Farmer preferences for attributes of conservation agriculture in Uganda

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Abstract

Conservation agriculture has many potential benefits for small-scale farmers in developing countries; however, adoption remains low. This study estimates the value that farmers in the Tororo and Kapchorwa districts of Uganda place on some potential benefits of conservation agriculture. Data from a choice experiment study were analysed with a mixed logit model to determine how reductions in erosion, reductions in labour requirements for land preparation, increases in yield and increases in input costs influence farmers' choices of production methods. Willingness-to-pay estimates for increases in maize yield, reductions in erosion and reductions in labour requirements for land preparation are all positive and statistically significant. Preferences for these attributes vary by district, gender and prior farming practices. Male farmers are less sensitive to cost increases than female farmers. Kapchorwa farmers are less sensitive to cost increases than Tororo farmers and also value erosion control and labour reductions more highly.

Key words: choice experiment; conservation agriculture; soil erosion; Uganda; adoption

1. Introduction

While agriculture serves as the livelihood for billions of people around the globe, it often conflicts with its own long-term viability. Sustainable methods, however, can protect agricultural land from soil erosion and degradation. Conservation agriculture (CA) is a system of farming methods that scientists have proposed to fill this role. It is "an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment" (FAO 2014). CA consists of permanent ground cover, reduced tillage, and improved crop rotations.

Soil erosion and fertility loss are problems for many farmers, particularly in developing countries, where farms often are located on marginal, low-productivity lands (Pimentel 2006). It is estimated that the world loses an average of 0.38 millimetres of topsoil each year. Erosion increases water and nutrient runoff and decreases soil water-holding capacity, which decreases productivity (Pimentel 2006). Soil becomes more vulnerable to erosion when it is tilled.

A major goal of CA is to reduce soil erosion and fertility loss. CA can improve water infiltration, make land more resilient to floods, droughts and extreme weather variability, and increase soil

biodiversity (FAO 2014). It may also contribute to carbon sequestration. CA thus may help farmers to mitigate and adapt to climate change. There also is the potential for increased yields as soil health improves, and reductions in labour requirements.

CA currently is being promoted in many African countries, but there are barriers to adoption. Farmers are uncertain about whether CA will be profitable relative to their current practices. In developed countries, CA is practised using mechanical planters, which may not be viable for small-scale farmers. It also is uncertain if and how farmers value the environmental benefits of CA.

This study determined how farmers in Uganda value three potential benefits of CA: increased yields, reduced labour for land preparation, and reduced erosion. It used choice experiment (CE) data collected in two districts of Uganda, Tororo and Kapchorwa, during June 2013, and analyses them with a mixed logit model. It also examined preference heterogeneity for these attributes, including random heterogeneity and systematic heterogeneity by district, gender, prior farming practices, age and education. This approach examines how production method outcomes influence how farmers value and decide between them. The goal of the paper was to help policy makers determine how and to whom to promote CA, because without adoption the benefits of more sustainable methods cannot be achieved. The results should be generalisable to the rest of Uganda and to other areas of Africa that face similar economic constraints and agro-ecological conditions. The methods could be used in any region to examine farmer preferences regarding CA or other sustainable methods. The next section of this paper reviews recent literature on CA. The subsequent sections outline the survey development, methods, results and conclusions.

2. Potential for adoption of conservation agriculture in sub-Saharan Africa

Agriculture is an important sector in African economies, but productivity rates have lagged behind those in other parts of the world, partly because the continent suffers from low soil fertility (Yu & Nin-Pratt 2011). Many studies have examined the effectiveness of CA in African countries, with mixed, but generally positive, findings.

A recent review of the evidence from sub-Saharan African and South Asia finds that yield increases under CA are uncertain and are more likely to occur after a few years of implementation than immediately (Brouder & Gomez-Macpherson 2014). Corbeels *et al.* (2014) found that short-term yield responses to CA tend to be positive but variable, and that yield benefits of CA accumulate over time. Mkoga *et al.* (2010) found that CA plots have higher yield than conventional plots when rainfall is relatively low, but lower yield when rainfall is high. Mazvimavi *et al.* (2010) found that farmers in Zimbabwe who had practised CA for at least five cropping seasons had a higher average maize yield in the 2009 harvest season. In eastern Uganda, the study area of this paper, CA was found to increase maize yields by over 1 000 kg/ha and reduce labour requirements by 11 to 19 family labour days per season (Bashaasha *et al.* 2013).

CA does lead to less soil erosion and greater water infiltration (Stevenson *et al.* 2014). Prior research demonstrates that farmers in Africa are aware of soil fertility and erosion problems and are willing to devote resources to dealing with them. A 2004 study by Asrat *et al.* found that 30% of farmers sampled in Ethiopia stated that they were willing to contribute money for soil conservation practices, and 60% were willing to contribute labour to participate in soil conservation practices. Birungi and Hassan (2007) report that 27.9% of farmers sampled throughout Uganda use traditional methods of enhancing soil fertility.

Few variables consistently explain why farmers adopt CA (Knowler & Bradshaw 2007). Some variables explain adoption in specific studies. These include concern for environmental threats, the

soil erosion rate and income. Others, such as level of education and steepness of slope, are frequently found to be determinants of adoption. Some variables, such as farmer age and farm size, are positively correlated with adoption in some studies but negatively correlated in others. The promotion of CA thus should be tailored to individual locations rather than to people who fit a certain profile (Knowler & Bradshaw 2007).

This study contributes to the information gap by using an experimental method to infer farmer valuation of hypothetical benefits of CA adoption. Knowledge of farmer values is crucial to policy makers and extension workers who wish to identify potential opportunities and challenges for the promotion of CA.

3. Survey development and data collection

3.1 Study area

CA has been promoted in the Tororo and Kapchorwa Districts for several years. Both districts are located in eastern Uganda. Tororo is flat and has an annual, bimodal rainfall of between 1 130 and 1 720 mm (Directorate of Water Development 2010a). Kapchorwa is mountainous, with the elevation ranging from 1 000 to 3 400 metres (Soini 2007). Annual average rainfall varies from less than 1 000 mm in the north to 2 000 mm on the slopes of Mt. Elgon (Directorate of Water Development 2010b). Kapchorwa has fertile, productive volcanic soil; however, loss of land productivity has been identified as the greatest problem facing agriculture in the region. Poor farming methods are the primary cause of the loss (Kapchorwa District Production and Environment Planning Committee 2004).

Staff at Appropriate Technology Uganda (AT Uganda), a local NGO, collected cost and production data from farmers in Tororo and Kapchorwa in June 2014. On average, they found that farmers in Tororo grow between 500 and 1 000 kg of maize per season and spend between 15 000 and 55 000 Ugandan shillings (Ush[1]) on inputs per acre. The sale price for one kg of maize at harvest time is 550 Ush (AT Uganda 2014). In Kapchorwa, farmers grow between 1 000 and 1 200 kg and spend between 71 000 and 366 000 Ush. The maize price at harvest is 650 Ush per kg (AT Uganda 2014). The differences in yield between the two districts can be attributed to higher input use and soil productivity in Kapchorwa. This productivity also likely contributes to the higher input use in a positive feedback loop.

3.2 Survey development

A CE was used to evaluate farmer willingness to pay (WTP) for different attributes of CA. A CE is a stated preference discrete choice method that researchers use to evaluate individuals' valuations of non-market goods and services. Respondents are asked a series of questions that contain attributes or traits that are of interest to the researcher. The respondents must choose between alternatives that contain varying levels of these attributes. Through an analysis of choice outcomes, the researcher can determine how each attribute affects the probability that an individual will make a particular choice. The researcher can then estimate WTP for each attribute if cost is included in the choices. WTP is estimated in order to put a dollar value on preferences. It allows the researcher to see not only how an attribute affects decision making, but how much a participant theoretically would pay for that attribute. It is relevant to this study because CA is likely to increase input costs, and if farmers are not willing to pay for the benefits of CA, adoption may be low or non-existent.

Examining farmer preferences has been a common application of the CE. Jaeck and Lifran (2014) used a CE to examine farmer preferences for technology and outcome attributes in southern France.

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[1] At the time of study, one US dollar was worth approximately 2 500 Ush.

Marenya *et al*. (2014) used a CE to determine which types of policy incentives are most likely to encourage adoption of soil conservation methods among farmers in Malawi.

Pilot testing took place in Tororo in June 2013. The final survey attributes and their levels are included in Table 1.

Table 1: Choice experiment attribute levels

Attribute	Level	Value
Yield	0	Current yield
	1	Current yield plus 100 kg
	2	Current yield plus 200 kg
Soil erosion	0	Current erosion
	1	Current erosion reduced by half
	2	Current erosion reduced almost totally
Land preparation labour	0	Current land preparation labour
	1	Current land preparation labour minus two days
	2	Current land preparation labour minus four days
Input costs	0	Current input costs
	1	Current input costs plus 30 000 Ush
	2	Current input costs plus 60 000 Ush
	3	Current input costs plus 90 000 Ush

Note: All attributes are on a per-acre basis for the current farming season

Because many farmers in the region are illiterate, the CE contained pictures to represent the traits. Attribute pictures are shown as Figures 1 to 4 below.
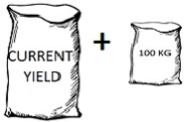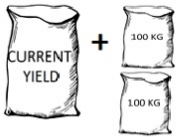

Figure 1: Yield attribute levels

Soil Erosion Attribute	Picture
Current Level of Soil Erosion	
Half Decrease from Current Level of Soil Erosion	
Almost Total Decrease from Current Level of Soil Erosion	

Figure 2: Erosion attribute levels

Note: Images were created by adding arrows to the photograph of soil erosion found at Oregon State University (2008)

Land Preparation Attribute	Picture
Current Land Preparation Labor Requirement	
Current Land Preparation Labor Requirement Minus Two Days	
Current Land Preparation Labor Requirement Minus Four Days	

Figure 3: Land preparation labour attribute levels

Note: Images were created by adding text boxes to the photograph found at Mulago Foundation (2012)
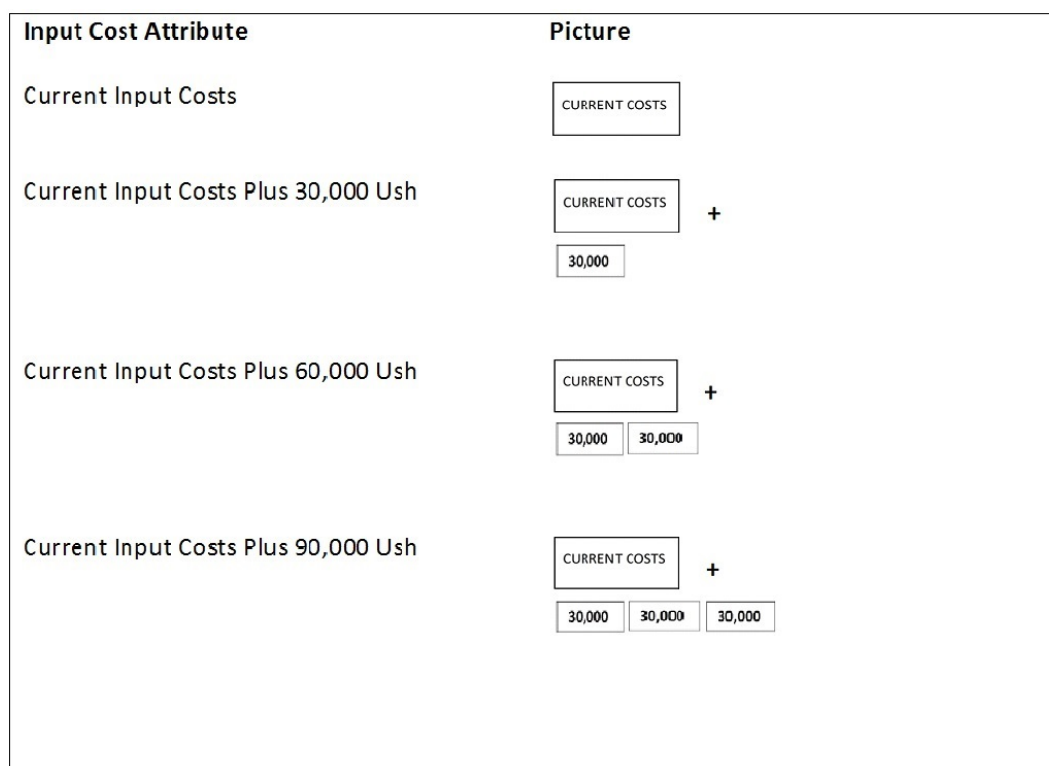
Figure 4: Input cost attribute levels

Two sub-counties were chosen in each district as representative of the overall population of the districts. Ten villages were chosen randomly from each sub-county and ten village households were chosen randomly from each village. Lists of villagers were given to the researchers by local village leaders. Because most farmers in the area do not speak English, data collection was performed by local enumerators. The enumerators went through day-long training that included explanations and practise of the surveys. Each enumerator was required to do a practice survey for the researchers to demonstrate that he or she understood and could properly administer the survey. Surveys were administered in June 2013. Two hundred farmers from each district were interviewed, and the data from farmers who were growing maize at the time were analysed.

The survey consisted of demographic questions, three choice sets and an example choice set. Each choice set included three options: Option A, Option B and Option C. Option A always represented a "no change" scenario; it contained the levels of "Current Yield", "Current Erosion", "Current Land Preparation Labour", and "Current Costs". Options B and C were randomly selected from a pool of scenarios according to an optimal design (more below).

The example question given to each participant was structured identically to the regular choice sets, except that Option C in the example had the highest level of utility, unambiguously, unless a farmer placed no value on any of the attributes, which was unlikely. If a farmer did not choose option C, it was assumed that she did not understand the question, so her responses to the subsequent choices were discarded. This served as a test of understanding for the experiment. Overall, only 18 respondents did not choose option C. The example question is shown in Figure 5.
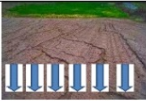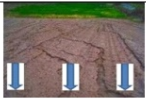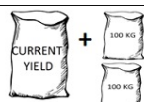
Figure 5: Choice experiment example question

3.3 Experimental design

Efficient design can be employed when developing the CE to reduce standard errors in parameter estimates. In situations in which it is possible to make estimates of the parameters, efficient designs are best (Choicemetrics 2012). Data from the pilot study were evaluated using a conditional logit model. The parameter estimates from this model were used as priors in the Ngene (Choicemetrics 2012) script to generate choice sets for the study. Twenty-four choice sets were generated and broken into groups so that each farmer had three choice sets to respond to.

4. Analytical methods

4.1 Random utility theory

Discrete choice models use random utility theory to estimate the probability that an alternative is chosen (McFadden 1974). This probability depends on the attributes of the alternative, competing options, and the characteristics of the individual. The utility an individual obtains from object j is:

$$U_j = V_{j+}\, e_j \tag{1}$$

U_j is the latent, unobserved utility obtained for the individual from object j. V_j is a vector of attributes of object j. These attributes can be observed and measured by the researcher, making up the systematic component of utility. The term e_j is a random error component containing unobserved factors influencing utility. Logit models assume that e_j follows a logistic distribution and is independently and identically distributed (iid).

Utility theory predicts that each individual makes choices to maximise her utility (Adamowicz *et al.* 1998). In the context of consumer choice, an individual will thus choose object j when the utility she obtains from j is higher than the utility she obtains from other choices. When compared to a different object choice, i, this means that she will choose option j over i when

$$V_j + e_j > V_i + e_i \quad \forall\, j \neq i \tag{2}$$

The probability of choosing object j is

$$rob \{j\ chosen\} = prob \{V_j + e_j > V_i + e_i\ \forall i \in C\} \tag{3}$$

where C is the set of all possible alternatives.

4.2 Random utility model estimation

The data from this study were analysed using a mixed logit model, a type of random utility discrete choice model commonly used for CE analysis. The mixed logit model has a flexible functional form that allows for heterogeneous preferences, or random taste variation. Variables (representing the attributes that affect utility) can be specified as having either fixed or random coefficients. Random coefficients have both a mean and a standard deviation, allowing for random preference heterogeneity as they can vary throughout the population. The mixed logit model also allows for unrestricted substitution patterns, relaxing the independence of irrelevant alternatives (IIA) assumption, and for correlation between unobserved factors over time (Train 2003). The IIA assumption states that, if an individual prefers A over B, then the addition of a third option, C, will not change that ranking. While this is consistent with economic theory, this assumption may or may not hold empirically. The mixed logit model also accounts for the panel nature of choice data by including an individual specific error term that is correlated across the choices made by a particular individual (Bateman *et al*. 2008).

The alternative specific constant (ASC) acts as an estimated constant in mixed logit modelling to control for unobservables. In the context of this CE, the ASC captures the difference in utility between the status quo and non-status quo options, controlling for all other attributes. If the ASC is statistically significant, it means that the respondents had a systematic preference for choosing a non-status quo option.

Attribute levels are included as variables in the model (Table 2). *Additionalyield*, *labordecrease* and *cost* are coded as continuous variables. *ASC* is coded as one if the respondent chose option B or C and 0 if he or she chose A. *Half* and *total* are effect coded, with the status quo level set to -1 for all observations. Effect coding is recommended for qualitative variables in discrete choice modelling, as it maintains the orthogonality of the design (Bech & Gyrd-Hansen 2005). All variables are specified as random with normal distributions, with the exception of *cost*, which is specified as fixed, meaning that the model does not allow its coefficient to vary over the population. Revelt and Train (2000) recommend using a fixed cost coefficient for ease of evaluating WTP estimates and to help model stability. This guarantees finite WTP confidence intervals, as WTP is calculated by dividing attribute coefficients by the cost coefficient. If the cost coefficient is specified as random, it sometimes may be arbitrarily close to zero, resulting in infinite WTP confidence interval estimates (Carson & Czajkowski 2013).

It is hypothesised that *ASC* will not be statistically significant, and that the coefficients for all other attributes aside from *cost* will be statistically significant and positive. *Cost* should have a significant and negative coefficient.

Table 2: Model variables

Variable Name	Definition/concept
ASC (alternative specific constant)	Constant term estimated as a part of mixed logit models
additionalyield	Additional 100 kg bags of maize
currenterosion	Current level of soil erosion
half	A reduction in soil erosion by 50%
total	An almost total reduction in soil erosion
labordecrease	Decrease in labour requirements in increments of 1 day
cost	An increase in input costs

4.3 Systematic preference heterogeneity

Systematic preference heterogeneity may be present in the study population. In particular, a respondent's gender, location, experience with prior farming practices, age and education level all may affect how she values the CE attributes. It is hypothesised that farmers who live in Kapchorwa will value decreases in erosion more highly than farmers in Tororo, because Kapchorwa is more mountainous and therefore more vulnerable to erosion. Farmers who have practised CA methods in the past are expected to place a higher value on decreases in soil erosion and be more likely to choose a non-status quo option because their past farming behaviour suggests these preferences. Male and female farmers may also have different preferences. Higher levels of education may make farmers more aware of the benefits of erosion control and of choosing new farming practices. Finally, older farmers may be less likely to choose a non-status quo farming option. In order to measure how these factors influence preferences, interaction terms between the demographic variables and the attributes presented in the CE are added to the model (Kragt & Bennett 2011). These terms are presented in Table 3.

Table 3: Interaction variables

Variable name	Definition
kapASC	Interaction term between the respondent living in Kapchorwa and the *ASC* variable
kaphalf	Interaction term between the respondent living in Kapchorwa and the *half* variable
kaptotal	Interaction term between the respondent living in Kapchorwa and the *total* variable
kapyield	Interaction term between the respondent living in Kapchorwa and the *additionalyield* variable
kaplabor	Interaction term between the respondent living in Kapchorwa and the *labordecrease* variable
kapcost	Interaction term between the respondent living in Kapchorwa and the *cost* variable
maleASC	Interaction term between the respondent being male and the *ASC* variable
maleyield	Interaction term between the respondent being male and the *additionalyield* variable
malelabor	Interaction term between the respondent being male and the *labordecrease* variable
malehalf	Interaction term between the respondent being male and the *half* variable
maletotal	Interaction term between the respondent being male and the *total* variable
malecost	Interaction term between the respondent being male and the *cost* variable
mintilASC	Interaction term between having ever practised minimum tillage and the *ASC* variable
mintiltotal	Interaction term between having ever practised minimum tillage and the *total* variable
coverASC	Interaction term between having ever practised using cover crops and the *ASC* variable
covertotal	Interaction term between having ever practised using cover crops and the *total* variable
rotateASC	Interaction term between having ever practised crop rotation and the *ASC* variable
rotatetotal	Interaction term between having ever practised crop rotation and the *total* variable
educationASC	Interaction term between years of education and the *ASC* variable
educationtotal	Interaction term between years of education and the *total* variable
ageASC	Interaction term between age and the *ASC* variable

4.4 Willingness to pay

Mean WTP is computed using the estimated coefficients of the mixed logit model by dividing the attribute coefficient by the input cost coefficient.

$$WTP_{Attribute} = \beta_{Attribute}/\beta_{Cost} \tag{4}$$

Standard errors and confidence intervals for the WTP estimates are evaluated using the Krinsky-Robbs method (Hole 2007).

It is hypothesised that *additionalyield*, *half*, *total* and *labordecrease* will have a positive and statistically significant WTP value. The WTP for *additionalyield* should be between 55 000 Ush and 65 000 Ush, the market prices for 100 kg of maize in Tororo and Kapchorwa respectively.

5. Results and discussion

5.1 Overview of results

The results show that the farming outcome attributes of the study affect farmer decision making and that farmers have a statistically significant WTP at the 5% level for *additionalyield*, *half* and *total*. Willingness to pay for *labordecrease* is significant at the 10% level. In addition, preferences vary by gender, location and prior farming practices.

5.2 Individual and household demographic characteristics

Table 4 gives descriptive statistics from the sample. The residents of Kapchorwa were, on average, significantly younger and better educated than those of Tororo. They also had less farming experience and fewer children.

Comparing the descriptive statistics of the sample population with those of Uganda indicates how representative the sample is of the overall population of the country. In Uganda, adults over the age of 25 have had 4.7 years of schooling on average, a number that has been growing steadily over the past few years (United Nations Development Programme 2013). The sample population of this study had a higher average level of schooling. This may be because the sample is of adults over the age of 18, rather than 25. Average household size in eastern Uganda in 2009/2010 was 5.6 people (Uganda Bureau of Statistics 2010), lower than the average household size in the sample. Nearly 60% of heads of households in Uganda are between the ages of 26 and 49, which covers the average age in the sample (Uganda Bureau of Statistics 2010). Average farm size in the sample falls within the average estimate for the country (Republic of Uganda Ministry of Agriculture, Animal Industry and Fisheries 2011). Based on this brief comparison, the sample of this study appears to be roughly representative of the country as a whole, although the sample population has a higher average level of education and household size than the average of Uganda.

Table 4: Descriptive statistics

Demographic characteristic	Total sample	Tororo	Kapchorwa	P-value
Gender (% male)	47.4%	47.7%	47.0%	0.7244

Location	Tororo 46.6%
	  Molo 26.4 %
	  Kisoko 20.2 %
	Kapchorwa 53.4%
	  Kwosir 29.1 %
	  Kapchesombe 23.2%			

Age	42.6 (15.2)	45.2 (15.6)	40.4 (14.5)	0.0000
Years of education	5.8 (3.9)	5.5 (4.0)	6.2 (3.8)	0.0000
Years of farming experience	24.3 (15.6)	29.3 (17.1)	19.9 (13.4)	0.0000
Household members	7.2 (3.2)	7.2 (3.1)	7.2 (3.2)	0.9692
Household members who work on farm	4.2 (2.4)	4.1 (2.3)	4.2 (2.5)	0.1160
Number of children under 13	2.9 (1.9)	3.1 (1.9)	2.7 (1.8)	0.0000

Note: Table gives the mean and (standard deviation) for each variable for the total sample, and for Tororo and Kapchorwa. The p-values are for the test that the values in Tororo and Kapchorwa are equal.

Table 5 gives descriptive statistics of farm characteristics and farming practices. Although CA as a system has not had widespread adoption, the individual practices of CA have been practised by some farmers in the area. These statistics indicate that farmers are interested in protecting their soil, and that farmers in Kapchorwa are more concerned with erosion than those in Tororo. More farmers in Kapchorwa have practised minimum tillage and used a cover crop than those in Tororo, while crop rotation is more popular in Tororo.

Table 5: Farm characteristic and farming practice descriptive statistics

Farm characteristic/Farming practices	Total sample	Tororo	Kapchorwa	P-value
Acres farmed this season	3.0 (5.7)	2.8 (1.8)	3.2 (7.6)	0.0545
Acres owned	2.5 (5.4)	2.5 (1.7)	2.6 (7.3)	0.7029
Have you ever used/practised _____ in the past? (% responding yes)				
Reduced tillage	25.0%	16.4%	32.6%	0.0000
Cover crops	67.5%	60.5%	73.6%	0.0000
Crop rotation	86.4%	92.1%	81.7%	0.0000
Do you currently use/practise _____? (%responding yes)				
Reduced tillage	22.3%	11.8%	31.6%	0.0000
Cover crops	63.7%	55.0%	71.2%	0.0000
Crop rotation	84.6%	92.1%%	81.4%	0.0000
Do you view erosion as a problem on your field? (% responding yes)	93.6%	90.1%	96.6%	0.0000
Are you doing anything to control erosion?	85.1%	85.4%	84.9%	0.6794

Note: The p-values are for the test that the values in Tororo and Kapchorwa are equal.

5.3 Mixed logit model results

The model results lead to rejection of the null hypothesis that all standard deviations are zero, meaning that preference heterogeneity exists in the sample.[2] This confirms that the mixed logit model is an appropriate model choice.

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[2] The data were initially analysed with a conditional logit model, which assumes independence of irrelevant alternatives (IIA) and fixed preferences, while the mixed logit model does not. A Hausman test proved that the IIA assumption does not hold for these data (Hausman & McFadden 1984).

The model was first run without the demographic interaction term variables to obtain coefficients from which to calculate WTP estimates. When interaction terms are included, it is unclear for whom the WTP estimates are relevant. Therefore, full-sample WTP estimates are calculated from the model that includes no interaction terms. Preference heterogeneity is then examined separately with the full model.

All variables in the restricted model are significant at the 5% level, with the exception of *labordecrease*, which is significant only at 10% (Table 6). All coefficients have the expected signs, with the exception of *ASC*, which was not expected to be significant. *ASC* is statistically significant at the 5% level and positive. This indicates that farmers have a preference for choosing a non-status quo option after controlling for the attributes included in the experiment. Variables that have a statistically significant standard deviation exhibit preference heterogeneity. Here, *half* and *labordecrease* do not have significant standard deviations, while *total*, *additionalyield* and *ASC* all exhibit preference heterogeneity.

WTP estimates derived from the results in Table 6 are found in Table 7. They represent WTP for farm outcomes in the current farming season. All are significant at a 5% level, except for *labordecrease*, which is significant at 10%. Farmers were willing to pay 55 821 Ush ($22.33) for a 100 kg increase in maize yield, 26 031 Ush ($10.41) for a one half reduction in erosion, 139 654 Ush ($55.86) for a near total reduction in erosion, and 8 073 Ush ($3.23) for a one-day decrease in land preparation labour.

The estimated WTP for an increase of 100 kg of maize lies between the harvest selling prices of 100 kg of maize in the two districts. This is to be expected and lends confidence that the results make sense and reflect reality.

Although no data were available for the Tororo and Kapchorwa districts specifically, a 2012 study that surveyed 1 300 workers throughout the country found the median wage to be 1 121 Ush (Besamusca *et al.* 2012). The WTP of farmers in this CE study for a reduction in one day of labour thus appears to be reasonable.

Farmers are willing to pay a much larger premium for a "near total" decrease in erosion than for a 50% decrease in erosion. It would be expected that farmers would be willing to pay less for the second half of erosion control than for the first half, but the results imply that there may be an added psychological benefit to being rid of almost all erosion. The WTP for erosion reduction represents what farmers are willing to pay to prevent off-farm damages from their erosion during the season, as well as any future benefits they perceive it will bring their farm. The erosion variable captures off-farm and future benefits of erosion control.

The interaction term results are presented in Table 6. All interaction terms were treated as fixed variables to reduce model convergence time. Only five interaction terms are significant. These are *kapcost* (5%), *kaplabor* (5%), *kaptotal* (1%), *coverASC* (10%) and *malecost* (5%). The significance of the district interactions indicates differences in valuation of the attributes between the two study areas. Farmers from Kapchorwa value total erosion control and labour savings more than farmers in Tororo, and they care relatively less about input cost increases. Male farmers care less than female farmers about input cost increases. Farmers who have practised cover cropping in the past are more likely to choose a non-status quo option. A likelihood ratio test confirms that the addition of interaction terms improves model fit.

The results therefore indicate significant preference heterogeneity amongst the respondents, both random and systematic. Random taste variation exists in the region for total erosion reductions,

increases in yield, increases in input costs and choosing a non-status quo option. Preferences also vary by district, gender and prior farming practices.

Table 6: Mixed logit results

	Mixed logit			Mixed logit with significant interactions		
	n	2931		n	2868	
	LR chi^2 (6)	81.82		LR chi^2 (6)	59.83	
	Prob > chi^2	0		Prob > chi^2	0	
	Log likelihood	-467.5		Log likelihood	-433.7	
Mean						
ASC	2.98979	(-1.20458)	**	1.691932	(-1.050356)	
additionalyield	0.83189	(-0.15281)	***	0.887914	(-0.160074)	***
half	0.38794	(-0.11073)	***	0.389724	(-0.113042)	***
total	2.08124	(-0.22293)	***	1.544685	(-0.22836)	***
labordecrease	0.12031	(-0.07222)	*	0.01825	(-0.08531)	
cost	-0.00001	(0)	***	-2.90E-05	(-6.74E-06)	***
kaptotal				1.115772	(-0.277745)	***
kaplabor				0.250692	(-0.106343)	**
kapcost				1.87E-05	(-7.40E-06)	**
malecost				1.40E-05	(-6.42E-06)	**
coverASC				1.427545	(-0.75451)	*
Standard deviation						
ASC	2.36301	(-0.82342)	***	1.932513	(-0.808099)	**
additionalyield	0.79361	(-0.2097)	***	0.854852	(-0.21586)	***
half	0.00723	(-0.19886)		0.01135	(-0.210983)	
total	1.38295	(-0.21888)	***	1.247721	(-0.226515)	***
labordecrease	0.04446	(-0.15123)		0.008939	(-0.149572)	

Note: * significant at 10%; ** significant at 5%; *** significant at 1%. The "n" for the two sets of results differs because some observations were missing information for certain demographic variables. Running the original model with n = 2 868 changes the results only slightly. The likelihood ratio test comparing these two models was run using the same observations for both models.

Table 7: Results for willingness to pay (rounded to the nearest Ush)

	additionalyield	half	total	labordecrease
WTP	55 821	26 031	139 654	8 073
LL	26 013	9 436	83 330	-1 076
UL	165 506	78 877	349 597	37 332

Note: LL and UL are lower level and upper level of a 95% confidence interval respectively, and were calculated using the Krinsky-Robb simulation method with 15 000 draws.

6. Conclusions and discussion

The literature indicates that CA has the potential to raise long-term yields, decrease labour requirements and improve soil quality and health, while reducing erosion; however, adoption amongst small-scale farmers in sub-Saharan Africa, including in Uganda, has been slow. Without adoption the benefits of CA will never be realised. In order for policy makers and extension workers to promote the practices, they need to know which of the potential outcomes of CA are valued by farmers. These results imply that erosion control, yield increases and labour savings could all induce farmers to adopt CA. Farmers had a positive and significant WTP for increases in yield and reductions in erosion in the current season, at a 5% significance level. These WTPs are encouraging for policy makers who wish to promote CA practices. If CA has a positive impact on erosion control, yield or reductions in the labour requirements for land preparation, farmers may be willing to adopt it even if it raises input costs by as much as the WTP estimates.

The significant *ASC* coefficient suggests that farmers were biased toward choosing a non-status quo option while completing the CE. There is something about switching from their current farming

outcomes that appeals to farmers, aside from the attributes in the experiment. This could be encouraging for the spread of CA, as it indicates that farmers are at least hypothetically interested in trying something new.

If CA decreases erosion, reduces labour requirements or increases costs, farmers in Kapchorwa may be more likely to adopt than farmers in Tororo, which means that policy makers in this and in other regions may wish to focus CA promotion in mountainous areas. In addition, farmers who have used a cover crop in the past may be more likely to choose a new farming method compared to farmers who have not. Extension workers therefore may wish to target their efforts in promoting CA among farmers who have already tried cover cropping. Lastly, women care relatively more about cost increases than do men. This cost sensitivity indicates that women make more budget-conscious farming decisions. The preferences of farmers of different education levels, age and most prior farming practices do not vary systematically, indicating that these groups make farming decisions in similar ways. Policy makers and extension workers can use this knowledge to target the promotion of CA more effectively in order to increase the adoption of sustainable agricultural methods.

Acknowledgements

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