



Factors contributing to disadoption of conservation agriculture among smallholder farmers in Petauke, Zambia

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Abstract

This study identified factors that contribute to the disadoption of conservation agriculture (CA) among smallholder farmers in Petauke, Zambia. Data were collected through interviews with 92 randomly selected smallholder CA households, seven key informants, and four focus group discussions. The results showed that 29 percent of the sampled households disadopted CA. The four most commonly cited factors leading to disadoption of CA were lack of transport for manure (31%), high labor demands (25%), inadequate knowledge on CA (16%), and lack of material incentives (16%). The study recommends that CA promoters should stop inducing CA adoption through the provision of material incentives to adopters.

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Introduction

Land degradation has reportedly occurred in Zambia as a result of climate change and unsustainable farming practices such as shifting cultivation; the use of Green Revolution technologies and practices such as mineral fertilizers and continuous mono-cropping, and the use of heavy machinery for tillage (Government Republic of Zambia [GRZ], 2002). Land degradation is severe in the southern half of the country that covers the Central, Eastern, Southern, Western, and Lusaka provinces of Zambia. It has resulted in low land and crop productivity, water logging, biodiversity loss and human poisoning associated with pesticide use, and land degradation (GRZ, 2002; Pimentel & Pimentel, 1990; Pingali & Rosengrant, 1994). Several sustainable agricultural systems such as CA have been promoted to improve soil health as a way of

encouraging sustainable land management (Conservation Farming Unit [CFU], 2009). Despite the great alternative that CA is espoused to be for many smallholder farmers, disadoption of the innovation has been taking place (Wandel & Smithers, 2000).

We argue that the strategies used to make farmers adopt CA are ineffective for sustaining CA practice beyond project implementation phases. Although adoption levels may be high among smallholder farmers during the CA project implementation phases, they significantly drop after such projects end. Disadoption of CA is constraining the development of a sustainable agricultural system for smallholder farmers in Zambia. Furthermore CA disadoption is compromising the effectiveness of international development aid on which CA promotion depends. Ultimately, development initiatives such as CA will not lead to environmental sustainability, reduction in household food insecurity and in poverty at large if they continue to be characterized by disadoption. It is from this broader perspective that the current study has examined the factors that influence smallholder farmers to disadopt CA in Zambia using Petauke district as a case study.

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Literature Review

CA has been conceptualized as an agricultural system with three interrelated core principles: minimum soil disturbance, permanent soil cover, and diversified crop rotations or crop associations. According to CFU (2006) and Food and Agricultural Organization (FAO, 2006), CA provides farmers with a means for optimizing their yields and profits while maintaining a balance between agriculture, economic, and environmental benefits on a sustainable basis. CA has been widely promoted to address problems of low crop yields and food insecurity among smallholder farmers by a myriad of local and international actors in different regions of Zambia (FAO, 2011a). The CFU of the Zambia National Farmers Union (ZNFU) has championed the training of both institutions and individual farmers in CA in the country through its Conservation Agriculture Programme (CAP) (CFU, 2006; FAO, 2011b). Other non-governmental organizations such as the Land Management and Conservation Farming (LMCF) Project, the Golden Valley Agricultural Research Trust (GART), the Institute of Agricultural and Environmental Engineering (IMAG) Project, the Cooperative League of the USA (CLUSA), World Vision and various donors have also been promoting and developing CA in different regions of Zambia since the 1990s.

Despite the increasing interest and funding for CA in Zambia, there are reports of low adoption levels and also of disadoption (Gukurume, Nhodo, & Dube, 2010; Haggblade & Tembo, 2003). Haggblade and Tembo (2003) added that anecdotal evidence from their survey of 125 farms of smallholder farmers in Zambia indicated that after a period of time, some farmers disadopted the CA practices. In a similar vein, Gukurume et al. (2010) asserted that smallholder farmers' participation in CA was more cosmetic than genuine, since participation was out of fear of disappointing the organizations promoting CA. Other than Zambia, disadoption of CA among smallholder farmers has also affected countries such as Zimbabwe and Malawi. Chiputwa, Langyintuo, and Wall (2011) found that in Zimbabwe, the CA disadoption rate was relatively higher among zero-tillage farmers compared with other technologies. In their research, Ward, Bell, Parkhurst, Droppelmann, and Mapemba (2015) found that unfair provision of subsidies in Malawi resulted in subsequent disadoption of CA among farmers.

Research Methods

Data Collection and Analysis Methods

A mixed methods approach, involving the use of both quantitative and qualitative research tools was used in the collection of data. Mixed methods approaches offer an opportunity to draw from the strengths of both quantitative and qualitative research (Johnson & Onwuegbuzie, 2004). The two study sites, Wankhala and Mwanjawanthu, have population sizes of 2,350 and 1,450, respectively. Together, they have 920 households, all involved in farming (Ministry of Agriculture and Livestock (MAL), 2013). A register with the 920 smallholder farming households accessed from the Ministry of Agriculture district offices

was used as a sampling frame. A sample of 92 households (10%) was obtained using simple random sampling. This sample size was in line with Bless and Achola (1990)'s rule of thumb that to obtain a good sample in any study one can target at least 5 percent of the total population. Quantitative data were collected using a questionnaire administered on the randomly sampled smallholder farming households.

Qualitative data were collected through four focus group discussions (FGDs), that is, two from each Agricultural Camp. The discussants comprised CA farmers and CA disadopters. Seven key informants were also interviewed, consisting of two extension officers, two village head persons, and three lead farmers from the study sites. Purposive sampling was used in the selection of key informants and focus group discussants to include participants who were known to have knowledge, opinions, and experiences regarding CA in the study area.

Qualitative data analysis was a continuous process and started during the data collection phase on identified major themes and ended with an in-depth description of the results (Johnson & Onwuegbuzie, 2004). Descriptive and inferential statistics were used to analyze the quantitative data using statistical analysis programs. Associations between CA disadopters and non-CA disadopters with regard to explanatory variables were tested using the χ^2 test. A binary logistic regression model was used to determine factors influencing the disadoption of CA among smallholder farmers in the study area. According to Roger's theory on diffusion of innovation, a farmer's response toward an innovation is binary, to either adopt or reject. In this case, this means either continuing to practice or disadopting CA. This is an extension of Roger's theory which only looks at the adoption or rejection of an innovation. Hence the model for CA disadoption was specified as:

$$\text{Logit}(P(y = 1)) = \log(P/(1 - P)) \\ = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_K X_K \quad (1)$$

where y is a categorical dependent response variable with 1 = disadopters and 0 = otherwise; α is the intercept; $\beta_1, \beta_2, \dots, \beta_K$ are coefficients of independent explanatory variables $X_1, X_2, \dots, X_K$; P is the probability of a farmer in the study area disadopting CA and $(1-P)$ is the probability that a farmer in the study area does not disadopt CA. The odds ratio in this case is the probability that a farmer in the study area disadopts CA to the probability that a farmer does not disadopt CA. An odds ratio greater than one means that an increase in X leads to an increase in the odds that the dependent variable (y) equals one; an odds ratio less than one means that the odds are decreasing. A smallholder farmer is said to be a disadopter, if she or he has stopped practicing CA. The model is based on the assumption that disadoption is likely to be influenced by many of the same factors that influence adoption. It was tested using χ^2 and binary regression. Maximum likelihood estimation was applied to develop this binary regression model.

Results and Discussion

The questionnaire survey results showed that 29 percent of the smallholder farming households

interviewed had disadopted CA. The CA tillage systems that were being used by the smallholder farmers at the time of the research were CA basins and ripping. The results showed that of the two CA tillage systems used among smallholder farmers in the two agricultural camps, CA basins were the most disadopted at 96 percent and ripping was the least disadopted at 4 percent. The results from the χ^2 test showed that lack of access to transport for manure, higher labor demand, lack of access to incentives, and perceived poor local CA leadership were significantly associated with disadoption. Conversely, access to relief food, ownership of CA tillage assets (cattle) and equipment (*Chaka* hoe), gender, location, education levels attained, and CA training sessions attended were not significantly associated with disadoption (Table 1). The χ^2 test does not show the effect of explanatory variables on the response variable. This effect is shown by the regression analysis (see Table 2).

Lack of Adequate Knowledge in CA

A lack of adequate knowledge about CA was cited by 16% of the respondents as a contributing factor to its disadoption.

The CA disadoption regression model showed that attendance at training sessions in CA significantly reduced the likelihood of CA disadoption (Table 2). This implies that as farmers attend CA training they are less likely to disadopt CA. The results further showed that there were four main training sessions conducted by the CFU in an agricultural year. The distribution of attendance showed that the most attended training session was the digging of CA basins and the least attended was herbicide management.

Despite these four annual training sessions offered by the CFU, only 37 percent of the respondents had attended them. The discussants in one of the FGDs explained that they could not attend the trainings because of 'poor local CA leadership' which they claimed was not inclusive and had not extended invitations to attend CA training sessions to them. Furthermore, the lack of adequate knowledge of CA was also attributed to the lack of extension visits to individual farming households. The results show that 74 percent of the respondents had not been visited by extension officers over a period of 12 months at the time of the research (Table 3). These reasons could explain why there was inadequate knowledge on CA among the smallholder farmers in the study area. This poor attitude towards CA

Table 1
Descriptive statistics for explanatory variables used in the disadoption regression model

Variable	Variable description	CA Disadopters (n = 27) (%)	Non-CA Disadopters (n = 65) (%)	χ^2 statistic
Location	Wankhala Agricultural Camp	44.4	26.2	2.957
	Mwanjawanthu Agricultural Camp	55.6	73.8	
	TOTAL	100	100	
Gender	Men	77.8	69.2	.687
	Women	22.2	30.8	
	TOTAL	100	100	
CA labor attribute	Labor intensive	81.5	52.3	6.816*
	Non-labor intensive	18.5	47.7	
	TOTAL	100	100	
Education levels attained	No education	25.9	38.5	1.504
	Primary	51.9	46.2	
	Secondary	22.2	15.3	
Relief food	TOTAL	100	100	.001
	Received	29.6	29.2	
	Did not receive	70.4	70.8	
Assets owned	TOTAL	100	100	.499
	<i>Chaka</i> hoe			
	Yes	11.1	16.9	
	No	88.9	83.1	.675
	TOTAL	100	100	
	Cattle			
	Yes	55.6	46.2	16.943*
	No	44.4	53.8	
	TOTAL	100	100	
Access to CA Incentives	Yes	29.6	75.4	3.091
	No	70.4	24.6	
	TOTAL	100	100	
CA trainings attended	Attended	48.2	67.7	8.578*
	Never attended	51.8	32.3	
	TOTAL	100	100	
Transportation of manure	Had challenges	96.3	67.7	11.614*
	No challenges	3.7	32.3	
	TOTAL	100	100	
Local CA leadership	Good	66.7	93.8	
	Poor and Biased	33.3	6.2	
	TOTAL	100	100	

*Significant at .05 level.

Table 2

Regression estimates for socio-economic factors explaining disadoption of CA

Predictor	Coeff	SE Coeff	Z	p
CA Training attendance				
1 = Yes	−2.34037	.950978	−2.46	.014
Own means of transport for manure				
1 = Yes	−5.06272	1.57150	−3.22	.001
Location				
Wankhala	2.23189	.853520	2.61	.009
Gender				
Women	−.515090	.925073	−.56	.578
Cattle ownership				
Yes	.840135	.741815	1.13	.257
Local CA leadership				
1 = Good	−1.00747	1.00972	−1.00	.318
Access to incentives				
1 = Yes	−2.34338	.826246	−2.84	.005
CA Labor attribute				
1 = Labor intensive	.535613	.818145	.65	.513

Log-likelihood = −29.414

Test that all slopes are zero: G = 52.535, DF = 8, p = .000

Goodness-of-fit tests

Method	χ^2	DF	p
Pearson	25.0028	42	.983
Deviance	28.3662	42	.947
Hosmer–Lemeshow	8.6531	8	.372

training by smallholder farming households increased their likelihood to disadopt CA.

CA training sessions were the most important primary source of information on CA tillage systems, according to the respondents who had attended these training sessions. Training increases the ability of farmers to obtain, process, and use information relevant to the technology, leading to greater use and sustainability of new technologies (Wozniak, 1984). The farmer who rarely or does not attend such trainings will lag behind on the latest information on CA which might lead that farmer to disadopt. These results agreed with the findings by Nyanga (2012) who found that training in CA significantly increased the likelihood of its adoption.

Labor Demands and Asset Ownership

The regression model for CA disadoption showed that there was a high likelihood of disadoption for smallholder farming households that perceived CA to be labor intensive (Table 2). The results showed that 25 percent reported that CA basins were laborious to make. *‘The CA basins demand a lot of labor for them to be done and almost everyone in the family needs to be involved for you to be fast,’* argued a discussant in an FGD. The high labor demands in CA basins

Table 3

Number of times farmers were visited by the extension officers

Visitations by extension officers in 12 months	Frequency	Percent
None	68	73.9
1–3	21	22.8
4–6	2	2.2
7 and above	1	1.1
Total	92	100.0

was manifested during land preparation and weeding. Focus group discussants explained that larger families are less labor constrained and more likely to persist with digging basins because they have readily accessible labor resources compared to small-sized families. Field observations during this study showed that even among those still practicing CA, their largest fields were under conventional agriculture and only small fields or small plots of large fields were under CA.

The results further showed that 85 percent of the respondents did not own a *Chaka* hoe and 96 percent did not own a ripper. Some smallholder farmers reportedly discontinued ripping due to the costs associated with the purchase of rippers which were more expensive than ploughs and were rarely available on the market. Focus group discussants indicated that rippers could help greatly in continuing with CA where the farmer already owned oxen which could supply the draught power.

‘The heaviness of the Chaka hoe makes it hard to be used especially during the dry season when the soils are hard,’ a respondent observed. Nyanga, Johnsen, and Kalinda (2012) noted that the prescribed way of using the *Chaka* hoe during tillage increased the associated drudgery because it had to be swung from beyond the shoulders at a relatively fast speed so that its weight can break the soil easily.

The results showed that 56 percent of smallholder farmers who disadopted CA had herds of cattle for draught power giving them an option to move away from the drudgery of digging basins. One respondent retorted that *‘what will be the use of cattle, then, if I dig basins myself instead of using the cattle for draught power?’* Generally, the smallholder farmers agreed that ripping was less labor demanding than ploughing. A discussant declared that he was *‘ready to re-adopt CA if a ripper is given to my family as it can reduce my time and labor in the field in digging the basins and ploughing.’* This is consistent with the results reported by Umar, Aune, Johnsen, and Lungu (2012) that it took 3.8 man hours/ha to plough but only .8 man hours/ha to rip. However, the current study has shown that access to rippers was a challenge. This induced smallholder farmers to disadopt CA and revert to ploughing.

Access to Incentives

The provision of incentives to CA farmers has characterized CA promotion in Zambia. Approximately 16 percent of the respondents reportedly disadopted CA practices because they were not given the promised hybrid maize seed, fertilizer, and other incentives. A respondent explained that those practicing CA were given different types of incentives by different organizations and CA promoters, and those not given any incentives tended to disadopt CA. We argue that the incentives are given out as a way of encouraging the smallholder farmers to continue practicing CA so that the CA promoters can obtain the positive results they need to report to their funders. However, the sustainability of such incentivized adoption is questionable, as observed by the disadoption of CA once project support ceases. The incentives received vary from food stuffs and farming implements to cash.

In the quest to qualify for CA-based incentives, some smallholder farmers have small plots under CA while large fields are retained under conventional farming methods. This observation was similarly made by Umar, Aune, Johnsen, and Lungu (2011) who found that almost all of the 129 farmers they interviewed practiced both conventional and CA on different plots. In addition Gukurume et al. (2010) found that the majority of the farmers in their study thrived on misleading the NGOs into believing that they were full members of the project in order to get the much-needed seed and fertilizers. Once farmers got such inputs from the ‘missionaries’ they reverted to conventional farming methods (Gukurume et al., 2010).

Transportation of Manure

The regression model for CA disadoption showed that there was a significant likelihood of increased disadoption of CA by smallholder farmers who did not own means of transporting manure (Table 2). This implies that smallholder farmers who do not have transportation means for manure are more likely to disadopt than those that have. The results showed that 49 percent of the respondents owned cattle with an average of five cattle per household.

An oxcart was a common means of transport used in the two agricultural camps. This suggests that ownership of cattle is cardinal to the smallholder farmers. A general observation made was that most of the smallholder farmers did not own ox carts which they could easily use to ferry manure to their fields. The results further indicated that lack of access to oxen and transport to carry manure and difficulties to find manure influenced the smallholder farmers to disadopt CA. Of the respondents from the Mwanjawanthu Agricultural Camp and from the Wankhala Agricultural Camp who disadopted CA, 69 percent and 18 percent, respectively, cited manure transportation as a challenge.

Focus group discussants explained that the mixing of manure with soil made it very heavy to carry. This, coupled with the distance to their fields, discouraged smallholder farmers without transport from using manure. Women and children suffered the most in the transportation of manure on their heads because they were the most involved in cases of human portage. Others, especially men, use bicycles to carry manure but in small quantities which took time to cover a field of one hectare for example. The lack of flexibility resulted in some smallholder farmers only having small fields under CA or to completely disadopt it. This observation was supported by Marongwe et al. (2011) who reported that even though promotion increased the number of farmers practicing CA, expansion in the CA area has been more modest.

Weed Control

Weed control and management were reported by all the respondents to be more challenging under CA as the weed pressure increased with minimum tillage. Focus group discussants explained that there was higher weed pressure in the fields where they employed CA tillage systems

because in CA tillage systems, the soils are not supposed to be completely inverted and the burning of crop residues is also discouraged. Both complete soil inversion and crop residue burning serve as weed control measures.

Manure application is encouraged under CA as a way of adding nutrients to the soil. However, 3 percent of the respondents noted that manure supports the fast growth of weeds. Cow dung manure contains a variety of seeds which germinate and become weeds when the dung is applied to fields. Weed management challenges are compounded by the limited use of herbicides. Herbicide was the least used weed control method among the respondents, accounting for 3 percent only (Table 4). Generally, the smallholder farmers complained that the herbicides were an expensive method of weed management because they had several fields but insufficient funds to purchase the required quantities of herbicides for all their fields. We contend that it is such added costs to farming that lead smallholder farming households to disadopt CA. Our findings are similar to other studies that have acknowledged the increased weed pressure associated with CA. Vogel (1994) indicated that the CA principle of minimally tilling the soil commonly results in increased weed pressure. Umar, Aune, Johnsen, and Lungu (2011) established that weeding labor requirements tended to be higher on CA plots (in the absence of herbicide use) among smallholder farming households in southern Zambia.

Location and Local CA Leadership

From the FGDs held, the discussants had mixed feelings on the role the lead farmers (local CA leadership) played. Discussants cited poor local CA leadership as another contributing factor for smallholder farmers to disadopt CA. One discussant from Wankhala Agricultural Camp reported that

“the behavior of the lead farmers led me to disadopt CA because they are selfish and did not invite me and my friends to CA trainings the reason being they did not want to share the shareable incentives they received from the donors with others.”

Another one lamented, *“the lead farmers go to town and give fake reports that every farmer benefited from the shareable incentives; meanwhile we do not receive the incentives.”* These lamentations are in agreement with the regression model that showed that there is a significant increased likelihood of smallholder farmers in the Wankhala Agricultural Camp to disadopt CA (Table 2). Generally, it was observed that the incentives attached to practicing CA have brought conflicts between the lead farmers and smallholder farmers leading others to disadopt CA. This could imply that there was poor rapport between the local CA

Table 4
Weeding methods used by the smallholder farmers

Weeding method	All respondents	
	Frequency	Percent
Traditional hand hoe weeding	71	77
Oxen weeding	18	20
Herbicides	3	3
Total	92	100

leadership and smallholder farmers in this agricultural camp compared to the other.

Effective communication and good rapport between the leaders (local leadership and extension officers) and smallholder farmers are important in the reduction of disadoption. Extension provides farmers with information on the availability and properties of the new technology and technical skills for using it (Wozniak, 1984). Vanclay (2011) points out that good rapport and providing farmers with practical, useful answers that assist them in their day-to-day operations are important in enhancing the adoption and continuity of new innovations. This study has shown that the lack of good rapport results in CA disadoption.

Conclusion

This study assessed CA disadoption amongst smallholder farmers in the Petauke district of Zambia. The study showed that the most disadopted CA practices among the smallholder farmers in the study area were CA basins followed by ripping tillage systems. There was statistically significant evidence supporting the hypothesis that CA disadoption was associated with high labor demands, lack of incentives, lack of transport for manure, and perceived poor local CA leadership. Further, the study showed that the factors contributing toward the increased likelihood of CA disadoption were lack of transport for manure, lack of adequate knowledge in CA, location, and lack of incentives ($p < .05$). Disadoption of CA can constrain the development of a sustainable agricultural system for smallholder farmers in Zambia. The study thus recommends that CA promoters should train smallholder farmers to become self-reliant in terms of inputs either through livelihood diversification and a change in their mind set to reduce their dependence on free material incentives. CA promoters should focus on demonstrations of the benefits of CA to smallholder farming households rather than the provision of material incentives to lure them to adopt CA. There is a need to increase farmers' access to extension services to enhance their knowledge of CA by both public and non-public actors such as the Ministry of Agriculture and Livestock, and the Conservation Farming Unit.

Commercialization of rippers through small and medium enterprises and local artisans should be encouraged by donors, CA promoters, and Government to increase access to the rippers by smallholder farmers. This would be more effective than CA promoters continually providing free CA implements to would-be adopters during CA project implementation.

There is also a need to include livestock husbandry in CA promotion as access to animal draft power would reduce the labor demands associated with manual CA tillage methods, with manual weeding, manure transportation challenges, and providing smallholder farmers with more manure.

Conflict of interest

None.

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