hay, 2010), FGDs were conducted to get to the root of underlying reasons why farmers abandon CA. Respondents, who freely expressed their opinions during questionnaire surveys and had given consent to participate in FGDs, were selected. Eight FGDs were held with 82 participants (4 FGDs per district, 7-14 participants per group). To get insight into participants' experiences and perceptions of CA, discussions were guided by themes broadly categorised into: (1) knowledge of CA; (2) CA implementation; (3) CA benefits and constraints; (4) participants' views and sustainability of CA. The groups comprised male and female practising and dis-adopted CA farmers, lead farmers[3] and follower farmers. However, two FGDs involved only ordinary CA group members (follower farmers) to get their experiences and views

[3]Lead farmer is an experienced and self-motivated farmer in the community, who can disseminate his/her knowledge/skills with other follower (less progressive) farmers (Khaila *et al*., 2015)

independent of possible influence from opinion leaders. FGDs were held in Chichewa (local language) and were audio-recorded. The FGD data was triangulated with traditional chiefs, extension personnel and national agronomic guidelines e.g. Malawi Government (2012). Questionnaire data was analysed using SPSS (v20). Qualitative data was transcribed and processed using thematic analysis (Bryman, 2016) to identify main themes or issues emerging from FGDs. The detailed accounts gained from FGDs shed light on the research question and generated invaluable insights often lacking in typical adoption studies (Knowler & Bradshaw, 2007).

3. Results

This section presents findings based on study objectives. Farmers' motivations to start CA and practices implemented by respondents are presented first, followed by challenges faced during implementation. Finally, farmers' perceptions on CA and their implications on dis-adoption are illustrated.

3.1 Smallholder farmers' main motivation to start CA

Table 1 shows that farmers' main motivation to start CA was divergent from the main promotional message which focused on expected yield increases under CA.

Table 1: Farmers' main motivation for starting CA

Motivation	Proportion of survey respondents	Illustrative FGD comments
Soil moisture retention	34	"*If the soil is well covered and you are using planting basins, the moisture stays longer in the soil and you still harvest something [averts total crop failure]*" (Female, Practising, Dowa)
Improve soil fertility	22	"*When the project people came for orientation, they promised to give fertilisers to those willing to join*" (Female, Dis-adopted, Lilongwe)
Increase yields	15	"*When the soil is fertile and contains moisture, the result [improved yield] is automatic*" (Male, Practising, Lilongwe)
Reduce labour	12	[No particular illustrative comment identified]
Peer pressure	7	"*I am the chairman of the VDC[1] so I have to do CA, otherwise people will think that I am against development"* (Male, Practising, Lilongwe)
Self-initiative	7	"*I also have land along the road, close to the CA demo plot and I did everything as shown … when the field day came, I was given literally nothing*" (Male, Dis-adopted, Lilongwe)
Control soil erosion	3	[No particular illustrative comment identified]

Source: Questionnaires (n=300) & FGDs; VDC[1]= Village Development Committee

Findings show that the soil moisture retention attribute of CA was a key motivator for smallholders to start CA as it was seen to prevent total crop failure under dry spell conditions (Table 1). Although 22% of questionnaire respondents reported to have started CA to improve soil fertility, FGD sentiments suggest that the underlying motivation of most participants was to receive inorganic fertilisers promised by CA projects.

Project support to farmers played a key role in kick-starting CA as promoters issued various farm inputs to accelerate uptake. Questionnaire data showed that in year 1, respondents received different combinations of inputs: chemical fertilisers, herbicides,

hybrid seed and sprayers. Many of the respondents (64%) were issued input grants in year one while 14% bought their own inputs at commercial price. However, from year 2 onwards, most follower farmers had to self-finance inputs as only 13% received grants. Those that received grants from year 2 were mainly lead farmers for conducting demonstrations leading to inequity issues in CA clubs. FGDs revealed that some respondents who bought own inputs to start CA expected to be rewarded by the project, and felt disenchanted when such rewards did not materialise (Table 1). Although some participants received government subsidised inputs, such inputs were regarded to be exclusive for use in their conventional tillage farms, not CA. Since CA promoters focused on high cost inputs in promoting CA, many respondents could not sustain CA implementation after withdrawal of input support or project expiry.

Figure 2 shows CA practices implemented by questionnaire respondents (n=300, multiple responses, minimum 2 practices/respondent). The different combinations of CA practices implemented by respondents are a manifestation of the lack of universal definition and interpretation of CA, and also reflect the heterogeneity of farmers.

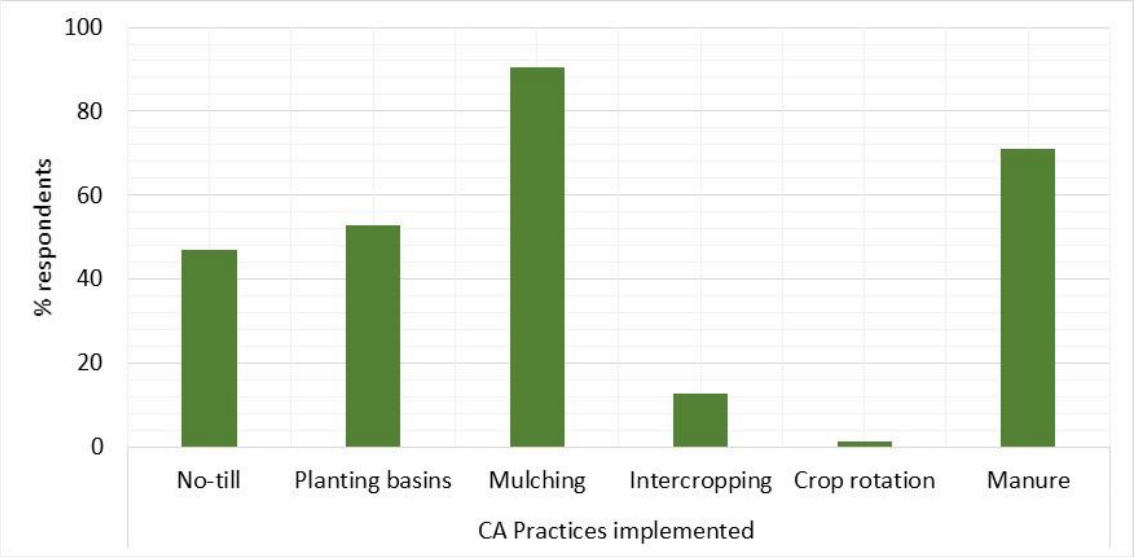

Figure 2: CA practices implemented by study respondents

Findings reveal that survey respondents implemented no-till and planting basins under the CA principle of minimum soil disturbance; mulching under the principle of

continuous soil cover and; intercropping/rotation under crop association. Manure application was the most prevalent CA complementary practice implemented by respondents (Figure 2), as a strategy to offset costs of chemical fertilisers: "*Fertiliser is very expensive so we apply a little bit [of inorganic fertiliser], and use a lot of manure*" (Female, Practising, Dowa).

3.2 Challenges encountered during CA implementation

The main challenges encountered by respondents when implementing CA are presented in Figure 3. FGDs shed more light on the challenges as outlined in the following sections addressing key challenges reported.

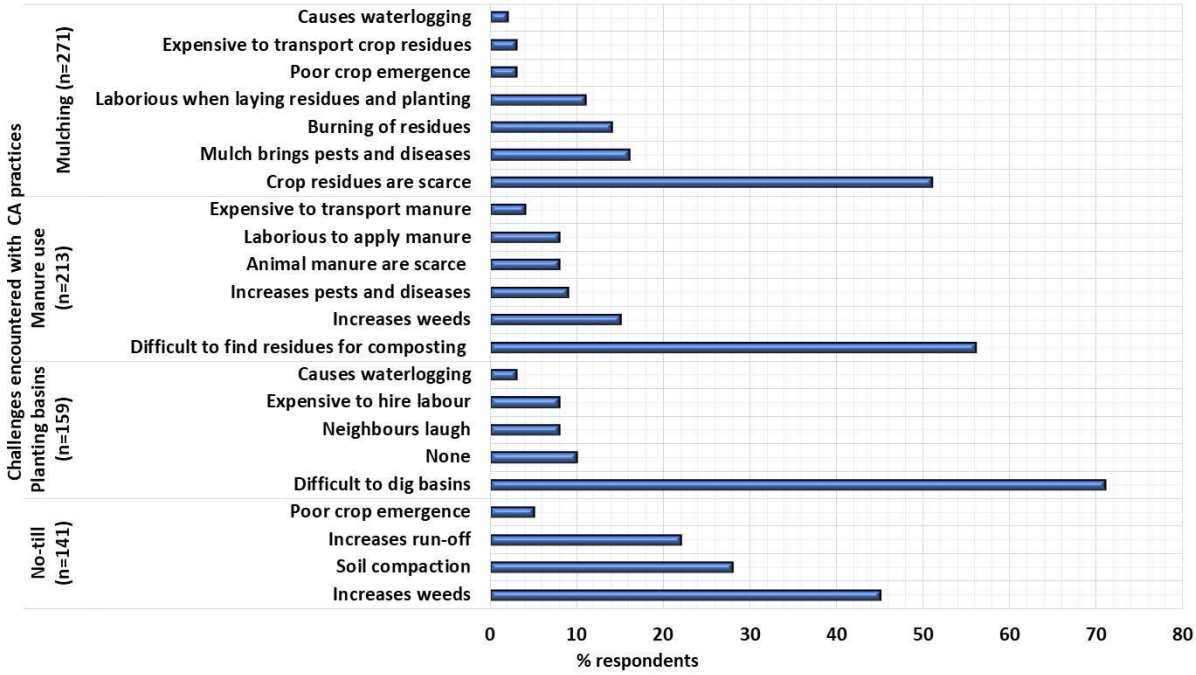

Figure 3: Main CA challenges encountered by study respondents

3.2.1 Challenges with no-till

The main challenge encountered under a no-till system was increased weed infestation (Figure 3). Some FGD participants observed that weeds persisted even after applying herbicides: "*When I sprayed Roundup™ [glyphosate herbicide], weeds grew even more profusely*" (Male, Dis-adopted, Lilongwe). Probing of FGD participants uncovered sentiments implying that some rural agro-dealers sometimes sold expired or fake products to farmers hence the ineffective herbicides. Lack of proper skills in herbicide

application was also expressed by FGD participants, with some indicating that they had never attended training in proper handling and use of agrochemicals. These findings suggest that concerns over herbicides aggravated the challenge of weeds which demonstrably dampened farmers' enthusiasm for CA. FGDs also exposed conflict between farmers' desire to intercrop maize with pumpkin and CA projects' requirement for farmers to apply herbicides in CA plots: *"The herbicide we sprayed killed all the weeds and my entire pumpkin crop, only the maize survived*" (Female, Dis-adopted, Dowa). Traditionally, pumpkin leaves are a popular vegetable relish (*nkhwani*), usually eaten with *nsima* (maize pulp), and the pumpkin fruit is a vital food during lean times of the year. As farmers could not intercrop pumpkin with maize in CA plots, some reverted to conventional tillage.

Evidence from FGDs also showed that farmers were concerned that no-till caused soil compaction: "*The soil in my [CA] plot became very dry and my hoes kept breaking"* (Male, Dis-adopted, Lilongwe). Some stated that shoots under no-till took longer to emerge whilst others claimed that most of their seeds failed to germinate: "*When we planted maize in the third year, only a handful emerged*" (Female, Dis-adopted, Dowa). FGD participants reported recurring incidents of poor crop emergence in CA which they attributed to no-till considering that the same stock of seed germinated well in their conventional farms where soils were tilled. Further sentiments suggest that strict enforcement of no-till by some CA proponents diminished prospects of *"ganyu*" (piece work), as it discourages ploughing, ridging or weeding using hoes (Ngwira *et al*., 2012; TLC, 2015). As such, some traditional leaders expressed reluctance to fully support CA, arguing that no-till risked the survival of households that relied on "*ganyu"* to get through food shortage months. Such sentiments suggest that CA promoters failed to customise CA projects to the local context, to minimise unintended consequences and conflicts with broader livelihood strategies and cultural norms.

Although no-till was implemented by close to half of the respondents (Figure 2), FGDs revealed that many practised it merely because it was a requirement from project promoters: *"No-till was brought in this village by the [CA] project and we just followed what they wanted*" (Female, Dis-adopted, Lilongwe). As project officials

(pre)determined the 'type of CA' to be implemented, farmers had to comply with the requirement if they were to join the project. Others expressed despondency with the apparent contradiction of the no-till system with their tradition of clearing and cultivating farmlands: "*Farming has entailed clearing the farm every year, making ridges, things like that…then the project people came saying no more tilling the soil, we should abandon our hoes*" (Male, Practising, Dowa). It was demonstrated in FGDs that tilling seemed to be entrenched in traditional belief system: "*A good, hardworking farmer is someone whose field is properly ploughed, with ridges and kept clean*" (Male, Practising, Dowa). This suggests that no-till conflicted with an important cultural symbol for hard work, as hoeing was generally believed to symbolise a hard worker, an attribute that generates respect from the community.

3.2.2 Challenges with planting basins

Although the use of planting basins was hailed across all FGDs to be effective in conserving soil moisture (Table 1), respondents encountered various challenges with them. Most respondents found constructing planting basins difficult without hands-on technical guidance: *"It is difficult and confusing to remember the precise procedures [of basin construction]"* (Male, Practising, Lilongwe). Furthermore, promotion of shallower basins by some CA promoters increased labour demand as they silted up quickly and needed de-silting: "*I dug my basins 30cm x 20cm x 15cm and all of them disappeared the moment rains came*" (Female, Dis-adopted, Dowa). Though extension agents claimed that farmers only dig basins once in three years, in practice, farmers widely indicated that they prepared basins annually. FGD comments also revealed that preparing basins between May-July as recommended, interfered with important social obligations. Communities were preoccupied with traditional ceremonies during the same period, perhaps because many families have relatively enough food and money: "*After harvest, it is our time to rest, have weddings, initiation ceremonies and enjoy gule wamkulu [spiritual masked dance]"* (Female, Practising, Lilongwe). Consequently, participants delayed preparing basins until October, and encountered problems

because the soil becomes dry and hard. Compounded by inappropriate equipment, basin preparation was largely regarded labour-intensive (Figure 3).

3.2.3 Challenges with manure use

While manure application was implemented by 71% of survey respondents, associated challenges, particularly weed infestation, surfaced regularly during FGDs. Although extension agents promoted use of dung as animal manure or booster in decomposition of crop residue-based compost, farmers lacked technical know-how for proper preparation or curing of manure before applying it to the field: "*I just collect cow dung from the kraal and spread it in my [CA] farm"* (Male, Practising, Dowa). Since the dung was predominantly from free ranging livestock, respondents experienced increased weed infestation. In addition, participants attributed increased prevalence of brown leaf spot disease to manure use. Increased weed and disease infestation also increased labour demand and costs of implementing CA.

3.2.4 Challenges with mulching

Though the majority (90%) of respondents implemented soil cover through mulching, numerous challenges were mentioned (Figure 3). FGDs revealed that CA farmers were confused by competing uses of crop residues promoted by extension agents. For instance, while the Department of Land Resources and Conservation (DLRC) encouraged farmers to make compost manure from crop residues, the same department and NGOs advised CA farmers to keep crop residues for mulching: "*It's hard enough to find crop residues…. I don't know whether I should follow the campaign advice [make compost] or I should just use them [crop residues] as mulch*" (Female, Practising, Lilongwe). While *in-situ* crop residues were not adequate to satisfy mulching requirement, CA farmers resorted to collecting mulch materials off-site, against Malawi Government (2012) guidelines as that transmits pests and diseases.

While maize stalks were the main source of mulch materials for most respondents (91%), FGD participants expressed that using maize stalks for mulching conflicted with

other important uses in the household: *"If you say just use maize stalks for CA, what else can we use for cooking?"* (Female, Practising, Dowa). Under such circumstances farmers had to prioritise: *"Priority was to find maize stalks for fencing my cassava farm to keep away goats"* (Male, Dis-adopted, Lilongwe). Findings suggest that overemphasis on using maize stalks as the key mulching material, mainly due to distorted extension messages, intensified competition between CA and other household functions utilising the same maize stalks. As farmers prioritised the more instantly rewarding non-CA use, very thin mulch was applied which largely left the soil bare.

Poor crop emergence under mulching was a recurring concern during FGDs though only 3% of questionnaire respondents cited it as a challenge. Those that applied a thick[4] mulch experienced the most severe germination problems: "*I applied a good thick mulch as advised, but most of the maize did not germinate"* (Female, Dis-adopted, Lilongwe). Concerns were raised as participants reported feeble, yellowish maize at emergence stage and others had to re-plant. FGDs imply that some farmers only persevered with CA in the hope that they would benefit from government fertiliser input subsidies (FISP), and emphasised that they deserved compensation for the extra resources used for re-planting: *"If government does not give us [FISP] coupons this year, we will forget CA because it is becoming more expensive*" (Male, Practising, Lilongwe). While FGD participants attributed poor seed germination to mulching, evidence suggests that the challenge emanated from farmers' lack of technical know-how on how best to apply mulch.

Since CA plots covered with mulch provided a fertile breeding ground for mice, they attracted mice hunters who set fire to the plots as they hunted. While providing a vital protein source to rural communities' diets, mice hunting led to frequent loss of hard-earned mulch through deliberate fires: *"You cover the CA plot nicely with maize stalks but these mice boys just come and set everything on fire"* (Female, Practising, Dowa). FGDs further hinted that some people acted out of envy and deliberately burned mulch materials. Other comments suggest that some farmers did not have the backing

[4] Field observations showed mulch thickness of up to 15cm with >100% ground cover

from their traditional leaders who appeared to condone anti-CA practices: *"I knew who stole my maize stalks, but when I reported him to the chief, no action was taken*" (Male, Dis-adopted, Dowa). Some chiefs did not act against those that stole or burned mulch since they were tobacco growers and/or owned livestock and might have had conflicting interests. FGD participants had a huge burden to replace the lost mulch and felt discouraged: "*I figured that even if I manage to replace the mulch, envious people would continue burning it, so I just stopped CA altogether"* (Male, Dis-adopted, Dowa). However, participants revealed that maize stalks systematically piled upright in a field were safe from theft/torching: "*If you gather maize stalks and leave them vertically like that, people think that the owner is a tobacco farmer so they don't vandalise*" (Male, Practising, Dowa). In adherence to the CA principle of continuous soil cover, extension agents insisted that CA farmers lay crop residues in the field immediately after harvest, however this rendered the mulch vulnerable to vandalism/theft. This shows the dilemmas CA farmers face, highlighting the need for promoters to harness local experiences and jointly devise locally applicable alternatives.

3.2.5 Inadequate extension and advisory support

Although many (72%) of the respondents needed a lot of technical hands-on guidance to implement CA, extension support was found to be inadequate. Despite 93% of questionnaire respondents indicated to have a designated extension worker in their section, only 2% of the respondents were visited twice a month, while 23% were visited once a month, 35% were visited once in two months, 22% were visited once in the whole cropping season and 18% were never visited. In all FGDs, participants expressed dissatisfaction with extension visits: "*In our section, the extension worker just came to introduce CA and has never come back since*" (Female, Dis-adopted, Dowa). A sense of frustration prevailed among respondents who expressed that, despite CA being complex, they did not get the necessary technical or advisory support. In addition, follower farmers commonly expressed that they felt alienated by extension officers who, in their opinion, concentrated their efforts on lead farmers while they grappled with problems of weeds, poor crop emergence or pests and

diseases in their plots. Some FGD participants openly conveyed their disillusionment: "*He [extension officer] is supposed to visit every farmer not only lead farmers*" (Female, Practising, Lilongwe).

3.3 Farmers' perceptions of CA

Based on their experiences from implementing CA, FGD participants expressed various views (Table 2).

Table 2: Illustrative FGD comments, dominant perceptions and underlying issues of CA

FGD comment	Dominant narrative/perception	Underlying issue(s)
"*Everybody knows our traditional way of farming, but with CA, you have to do this, you have to do that, very confusing*" (Female, Practising, Dowa)	Difficult to implement CA	Insufficient extension support; complexity of CA
"*CA requires many things, you need [inorganic] fertilisers, hybrid seed, others say spray herbicides. As poor as I am, how can I afford all that?* (Female, Dis-adopted, Dowa)	CA is expensive	Associating CA with expensive inputs
"*Why should I buy my own inputs when I am helping them implement their project?* (Male, Dis-adopted, Lilongwe)	Incentives/rewards prerequisite for CA implementation	Imposing CA on communities; enticing farmers with incentives
"*If a family has ten children but the mother only provides food to one child and tells the rest to fend for themselves, will they feel as being part of that family? Same with CA [projects]"* (Traditional Chief)	Unfairness/CA projects benefit lead farmers more than followers	Concentrating support and resources on lead farmers, alienating followers
"*We rest after harvest. But with CA, you are busy searching for maize stalks, laying mulch and guarding it, digging or de-silting basins, uprooting weeds and everything is regimented*" (Female, Dis-adopted, Dowa)	CA is too demanding	Emphasising dead mulch as soil cover; limited traditional leaders' support; distorted extension messages; not engaging farmers
"If livestock should not feed on crop residues during dry seasons [because of CA], then where should they graze?" (Male, Practising, Lilongwe)	CA conflicts with other livelihood sources	Focus on dead mulch as main source of soil cover; limited integration of CA in farming systems
"*We hear on the radio, even our extension officers say that CA improves soil fertility [yield] yet for five years now, I still have to use [chemical] fertilisers otherwise the harvest is miserable*" (Male, Practising, Lilongwe)	Unfulfilled expectations from CA	Emphasising high yields and profits in CA promotion

Surveys showed that 54% of respondents perceived CA to be suitable for them, however most pointed out some unfavourable aspects of implementing CA. This was

corroborated in FGD sentiments which portrayed CA to be labour-demanding and complex (Table 2). In addition, a general sense of frustration prevailed among follower farmers who felt alienated and believed that lead farmers benefitted more from CA projects. Despite CA promotional messages promising yield and profit increases, FGDs revealed a dominant perception that CA did not live to expectation and was expensive (Table 2). Further probing uncovered that such unfulfilled expectations were fuelled by underlying issues in institutional arrangements[5] of promoters which contributed to the ultimate decision to dis-adopt CA.

4. Discussion

Our findings reveal that drivers of dis-adoption are complex, multi-dimensional and multi-layered straddling social, economic, technological and institutional constraints. Disparity exists between CA selling points and farmers' real experiences of implementing CA. Although promotional messages claim that CA reduces production costs, labour and time while increasing profits (Ngwira *et al*., 2012; NCATF, 2016), respondents widely reported contrary experiences. For instance, respondents required more labour and time to uproot weeds by hand, (re)plant seeds or apply fertiliser through surface mulch or dig planting basins which translated into more production costs.

Although proponents often advocate CA on the basis of yield increase (Kassam *et al*., 2012; Thierfelder *et al*., 2016), study respondents reportedly failed to realise the "promised" yield gains. This is not surprising considering that studies have reported that accrual of yield benefits from CA is often gradual (Baudron *et al*., 2011 & 2015; Giller *et al*., 2015; Pannell *et al*., 2014), and that this can make CA less appealing to subsistence farmers who typically expect quick benefits (Corbeels *et al*., 2014; Lahmah *et al*., 2012). Findings from this study suggest that promoters' emphasis on economic benefits of CA, perhaps to enhance the perceived appeal of CA and attract project

[5] Institutional drivers are explored in-depth in our upcoming article, policy drivers have been examined in our recent article: Chinseu *et al*., 2018 available online at https://www.ccsenet.org/journal/index.php/sar/issue/current

participants, generates expectations which fail to materialise in the short-term. On the contrary, environmental attributes of CA, i.e. soil moisture retention, are often understated during CA promotion but are a major interest to smallholder farmers (Table 1) considering the frequent prolonged dry spells (Simelton *et al*., 2013). In other words, CA helps with the farmer's climate risk management. Baudron *et al*. (2015) argued that yield improvement is rarely farmers' main rationale to adopt CA, while evidence of increased incomes from CA in the short-term may be contentious (Corbeels *et al*., 2014; Pannell *et al*., 2014; Whitfield *et al*., 2015; Pittelkow *et al*., 2015). Failure of CA to deliver expected benefits is bound to erode farmers' interest as expected gains remain unfulfilled, and thereby instigates dis-adoption.

Emphasis on dead mulch, as the main source of soil cover intensified competition for crop residues among competing uses in the community. Exacerbated by insufficient biomass yield from smallholder plots (Baudron *et al*., 2011; Lahmah *et al*., 2012), CA farmers had to source extra mulch materials off-site, which was time consuming, costly to transport and facilitated pest and disease transmission. In addition, CA farmers suffered acts of sabotage from envious individuals, mice hunters, and deliberate grazing of livestock in mulched CA fields which triggered social tensions. This resonates with other authors who reported similar constraints faced by CA farmers in Malawi (e.g. Williams, 2008; Thierfelder *et al*., 2016b). As some CA farmers lacked support from traditional leaders, to protect their mulch, many were overwhelmed by social constraints and stopped CA altogether. Furthermore, scarcity of mulch materials forced households to prioritise or switch to alternative income sources perceived to deliver more and instant benefits, such as livestock or cassava (dubbed replacement discontinuance in Rogers, 2003). While multiple income sources may encourage technology adoption (Mwale & Gausi, 2012; Moser & Barrett, 2003), they may trigger competitive forces leading to dis-adoption of the enterprise perceived to be less attractive.

Sentiments commonly expressed in FGD revealed that CA promoters failed to genuinely engage local communities in the technology transfer process, resulting in mismatched priorities between CA promoters and local communities. For instance, no-

till was introduced in communities where ploughing was strongly attached to *ganyu* and cultural values. As individuals generally strive to conform to cultural norms (Rogers, 2003; Hay, 2010), continuity of CA after project expiry in such communities becomes uncertain. Similar tendency of organisations to override local priorities or preferences in development interventions has been highlighted in literature (Wood *et al*., 2016). Our findings suggest that failure to fully and continuously engage beneficiaries undermined learning from indigneous knowledge and experiences, thereby missing opportunities to customise CA to the local context. Mismatched priorities and preferences weakened local commitment and/or ownership of CA projects. This highlights the need for active involvement of communities from project design stage to adapt CA to local contexts, thus garner ownership.

Promotion of high input CA entrenched the perception that CA was expensive (Table 2), which contributed to dis-adoption when farmers were weaned from project support. In many instances, inputs were withdrawn before farmers could see benefits from CA. Although projects maintained input grants only to lead farmers for demonstration purposes, such a strategy inadvertently fuelled a sense of alienation from follower farmers who felt dis-advantaged. While Mlamba (2010) highlighted similar findings, this study shows that the real challenge lies in that CA promoters use expensive inputs in promotional strategies and implementation, putting little effort into sustainable, low-cost techniques. As argued by Lalani *et al*. (2017), smallholders can successfully implement CA using locally-based low-cost strategies.

Findings herein show that many farmers faced overwhelming technological challenges in implementing CA amidst inadequate extension support, leading to dissatisfactory CA performance and frustration. Respondents perceived CA to be knowledge-intensive, hence needed frequent reinforcement of appropriate skills to correctly implement it. In addition, farmers lacked requisite technical know-how to effectively implement various CA practices independently. While some applied a thick mulch which led to waterlogging and/or poor seed germination, others used very thin mulch (<30% ground cover) which escalated soil compaction amidst lack of soil-ripping strategy, thus enhanced soil erosion, reduced soil mosture retention or increased weeds. This

ultimately demanded more labour for weeding, increased costs and reduced yields. Increased incidences of pests and diseases attributed to application of mulch and manure precipitated disenchantment and eroded farmers' interest in CA. These findings support calls for collaborative research to address such technological challenges, including specialised equipment to aid CA continued implementation (Lahmah *et al*., 2012; Kassam *et al*., 2012; Dougill *et al*., 2017; Chinseu *et al*., 2018). Rogers (2003) argued that if an innovation is perceived to be complex, the amount of how-to knowledge for its continued adoption is much greater than less complex technologies, and, if insufficient knowledge is obtained, the likely result is dis-adoption.

5. Conclusion and recommendations

This study comprehensively explored drivers of dis-adoption by examining farmers' experiences and perceptions of CA in Malawi. Findings reveal that drivers of dis-adoption are multi-dimensional and multi-layered, mainly rooted in shortfalls of promoters' project implementation arrangements. Although promoters package CA as a time-saving, labour-saving and yield-enhancing technology, many farmers generally experience contrary outcomes. Technical capacity limitations in the absence of sufficient research and extension support, compounded by social and economic constraints, frustrate smallholder farmers implementing CA. Such constraints, coupled with unfulfilled expectations, often lead to dis-adoption.

Findings show the importance of giving voice to smallholder farmers, often overlooked in adoption studies though they are end users of CA. And that, project implementation arrangements of promoters are instrumental in determining how smallholders' experience and perceive CA and whether or not to dis-adopt. There is therefore clear need in future CA interventions to: (1) collaboratively design projects to suit local needs and context with inclusive project implementation arrangements; (2) provide regular hands-on training and extension support to all farmers with genuine interest in CA; (3) emphasise climate resilience (soil moisture retention) benefits of CA rather than economic benefits to manage farmers' expectations; (4) intensify multi-

disciplinary research that seeks to incorporate farmers' knowledge and/or experiences to develop suitable, flexible and low-input CA packages.

Our study makes an independent contribution to dis-adoption which has largely been 'the elephant in the room' among CA stakeholders, and provides an in-depth examination of why smallholders dis-adopt CA in Malawi. Findings of this study can widely be applicable to similar situations in sub-Saharan Africa; and are relevant for improving project design to enhance sustained adoption and ensuring shifts in farming system practices towards long-term sustainable land management.

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