Smallholder Farmers' Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia

Progress H Nyanga (Corresponding author), Fred H Johnsen & Jens B Aune
Department of International Environment and Development Studies (Noragric)
Norwegian University of Life Sciences, P.O Box 5003, NO-1432 Ås, Norway
Tel: +47-47707345/+260-979922201 Fax: +47-64965201
E-mail: progress.nyanga@umb.no or pnyanga@yahoo.co.uk

Thomson H Kalinda
Department of Agricultural Economics and Extension Education
The University of Zambia, P.O Box 32379, Lusaka, Zambia

Received: April 21, 2011 Accepted: May 10, 2011 doi:10.5539/jsd.v4n4p73

The study was conducted under Conservation Agriculture Programme in Zambia funded by the Norwegian Ministry of Foreign Affairs through the Royal Norwegian Embassy, Lusaka to Conservation Farming Unit. The views expressed in this paper are not of the sponsors but the authors.

Abstract

Actors involved in promoting conservation agriculture have often not taken into account perceptions of smallholder farmers of climate change and conservation agriculture as an adaptation strategy. This study documents smallholder farmers' perceptions of climate change and conservation agriculture. Most farmers attributed climate change to supernatural forces. Smallholder farmers' perceptions related to floods and droughts were significantly associated with adoption of conservation agriculture. The extent to which smallholder farmers perceived conservation agriculture as a climate change adaptation strategy was very low. This suggests existence of other important reasons for practicing conservation agriculture than adaptation to climate change. Policy implications of the study are: conservation agriculture projects should not only focus on technical approaches to increase adoption rates but also consider social aspects such as perceptions that are equally important in conservation agriculture. Inclusion of climate change communication to facilitate exchange of climatic information that could enable smallholder farmers relate to conservation agriculture as an adaptation strategy is essential.

Keywords: Adaptation, Technology adoption, Climate change, Conservation agriculture, Perceptions, Small-scale farmers, Zambia

1. Introduction

Adverse effects of climate change continue to be a major threat to rural livelihoods (IPCC, 2007a, 2007b; Nhemachena, 2009; Pouliotte, Smit, & Westerhoff, 2009). This poses a challenge of developing innovative technologies to improve rural livelihoods and environmental conservation and ensuring adoption of such technologies. Climate change refers to any change in climate over time, whether due to natural variability or/and as a result of human activity (IPCC, 2007a:871). This paper uses the term climate change in a broad context that includes changes in weather variability. Climate change imposes constraints to development especially among smallholder farmers whose livelihoods mostly depend on rain-fed agriculture (IPCC, 2007b; Tanner & Mitchell, 2008). Negative impacts of extreme events such as floods and droughts are expected to be high in developing countries especially in rural areas (Adger, Hug, Brown, Conway, & Hume, 2003; IPCC, 2007a).

In an era where climate change is central in development policies and practice, conservation agriculture appears to potentially contribute in addressing the challenge of adapting agricultural practices to climate change (FAO, 2011a; Giller, Witter, Corbeels, & Tittonell, 2009; Govaerts et al., 2009). Conservation agriculture is defined as an agricultural system involving minimum soil disturbance, permanent residue soil cover and diversified crop rotation (FAO, 2008; Govaerts et al., 2009; Hobbs, Sayre, & Gupta, 2008). It is a mix of agronomic practices proposed as essential for soil and water conservation, building and maintaining healthier soils, sustainable optimal crop production and maintenance of a rich agro-biodiversity (Dumanski, Peiretti, Benetis, McGarry, & Pieri, 2006; FAO, 2008). Conservation agriculture is claimed to reduce negative impacts of climate change by optimising crop yields and profits while maintaining a balance between agricultural, economic and environmental benefits (CFU, 2006; FAO, 2011b; Giller et al., 2009).

Promotion of conservation agriculture is influencing agricultural development in Sub-Saharan African countries like Zambia. In Zambia, development of conservation agriculture can be traced from the late 1980s and early 1990s (Haggblade & Tembo, 2003a). Hand hoe conservation agriculture technology recommends digging 15 850 permanent conservation planting basins per hectare. For animal draft power, a ripper is the main conservation agriculture technology for minimum tillage (CFU, 2009b).

Since the establishment of Conservation Farming Unit (CFU) of the Zambia National Farmers' Union in 1995, CFU has taken a leading role in training and promoting conservation agriculture in the country. In a series of donor supported projects and programmes, conservation agriculture programme (CAP) is the most recent. The first phase of CAP has been implemented by CFU from 2007 to 2011 funded mainly by the Norwegian Ministry of Foreign Affairs (CFU, 2006).

Review of literature shows that the donor community, international development agencies, regional political bodies, Non Governmental Organisations (NGOs), farmers' organisations and national government involved in conservation agriculture promotion have often not taken into account perceptions of smallholder farmers of climate change and conservation agriculture as an adaptation strategy (CFU, 2006; FAO, 2009, 2011b). Several studies on farmers' perceptions of climate change have shown a high correspondence of resource users' perceptions of climate change to meteorological data (Deressa, Hassan, Alemu, Yesuf, & Ringler, 2008; Maddison, 2007; Mertz, Mbow, Reenberg, & Diouf, 2009; Slegers, 2008; West, Roncoli, & Ouattar, 2008). This study uses a different approach that links perceptions of resource users to adoption of a planned adaptation strategy, conservation agriculture.

The study documents smallholder farmers' perceptions of climate change and adoption of conservation agriculture by addressing the following research questions:

1. What are smallholder farmers' perceptions of climate change?
2. What are smallholder farmers' perceptions of causes of climate change?
3. Is there any association between smallholder farmers' perceptions of climate change and adoption of conservation agriculture?
4. To what extent do smallholder famers perceive conservation agriculture as an adaptation strategy to climate change?

1.1 Theoretical perspectives: Climate change adaptation, perceptions and technology adoption

Adaptation is one of the policy options to climate change that is influencing development practice (IPCC, 2007a; Tanner & Mitchell, 2008). Adaptation to climate change refers to adjustments to practices, processes and systems to minimise current and/or future adverse effects of climate change and take advantage of available opportunities to maximize benefits (Eriksen et al., 2011; Pouliotte et al., 2009; Smithers & Smit, 2009). Adaptations can either be planned or autonomous with the latter being done without awareness of climate change predictions but based on experience and prevailing conditions (Smithers & Smit, 2009).

Adaptation does not occur without influence from other factors such as socio-economic, cultural, political, geographical, ecological and institutional that shape the human-environment interactions (Eriksen et al., 2011). Adaptation to climate change is needed both in the short term and long term basis (Adger et al., 2003; Eriksen et al., 2011; Pittock & Jones, 2009). The adaptation theory posits that social, economic, ecological and institutional systems as well as individuals can and do adapt to changing environment (Smithers & Smit, 2009:19). The extent of sustainable adaptation depends on the adaptive capacity, knowledge, skills, robustness of livelihoods and alternatives, resources and institutions accessible to enable undertaking effective adaptation (IPCC, 2007a). The adaptive capacity is influenced by factors such as knowledge about climate change, assets, access to appropriate technology, institutions, policies and perceptions *inter alia* (Adger et al., 2003; IFAD, 2008). Smithers and Smit (2009) contend that environmental perceptions are among key elements influencing adoption of adaptation strategies. Actions that follow perceptions of climate change are informed by different processes such as perception of risk associated with climate change, resource endowments, cultural values, institutional and political environment and there is no guarantee that having perceptions that climate change has or is occurring would prompt effective adaptation responses (Weber, 2010).

Technology adoption has been guided mainly by innovation-diffusion paradigm, economic constraint paradigm and adopter perception paradigm. Rogers' innovation-diffusion paradigm identifies information dissemination as a key factor in influencing adoption decision (Adesina & Zinnah, 1993; Prager & Posthumus, 2010; Rogers, 2003). The economic constraint paradigm contends that technology adoption is influenced by utility maximization behaviour and economic constraints due to asymmetric distribution of resources (Deressa et al., 2008; Prager & Posthumus, 2010).

The adopter perceptions paradigm posits that the adoption process starts with the adopters' perception of the problem and technology proposed (Adesina & Zinnah, 1993). This paradigm argues that perceptions of adopters are important in influencing adoption decisions (Prager & Posthumus, 2010). Perceptions are context and location specific due to heterogeneity in factors that influence them such as culture, education, gender, age, resource endowments and institutional factors (Ervin & Ervin, 1982; Posthumus, Gardebroek, & Ruerd, 2010).

2. Research methods

2.1 Study areas and sampling

The study areas consisted of 12 districts: Choma, Kalomo, Mazabuka, Monze, Sinazeze, Chibombo, Chongwe, Kapiri Mposhi, Mumbwa, Chipata, Katete and Petauke (Fig 1). These districts were chosen because conservation agriculture programme (CAP) has been operating there since 2007. The districts are organised into four regions: Southern, Central, Western and Eastern for operational purposes of CAP. Districts Choma, Kalomo, Mazabuka and Sinazeze consititute the Southern region; Chibombo and Chongwe constitute Central region; Western region has Mumbwa district while the Eastern region consists of Chipata, Katete and Petauke districts. Each region had 10 agricultural extension officers. This study uses same farmers that were randomly selected in 2007 for the purposes of monitoring and evaluation of CAP. In 2007, the random sample was drawn from updated CAP registers. Under each agricultural extension officer 16 farmers were randomly chosen resulting in a selection of 160 farmers from each of the four regions. Hence, a total sample of 640 farmers was selected. Out of the 2007 sample, 469 farmers in 2009 were available for interviews on which this study is based. The sample had reduced to due to deaths, migration, declining to be interviewed and non availability of respondents at the time of interviews. Purposive sampling was used in the selection of key informants and focus group discussants so as to have participants who are known to have opinions and experiences on the topics for discussion. CAP has targeted 120,000 smallholder farmers to adopt conservation agriculture technologies from 2007 to 2011. Haggblade and Tembo (2003b) defined smallholder farmers as those farmers farming less than 20 hectares.

CFU provides extension support to selected farmers in the study areas in an effort to increase the adoption of minimum tillage, crop rotation including legumes and crop residue retention. To these core conservation agriculture principles CFU has also integrated early land preparation and planting, accurate and precise input application, early weeding and planting of *Faideherbia albida* (locally known as *musangu* tree) for soil fertility improvement (CFU, 2009b). Common crops grown in the study areas are maize, sweet potatoes, cassava, mixed beans, cowpeas, cotton, sorghum, millet, sweet stalks, pumpkins, water melons and cucumbers. Crop production is dependent on rain and smallholder farmers are often not involved in irrigation (Siegel & Jeffrey, 2005). The main livestock kept in the study areas are cattle, goats, pigs and poultry.

2.2 Data collection and analysis

A total of 469 randomly sampled farmers were interviewed using a structured questionnaire with closed and open ended questions (Bryman, 2008). Research objectives and theory informed the kind of data collection methods used while research questions influenced the type and content of questions used in this study. Information to be collected was characterised in three categories in accordance to Newing (2011) being: basic characteristic of respondents; information on knowledge (memories and experiences regarding climate changes) and information on behaviour (adoption of conservation farming). The questions for the questionnaire and interview guide for key informants were jointly developed by authors. After pre-testing, the research instruments were revised.

For information on personal attributes, respondents were asked to state their age or when they were born and highest level of formal education attained. On information on respondents' knowledge, questions sought causes of climate change, perceived changes on onset and offset of seasons, duration of seasons, coldness, hotness, frequency of droughts and floods. Questions were framed in a way that allowed respondents to compare conditions in the recent past (less than 5 years) and long time ago (time from their teenagehood). The period of teenagehood was used because farmers could more easily relate to such specification of time compared to using numbers such as 30 years ago. This became apparent during the pre-testing of the questionnaire. Focus group discussions, key informant interviews and review of secondary data were also conducted (Newing, 2011).

Respondents were asked if they had experienced any change or not in the onset and offset of seasons since their teenagehood. If respondents had experienced any change, they were asked to state whether the onset of a season came early or delayed in the recent past as compared to a long time ago. Bryman (2008) emphasises the importance of ensuring trustworthiness, that the responses and findings are believable, in social research. Therefore, respondents were asked to state months for the onset and offset of respective seasons in the recent past and a long time ago to allow cross-checking of responses. This was also useful in calculating the durations of seasons in the recent past and long time ago in order to determine any perceived changes in duration. For perceptions of changes in coldness, hotness, droughts and floods, farmers were asked to state if conditions had increased, decreased or remained the same since their teenagehood as compared to the recent past. Farmers were also asked to list causes of climate change, positive and negative effects of climate change that they have experienced and responses they have undertaken. For the information on behaviour (adoption of conservation agriculture in this case), respondents were asked to state if they had any area under conservation agriculture. Area under minimum tillage was used as a proxy indicator for adoption of conservation agriculture.

Descriptive statistics was used to analyse quantitative data and results were presented either as percentages or counts. Percentage of farmers who cited conservation agriculture as a response to climate change was used to indicate the extent to which conservation agriculture was perceived as an adaptation strategy. Pearson

Chi-Square (χ^2) test was used to determine at 5% significance level any association between smallholder farmers' perceptions of climate change and their adoption of conservation agriculture. Area under minimum tillage for both conservation farming basins and animal draft power ripping was used as a proxy indicator for adoption of conservation agriculture. From farmers' responses on the months when a particular season was starting and ending, the durations of seasons was calculated in the recent past and long time ago. A paired t-test was then used to test if there were any significant differences at 5% level in the changes in mean duration of seasons from farmers' perspective. This also provided a check for consistency in farmers' responses and perceptions in accordance to the requirement of ensuring credibility of results (Newing, 2011). Content analysis was used in the analysis of qualitative data (Bryman, 2008). Lists of causes of climate change, effects and responses undertaken were summarised according to emerging themes and presented as counts. Qualitative analysis of information from focus group discussions and key informant interviews is a continuous process starting during data collection with identification of major themes and ending with an in-depth description of the results. In accordance to Newing (2011) data from focus groups and key informants was summarised according to key themes and illustrated by direct quotes, recounting particularly relevant experiences and views of smallholder farmers, essential for authenticity of findings.

This study relies on farmers' recall of climate and weather changes. This imposes a limitation in this study as it could have been difficult for most farmers to remember past events. However, the use of multiple methods of data collection, local names of seasons when collecting data, local time frames such as teenagehood, climatic events that can easily be remembered such as droughts and floods due to their severe impact on livelihood and food security helped in addressing the limitation.

3. Results

Females accounted for 44.1% of respondents and males 55.9%. The average age for respondents was 45.8 years with 85.1% being above 30 years of age. Majority (68.7%) had not more than 7 years of primary education. Results indicated that 65.0% of the respondents had adopted conservation agriculture by the third year of CAP implementation.

3.1 Perceptions of changes in the onset and offset of seasons

There are three main seasons in Zambia: rainy season (wet warm season) normally from November to April; cold season (cold and dry winter) normally from May to July; and hot season normally from August to October (Saasa, 2003). Most farmers experienced changes in the onset of the cold season (59.4%), the hot season (56.5%) and the rainy season (80.5%). Similar trend was observed on the offset of seasons (Table 1). Most farmers felt that the rainy season started later and stopped earlier in the recent past as compared to a long time ago. Respondents were more aware of climatic changes related to the rainy season than other seasons. A 57 years old farmer explained that:

> "...there were clear cut differences in the seasons when we were young but nowadays there is a lot of mix, it gets cold when it is not supposed to and gets hot when it wants, rains are no longer good... Seasons are confusing nowadays..."

The results show a shift in the timing of seasons. However, a Chi-Square (χ^2) test showed no significant association between smallholder farmers' perceptions of changes on the onset and offset of seasons and their adoption of conservation agriculture.

3.2 Perceptions of changes in duration of seasons, temperature, droughts and floods

Farmers who perceived an increase in the duration of the cold season were more than those who did not. Most farmers perceived no change in the duration of the hot season but reduction in the rainy season duration. Cross checking with paired t-test of changes in duration of seasons from farmers' responses shows significant changes in both cold season and rainy season indicating consistency in smallholder farmers' responses and perceptions (Table 1). Discussants and key informants often pointed out that the cold season was extending with increasing incidences of cold days or cold spells during hot and rainy season while the rainy season had shortened.

It was very common for focus group discussants to come easily to a consensus that there is an overall increase in temperatures (increase in hotness and reduction in coldness). A male key informant born in 1924 observed that:

> "Cold season used to start in May, *Kaanda kaniini* (local name for May meaning "a small freezing" directly translation from Chitonga a dominant language in Southern Zambia) and in June, *Ganda pati* (meaning "a big freezing") it was common to find some ice in *misena* (dambos) but it is not common nowadays because of hotness..."

Another key informant in her 80s pointed out that:

> "...when we were young, we used to find some ice around the mouth of wells in the morning during *mupeyo* (winter) when we went to draw water but nowadays there is nothing because of hotness..."

Perceptions of changes in frequency of droughts and floods were significantly associated with adoption of conservation agriculture. Most key informants argued that droughts and floods were not new but what was new was an increase in their frequency in the recent past. Smallholder farmers were more concerned with changes in rainfall distribution and intensity than total amounts. Focus group discussants and key informants expressed experiencing increased variation in rainfall between nearby places with some areas experiencing prolonged dry spells while others flooding during the same season. Often farmers complained that rainfall had become more erratic than before. One respondent aged 67 explained that

> "...when we were still boys the first rains that came in October were called *chivuna ng'ombe* (that means "saviour of cattle" direct translation from Chitonga) that was meant to relieve animals from a hot and dry season characterised by less water and poor grazing pastures. The second set of rains that started from late October or early November was for tilling and planting. Normally in December the rains would give us chance (through short dry spell) to do our weeding. But nowadays, *chivuna ngo'mbe* is no longer there. Rain nowadays just comes in a haphazard manner, whenever it wants and goes at anytime. Sometimes it rains continuously such that we cannot weed nor do any work. Other times instead of the rains reducing and stopping, it continues and sometimes falls heavily destroying our crops that were ready for harvesting. It is difficult to understand the rains nowadays..."

3.3 Perceptions of causes of climate change

Most smallholder farmers perceived supernatural forces as cause of climate change (Table 1). Farmers often referred to the Bible arguing that disobedience of humankind to God's principles and/or lack of respect to ancestral spirits and other customs caused climate change. The second most common set of causes was associated with environmental explanations that identified deforestation, pollution from industries and modernisation as causes of climate change. Some of the expressions from farmers pointing to modernisation were:

> "We are following the modern world and everything is changing..."
>
> "Most of the land is being used for construction of buildings and roads..."
>
> "Experiments done by scientists and western countries disturb the weather..."

A few believed that climate change was a natural and normal process as reflected from farmers' expressions such as:

> "Weather keeps changing from time to time…"
>
> "Everything is normal only that we are experiencing weather pattern in short nature (short time frame)..."
>
> "Weather keeps changing every 10 years…"
>
> "Weather normally changes as years change…"
>
> "It is just normal climate and weather cycles..."

A Chi-square test showed no significant association between smallholder farmers' perceptions of causes of climate change and adoption of CA. However, there was a significant association (Chi-Square (χ^2) =16.083, DF = 3, P-Value = 0.001) between the levels of education (up to primary school level, and beyond primary school level) and perception of causes (supernatural forces, environmental factors, normal and don't know) of climate change (Table 1). A test of proportions of the two most common perceived causes, supernatural factors and environmental factors, also showed significant difference. The percentage of respondents with more secondary and higher level of education that cited environmental factors was significantly more than that of the less educated (Table 1). On the other hand, the percentage of the less educated that cited supernatural forces was significantly higher than the percentage of the more educated that cited the supernatural forces as causes of climate change. Generally, it was a very common feature across the study areas that elderly participants had an advantage of experience and had more information about the past climatic changes than young ones.

3.4 Perceptions of positive effects of climate change

Positive effects of climate change were listed by 28.8% of respondents (Table 2). The three most common positive effects cited were increased gardening, increased access to adequate water and an improvement in working. An old man used a Tonga traditional saying "*Lya miyoba kuligwa michelo*" literally meaning "with floods you eat fruits." This indicates a perception that there are some advantages of having floods over droughts. Farmers explained that vegetable gardens were doing better because of increased water from flooding. Due to prolonged cold season, farmers explained that they could work more hours. Other positive effects were growing of new crops like cassava in Southern Zambia, learning of conservation agriculture, growing of early maturing varieties and new variety of cowpeas. Farmers engaged in tobacco growing in Eastern Zambia explained that increase in hotness was good for drying their tobacco and spending less firewood. Those farmers who were also engaged in fishing indicated that the increase in hotness was good for fishing. These results show that positive effects of climate change are context and site specific.

3.5 Perceptions of negative effects of climate change

Negative effects of climate change were cited by 81.4% of respondents (Table 2). The three most common negative effects were poor crop production (due to flooding, prolonged dry spells and droughts), poor livestock production (due to increased diseases) and increased food insecurity. Other negative effects included increased pests and diseases, destruction of physical infrastructure, difficulty in planning because of increased variability of the weather and reduced access to inputs due to low income from poor crop production. Some of these effects are not entirely due to climate changes but a result of multiple factors such as late delivery of subsidised inputs and poor markets for farmers' produce.

3.6 Responses to climate change

Most farmers (56.1%) listed some responses while 43.9% did not. Three most common responses to climate change related to cropping were crop diversification, practicing of conservation agriculture and gardening (Table 3). Use of conventional medicine, increasing livestock diversity and stocking, seeking support from agricultural extension officers and veterinary officers were the top three responses cited related to livestock. Among other responses, small businesses, hiring out labour and crafts work were the three most common.

3.7 Perceptions of conservation agriculture as an adaptation strategy

Although conservation agriculture was being practiced by 65.0% of farmers, only 7.9% of farmers cited it as a climate change adaptation strategy. Of those who listed adaptation strategies, 85.9% did not cite conservation agriculture. Among those who did not list any adaptation strategy, 57.6% were practicing conservation agriculture. These results show that there are other more important reasons for practicing conservation agriculture than adaptation to climate change from the farmers' opinions. Further studies on drivers for adoption of conservation agriculture among smallholder farmers are need.

4. Discussion

Smallholder farmers in Zambia are aware of climate change through their experiences. This is a common finding from other studies on perceptions of resource users of climate change such as in the Sahel (Mertz et al., 2009), Nile basin of Ethiopia (Deressa et al., 2008), semi-arid central Tanzania (Slegers, 2008) and Asia (Marin, 2010).

Consistent with adopter perception paradigm (Adesina & Zinnah, 1993) this study has shown that there is a significant association between smallholder farmers' perceptions of extreme climatic events and adoption of conservation agriculture. Farmers often pointed out that during seasons with less rain, maize yields per hectare from conservation agriculture fields were much higher than from conventional agriculture. Farmers attributed it to higher water retention capacity in conservation agriculture than in conventional agriculture. Other studies have shown higher infiltration rates and water holding capacity in conservation agriculture plots than in conventional agriculture plots (Marongwe et al., 2011; Zarea, 2011). Farmers also argued that early land preparation and planting associated with conservation agriculture increased chances of survival of the maize crop from floods. This is because the crop would most likely grow early enough before floods and quite strong enough not to be damaged severely at the time of flooding. A few farmers also gave a counter view that if floods came early in the rainy season, early planted maize was most likely going to be destroyed or have poor harvest and those with conservation basins would be faced with increased labour to backfill the basins with soil to minimise water logging.

Nevertheless, the perceptions of conservation agriculture as an adaptation strategy were very low despite more than half of the respondents having adopted it. Farmers often digressed during discussions and interviews to talk about their problems regarding poor access to reliable markets for their produce, limited access to hybrid seeds, chemical fertiliser, veterinary services and animal draft power. Immediate need for household food security was also among farmers' major concerns. These sentiments imply that the problem of climate change is not the most pressing one among smallholder farmers. Mertz et al (2009) asserts that change in land use and livelihood strategies is driven by a range of factors of which climate change appears not to be the most important. This partly explains smallholder farmers' low perception of conservation agriculture as an adaptation strategy.

In line with climate change adaptation theory, smallholder farmers are faced with multiple constraints that are contributing to low adaptive capacity (Eriksen et al., 2011). Conservation agriculture as a sustainable adaptation strategy to climate change, does not only depend on making changes in agronomic practices and attitudes but also depends on supportive functions of other farm enterprises (like livestock) and institutions both at micro and macro levels.

Farmers almost always asked what they would be given as a result of adopting conservation agriculture. Smallholder farmers perceived conservation agriculture more as a means to access incentives and solve their immediate food security problems than as an adaptation to climate change. This is because development of conservation agriculture has often been associated with some material incentives given to farmers. These handouts or incentives have ranged from free hybrid seeds, fertiliser, cassava cuttings, food, sweet potato vines and electronic money vouchers to bicycles and tillage equipments (CFU, 2006, 2010; Giller et al., 2009; Merrey & Gebreselassie, 2011). It was very common among farmers that had participated in other conservation agriculture projects to cite their experiences in receiving some incentives often after having done at least a quarter of a hectare of minimum tillage either by hand hoe conservation planting basins or animal draft ripping. The expectation of being given incentives further explains the gap between farmers' perceptions of climate change and adoption of conservation agriculture.

Lack of climate change communication in most conservation agriculture projects like CAP, CASIPP (Conservation Agriculture Scaling up for Increased Productivity and Production) and FISRI (Farmer Input Support Response Initiative) could also account for the results that most smallholder farmers did not perceive conservation agriculture as an adaptation to climate change. The extension system has no space for social approaches that would evoke climate change communication with farmers. Review of extension materials (CFU, 2009a, 2009b) indicated a strong emphasis on transfer of technical skills to farmers without addressing social aspects that equally influence adoption. An integration of both technical and social approaches in the promotion of conservation agriculture as a climate change adaptation strategy is necessary.

5. Conclusion and policy implications

This study has shown that most smallholder farmers in Zambia perceived shifts in the timing of seasons, increase in temperature, droughts and floods. Most common causes of climate change were supernatural forces according to farmers' perceptions. Majority of farmers perceived changes in the rainy season more than other seasons. Farmers expressed shortening of the rainy season and increased variability in intensity and distribution. Perceptions related to changes in floods and droughts were significantly associated with adoption of conservation agriculture. However, the extent to which conservation agriculture was perceived by smallholder farmers as an adaptation strategy to climate change was very low.

This study raises the following policy implications: In the design and implementation of projects on planned adaptations such as conservation agriculture, there is a need to focus not only on technical aspects but also social dimensions such as perceptions of smallholder farmers. Climate change communication provides an avenue through which perceptions of resource users can be integrated in climate change adaptation projects. This would facilitate exchange of climate change information between smallholder farmers on one hand and donors and conservation agriculture project implementers on the other. It would also provide additional climatic information that would enable farmers relate to conservation agriculture as an adaptation strategy.

Acknowledgements

We are grateful to the Norwegian Ministry of Foreign Affairs through the Royal Norwegian Embassy (Lusaka) and Conservation Farming Unit for funding this study under Conservation Agriculture Programme (CAP). We thank Conservation Farming Unit for their collaboration and support during field work in their project areas, the farmers for their time and valuable information and Precious Syandebwe for crosschecking the data set. We also thank the anonymous reviewers for valuable comments and suggestions.

References

Adesina, A. A., & Zinnah, M. M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. *Agricultural Economics, 9*, 297-311.

Adger, W. N., Hug, S., Brown, K., Conway, D., & Hume, M. (2003). Adaptation to Climate Change in Developing World. *Progress in Development Studies, 3*(3), 179-195. doi:10.1191/1464993403ps060oa, http://dx.doi.org/10.1191/1464993403ps060oa

Bryman, A. (2008). *Social Research Methods* (3rd ed.). Oxford: Oxford University Press.

CFU. (2006). *Reversing Food Insecurity and Environmental Degradation in Zambia through Conservation Agriculture*. Lusaka: Conservation Farming Unit.

CFU. (2009a). *Conservation Farming & Conservation Agriculture Handbook for Ox Farmers in Agro-Ecological Regions I & II*. Lusaka: Conservation Farming Unit.

CFU. (2009b). *Conservation Farming and Conservation Agriculture Hand Book for Hoe Farmers in Agro-Ecological Regions I & IIa-Flat Culture*. Lusaka: Conservation Farming Unit.

CFU. (2010). *Zambia Conservation Agriculture Programme (CAP) –a brief update*. Lusaka: Conservation Farming Unit.

Deressa, T., Hassan, R. M., Alemu, T., Yesuf, M., & Ringler, C. (2008). Analysing the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia, *IFPRI Discussion Paper 00798*: International Food Policy Research Institute.

Dumanski, J., Peiretti, R., Benetis, J., McGarry, D., & Pieri, C. (2006). *The paradigm of conservation tillage.* Proceedings of World Association of Soil and Water Conservation, India. 58-64

Ericksen, S., Aldunce, P, Bahinipati C. S., Martins R. D., Molefe J. I., Nhemachena C., O'brien K., Olorunfem, F., Park J., Sygna L., Ulsrud K. (2011). When not every response to climate change is a good one: Identifying principles for sustainable adaptation. *Climate and Development, 3*, 7-20. doi:10.3763/cdev.2010.0060, http://dx.doi.org/10.3763/cdev.2010.0060

Ervin, C. A., & Ervin, D. E. (1982). Factors Affecting the Use of Soil Conservation Practices: Hypothesis, Evidence, and Policy Implications. *Land Economics, 58*(3), 277-292.

FAO. (2008). Conservation Agriculture: Conserving resources above – and below – the ground. [Online] Available:ftp://ftp.fao.org/docrep/fao/010/ai552e/ai552e00.pdf (May 09, 2011)

FAO. (2009). Conservation Agriculture Scaling Up for Increased Productivity and Production. [Online] Available: http://www.norway.org.zm/Embassy/norwayzambia/Project-Archives/ConservationAgriculture/(May 09, 2011)

FAO. (2011a). *Climatic Risk Analysis in Conservation Agriculture in Varied Biophysical and Socio-economic Settings of Southern Africa*. Rome: Food and Agriculture Organisation of the United Nations.

FAO. (2011b). *Socio-Economic Analysis of Conservation Agriculture in Southern Africa*. Rome: Food and Agriculture Organisation of the United Nations.

Giller, K. E., Witter, E., Corbeels, M., & Tittonell, P. (2009). Conservation agriculture and smallholder farming in Africa: The heretics' view. *Field Crops Research, 114*(1), 23-34. doi:10.1016/j.fcr.2009.06.017, http://dx.doi.org/10.1016/j.fcr.2009.06.017

Govaerts, B., Verhulst, N., Castellanos-Navarrete, A., Sayre, K. D., Dixon, J., & Dendooven, L. (2009). Conservation Agriculture and Soil Carbon Sequestration: Between Myth and Farmer Reality. *Critical Reviews in Plant Science, 28*, 97-122. doi:10.1080/07352680902776358, http://dx.doi.org/10.1080/07352680902776358

Haggblade, S., & Tembo, G. (2003a). Development, Diffusion and Impact of Conservation Farming in Zambia. *Working paper 8*. Lusaka: Food security Research Project.

Haggblade, S., & Tembo, G. (2003b). *Early evidence of Conservation Farming in Zambia*. Paper presented at the International workshop on "Reconciling Rural Poverty and Resource Conservation: Identifying Relationships and Remedies." New York, May 2-3

Hobbs, P. R., Sayre, K., & Gupta, R. (2008). The role of conservation agriculture in sustainable agriculture. *Philosophical transactions of the royal society, 363*, 543-555. doi:10.1098/rstb.2007.2169, http://dx.doi.org/10.1098/rstb.2007.2169

IFAD. (2008). Climate change and the future of smallholder agriculture: How can rural poor people be part of the solution to climate change? *Discussion paper prepared for the Round Table on Climate Change at the Thirty-first session of IFAD's Governing Council*. [Online] Available: http://www.ifad.org/climate/roundtable/index.htm (May 09, 2011)

IPCC. (2007a). *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Cambridge: Cambridge University press.

IPCC. (2007b). *Climate Change: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva: Intergovernmental Panel on Climate Change.

Maddison, D. (2007). *The Perceptions of and Adaptation to Climate Change in Africa*. Washington DC: World Bank.

Marin, A. (2010). Riders under storms: Contributions of nomadic herders' observations to analysing climate change in Mongolia. *Global Environmental Change, 20*(1), 162-176. doi:10.1016/j.gloenvcha.2009.10.004, http://dx.doi.org/10.1016/j.gloenvcha.2009.10.004

Marongwe, L. S., Kwazira, K., Jenrich, M., Thierfelder, C., Kassam, A., & Friedrich, T. (2011). An African success: the case of conservation agriculture in Zimbabwe. *International Journal of Agricultural Sustainability, 9*(1), 153–161. doi:10.3763/ijas.2010.0556, http://dx.doi.org/10.3763/ijas.2010.0556

Merrey, D. J., & Gebreselassie, T. (2011). *Promoting improved rainwater and land management in the Blue Nile (Abay) basin of Ethiopia*. Nairobi: International Livestock Research Institute.

Mertz, O., Mbow, C., Reenberg, A., & Diouf, A. (2009). Farmer's Perception of Climate Change and Agricultural Adaptation Strategies in Rural Sahel. *Environmental Management, 43*, 804-816. doi:10.1007/s00267-008-9197-0, http://dx.doi.org/10.1007/s00267-008-9197-0

Newing, H. (2011). *Conducting Research in Conservation. A Social Science Perspective*. London: Routledge.

Nhemachena, C. (2009). *Agriculture and Future Climate Dynamics in Africa: Impacts and Adaptation Options*. Pretoria: University of Pretoria.

Pittock, B. A., & Jones, N. R. (2009). Adaptation to What and Why? In L. E. Schipper & I. Burton (Eds.), *Adaptation to Climate Change* (pp. 35-62). London: Earthscan.

Posthumus, H., Gardebroek, C., & Ruerd, R. (2010). From Participation to Adoption: Comparing the Effectiveness of Soil Conservation Programs in the Peruvian Andes. *Land Economics, 86*(4), 645-667.

Pouliotte, J., Smit, B., & Westerhoff, L. (2009). Adaptation and development: Livelihoods and climate change in Subarnabad, Bangladesh. *Climate Change and Development, 1*, 31-46. doi:10.3763/cdev.2009.0001, http://dx.doi.org/10.3763/cdev.2009.0001

Prager, K., & Posthumus, H. (2010). Socio-Economic Factors Influencing Farmers' Adoption of Soil Conservation Practices in Europe. In T. L. Napier (Ed.), *Human Dimensions of Soil and Water Conservation* (pp. 203-223): Nova science publishers.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). London: Free Press.

Saasa, O. (2003). *Macro Study: Agricultural Intensification in Zambia. The Role of Policies and Policy Processes*. Lusaka: The Institute of Economic and Social Research of the University of Zambia, and Lund University.

Siegel, B. P., & Jeffrey, A. (2005). *Poverty Reducing Potential of Smallholder Agriculture in Zambia: Opportunities and Constraints*. Washington, DC: World Bank.

Slegers, M. F. W. (2008). "If only it could rain": Farmers' perceptions of rainfall and drought in semi-arid central Tanzania. *Journal of Arid Environments, 72*, 2106-2123. doi:10.1016/j.jaridenv.2008.06.011, http://dx.doi.org/10.1016/j.jaridenv.2008.06.011

Smithers, J., & Smit, B. (2009). Human Adaptation to Climatic Variability and Change. In L. E. Schipper & I. Burton (Eds.), *Adaptation to Climate Change* (pp. 15-33). London: Earthscan.

Tanner, T., & Mitchell, T. (2008). Entrenchment or Enhancement: Could Climate Change Adaptation Help to Reduce Chronic Poverty? *Institute of Development Studies Bulletin Volume 39*(4 September), 6-15.

Weber, E. U. (2010). What shapes perceptions of climate change? *Wiley Interdisciplinary Reviews: Climate Change 1* (3), 332-342. doi:10.1002/wcc.41, http://dx.doi.org/10.1002/wcc.41

West, C. T., Roncoli, C., & Ouattar, F. (2008). Local perceptions and regional climate trends on central plateau of Burkina Faso. *Land degradation and Development, 19*, 289-304.

Zarea, M. J. (2011). Conservation Tillage and Sustainable Agriculture in Semi-arid Dryland Farming. In E. Lichtfouse (Ed.), *Biodiversity, Biofuels, Agroforestry and Conservation Agriculture: Sustainable agriculture reviews 5:195-238*. Netherlands: Springer. doi:10.1007/978-90-481-9513-8_7, http://dx.doi.org/10.1007/978-90-481-9513-8_7

Table 1. Smallholder farmers' perceptions of climate change in Zambia

Perceptions of changes in the onset and offset of seasons

Perceptions	Cold season		Hot season		Rainy season	
	Onset (n=466)	Offset (n=466)	Onset (n=464)	Offset (n=463)	Onset (n=452)	Offset (n=456)
Comes early (%)	33.91	9.23	14.01	7.34	5.75	58.99
Delays (%)	25.54	47.21	42.46	35.64	74.78	14.47
No change (%)	40.56	43.56	43.53	57.02	19.47	26.54

Perceptions of changes in duration of seasons, coldness, hotness, droughts and floods

	Duration of seasons			Temperature		Extreme events	
Perceptions	Cold (n=466)	Hot (n=463)	Rainy (n=450)	Coldness (n=469)	Hotness (n=469)	Droughts (n=468)	Floods (n=466)
Increased (%)	46.14	20.52	6.89	33.69	41.79	46.37	54.72
No change (%)	36.70	53.35	17.11	14.07	22.17	9.19	10.52
Reduced (%)	17.17	26.13	76.00	52.03	34.97	43.8	33.91
Don't know (%)	0	0	0	0.21	1.07	0.64	0.86
Chi-Square (χ^2)*	0.09^{ns}	1.89^{ns}	1.90^{ns}	0.10^{ns}	0.08^{ns}	6.08^{s}	7.10^{s}

Perception of changes in the mean durations of seasons in months (n=469)

	Cold season (n=466)	Hot season (n=463)	Rainy season (n=450)
Recent past	4.05±1.46	3.19±1.11	5.19±1.13
Long time ago	3.47±1.30	3.22±1.18	6.65±0.99
T-Value	8.36^{s}	-0.60^{ns}	-22.23^{s}

Perceptions of causes of climate change

Explanation	Identified cause	Percentage (n=465)
Religious explanations (Supernatural factors)	God	50.54
	Ancestral spirits and gods	3.01
Environmentally related explanations (Environmental factors)	Cutting down trees	19.78
	Pollution	2.58
	Scientists and modernisation	1.94
	Global warming	0.86
	Change in the wind patterns	7.53
No explanations	Natural and normal	4.30
	Don't know	11.61

Proportions of major perception of causes by level of education and age group

Most common Perceived causes	Up to primary school (n=301)	Beyond primary school (n=130)	Test of proportions (Z-value)	Below 31 years (n=68)	Above 30 years (n=384)	Test of proportions (Z-value)
Supernatural forces (%)	56.14	40.00	3.13^{s}	47.06	52.34	-0.80^{ns}
Environmental factors (%)	34.21	55.38	-4.11^{s}	47.06	38.54	1.3^{ns}

* The chi-square test relates to significance of differences between CA adopters and non-adopters vis-a-vis perceptions. s=significantly different at 5% level, ns=not significantly different

A multi response frame was used. Hence, total percentage under causes of climate change is more than 100 while the totals in the last part of the table are less than 100 because only most common perceived causes were considered.

Table 2. Smallholder farmers' perceptions of positive and negative effects of climate change

Areas where positive effects have been noticed	Counts (n=469)
Increased access to adequate water for both people and livestock due to floods	18
Increased access to enough water and increased production of crops or livestock	12
Floods have a cooling effect	1
Increased and better crop production mostly through gardening	48
Increased and better livestock production	11
Increased household food security	7
Better crop and livestock production	13
Livestock and Household food security	1
Learning of new things i.e. tillage methods, crops and new breeds of goats	5
Life is better	1
Warmness is good for school going children	1
Working is better when cold and dry spells coincide with time of weeding	21
No positive effects cited	334
Areas where negative effects have been noticed	
Poor crop production	214
Soil erosion	2
Increase in pests and diseases	30
Increase in household food insecurity	96
Reduction in access to inputs	9
Poor livestock production	137
Houses washed away	1
Planning is becoming very difficult	1
Transportation has become difficult	1
Water scarcity from droughts and damage from flooding	35
Working has become difficult due to hotness	8
Increased suffering and poverty	4
No negative effects cited	87

Note: A multi response frame was used. Hence, total count is more than the number of respondents

Table 3. Smallholder farmers' responses to climate change

Responses related to cropping	Counts (n=469)
Practicing of conservation agriculture	37
Crop diversification	58
Crop rotation	2
Covering vegetables with grass to prevent coldness	1
Early land preparation and planting	21
Use early maturing varieties and drought tolerant crops	4
Increasing the area under cultivation	6
Reduce area under cultivation	1
Follow new programmes brought by NGOs	1
Follow the weather forecast	3
Gardening	36
Getting more information on weather and farming	1
Increase food stored and growing of maize	10
Buying inputs in time and increasing hours of working	18
Planting on hill sides and elevated land	13
Reverting from conservation to conventional farming	4
Shifting from cropping to livestock rearing	3
Responses related to negative effects on Livestock	
Building better crawls and other structures for livestock	4
Increase livestock diversity and increase stocking	14
Use conventional medicine	22
Use traditional medicine	4
Move long distances to find water for livestock	1
Seek advice from extension officers and veterinary officers	7
Selling animals regularly	3
Keep fodder	1
Other responses	
Bought a bicycle to ease transportation	1
Engage in crafts work	5
Join several NGOs	2
Construct small dam	1
Opened a nursery school in the village	1
Small businesses	20
Hiring out labour	7
Prayers	1
Renting out land	2
Asking for help	1

Note: A multi response frame was used. Hence, totals are more than the number of respondents

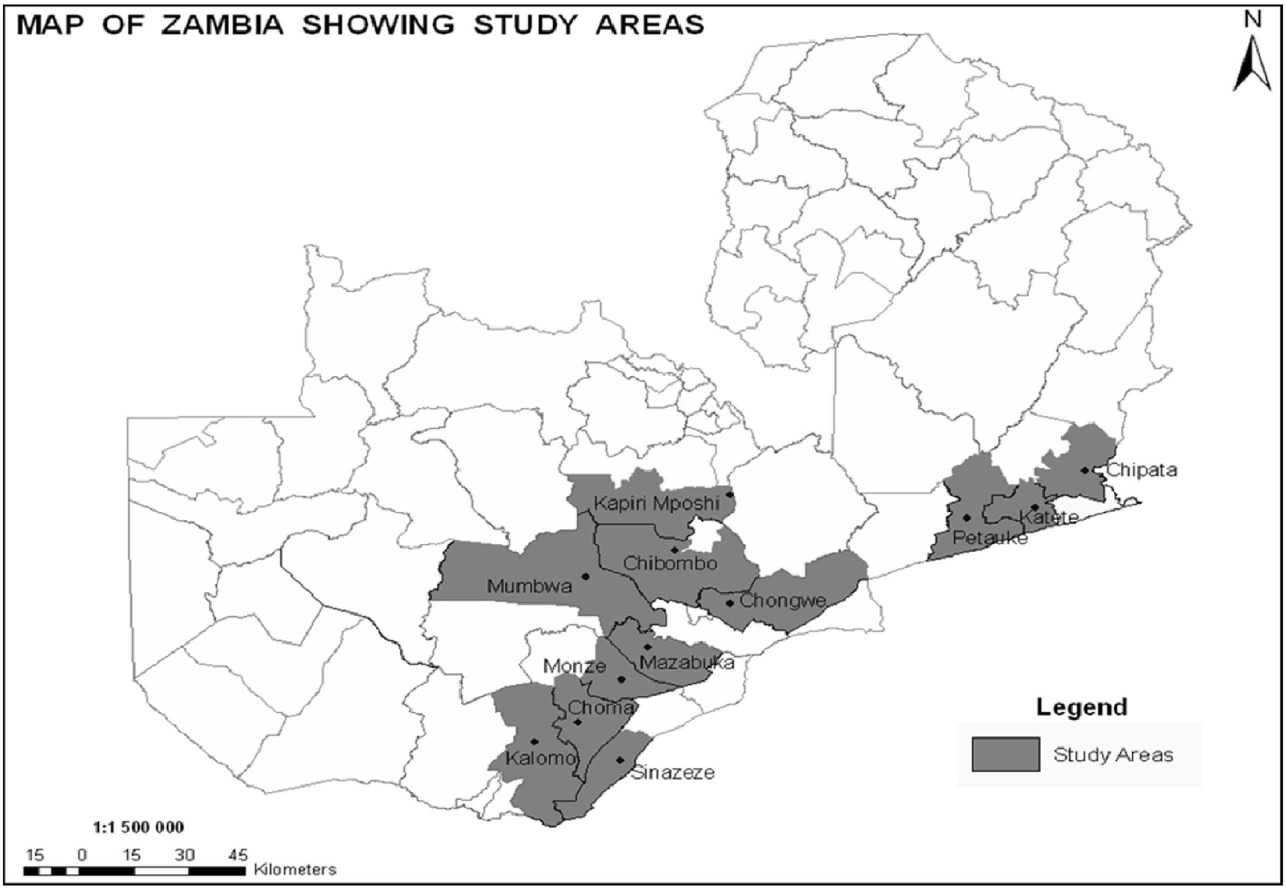

Figure 1. Map of Zambia showing study areas