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CLIMATE CHANGE AND VARIABILITY: SMALLHOLDER FARMING COMMUNITIES IN ZIMBABWE PORTRAY A VARIED UNDERSTANDING

F. MTAMBANENGWE[1], P. MAPFUMO[1,2], R. CHIKOWO[1] and T. CHAMBOKO[3]
[1]Department of Soil Science and Agricultural Engineering, University of Zimbabwe, P. O. Box MP 167, Mount Pleasant, Harare, Zimbabwe
[2]Soil Fertility Consortium for Southern Africa (SOFECSA), CIMMYT- Zimbabwe, Box MP 163, Mount Pleasant, Harare, Zimbabwe
[3]Department of Agricultural Economics and Extension, University of Zimbabwe, P. O. Box MP 167, Mount Pleasant, Harare, Zimbabwe
Corresponding author: fmtamba@agric.uz.ac.zw

ABSTRACT

Increasing awareness of risks associated with climate change and variability among smallholder farmers is critical in building their capacity to develop the necessary adaptive measures. Using farmer participatory research approaches and formal questionnaire surveys, interaction has been made with >800 farmers in two distinct smallholder farming systems of Makoni and Wedza Districts in eastern Zimbabwe to determine the current level of understanding of climate change and variability, current responses to perceived changes, as well as identify sources of agro-meteorological information. The results indicated that farmers portrayed a varied understanding both within and across the study sites. While poor rainfall distribution was seen as the major indicator for climate change by over two-thirds of the respondents in both sites, more farmers in Makoni attributed delay in onset of rains, high incidences of flush floods and unpredictable 'wind movements' yielding cyclones to climate change. In Wedza, it was recurrent droughts, winter and summer temperature extremes, and increased pest and disease incidences for both crops and livestock that indicated climate change. Perceived changes were linked more to natural and human forces (Makoni), unknown forces as well as breakdown in cultural norms and beliefs and rise of Christianity (Wedza). Disparities between the two sites could be attributed to the inherent differences of the communities in terms to their social settings. The national extension, Agritex, was ranked first by 50-60% of the farmers as major source of weather information. Electronic media (radio and television) ranked second with 47% of farmers in Makoni and 35% in Wedza. Concerns were raised over inadequacies of such information, apparent lack of reliability, timing and frequency of dissemination that directly influenced the utilisation of the information. Common coping strategies included early planting which was the more prevalent in Makoni, while combinations of cereals and legumes were a preferred solution in Wedza. We concluded that farmers' interaction with various information sources and knowledge sharing platforms needs to be enhanced in order to deepen their understanding as well as increase their capacity to respond to pressures of climate variability and change.

Key Words: Access to climate information, causes of climate change, coping strategies, farmer learning, local knowledge, rainfall distribution

RÉSUMÉ

L'amélioration des connaissances des petits fermiers sur les risques lies au changement du climat et sa variabilité est un fait important pour l'édification de leur capacité de développer des mesures nécessaires d'adaptation. En utilisant des méthodes de recherche participative et un questionnaire d'enquête formelle, l'interaction a été faite avec plus de 800 fermiers de deux systèmes d'exploitation distincts de districts de Makoni et Wedza à l'Est du Zimbabwe, afin de déterminer le niveau actuel de compréhension du changement du climat et sa variabilité, les mécanismes d'adaptation aux changements perçus, ainsi qu'identifier les sources d'information agro météorologique. Les résultats ont indiqué que les fermiers avaient un niveau varié de compréhension dans les deux sites d'étude.

Alors qu'une faible distribution des précipitations était considérée comme étant l'indicateur majeur du changement du climat par plus de 2/3 des répondants dans les deux sites, la plupart des fermiers de Makoni ont affirmé que le retard dans l'apparition des pluies, incidence élevée des inondations et mouvement du vent imprédictible résultant du cyclone par le changement du climat. En Wedza, le changement du climat était manifesté à travers les sécheresses récurrentes, des températures extrêmes pendant l'hiver et l'été ainsi que l'accroissement d'incidences de pestes et maladies affectant des cultures et le bétail. Les changements perçus étaient plus liés aux forces naturelles et humaines (Makoni), des forces inconnues aussi bien que la non-observance des normes culturales et les croyances et le développement de la chrétienté (Wedza). Les disparités entre les deux sites pourraient être attribuées aux différences inhérentes des deux communautés en termes de leurs environnements sociaux. La vulgarisation nationale, Agritex, était rangée la première par 50-60% des fermiers comme source majeur de l'information sur le climat suivi du media électronique (radio et télévision) avec 47% des fermiers dans Makoni et 35% dans Wedza. Les problèmes évoqués étaient liés au manque de consistance de l'information, manque apparent de fiabilité, le temps et la fréquence de dissémination qui directement influencent l'utilisation de l'information. Les stratégies communes d'adaptation consistaient en la plantation à temps spécialement dans Makoni, pendant que les combinaisons des céréales et des légumes étaient une solution préférée en Wedza. En conclusion, l'interaction des fermiers avec des sources variées d'information et les plateformes de partage de connaissance ont besoin d'être développée afin d'améliorer leur niveau de compréhension aussi bien renforcer leur capacité à répondre aux pressions du changement du climat et sa variabilité.

Mots Clés: Accès à l'information sur le climat, stratégies d'adaptation, connaissances locales

INTRODUCTION

Over 75% of rural populations within sub-Saharan Africa rely on rainfed smallholder agriculture for subsistence and livelihoods (FAO, 2006). Often, resource endowment in these communities is determined by factors that include the size of herd of cattle, average landholding and outputs from the arable fields (Mtambanengwe and Mapfumo, 2005; Tittonel *et al*., 2005; Zingore, 2006). Rainfall, in terms of total amounts and within season distribution, is the most important climatic element in the predominantly rainfed smallholder agricultural systems. In addition, floods and drought spells, extreme weather phenomena such temperature extremes and unpredictable wind movements, strongly impact on agricultural productivity. This implies that any significant change in climate or weather patterns, not only has the potential to impact on farming activities (Schlenker and Lobell, 2010), but also threatens to increase poverty in the already vulnerable communities. Climate change and variability in African smallholder farming systems can be considered as an additional threat and burden to pressures of population, poverty and killer diseases (HIV/AIDs and malaria) to development of sustainable livelihoods (Mapfumo *et al*., 2008).

In a large scale survey of 10 African countries, Maddison (2006) has shown that there is still a thin divide between the realisation by farmers that climate is indeed changing and perceived deviations from the norm or episodic events. However, any significant changes in weather patterns, particularly rainfall events, inevitably leaves the farmer with very little choice but to shift their farming season activities to include choice of crop types and varieties, timing of major operations and the bias towards off-farm activities as a risk aversion strategy (Thornton *et al*., 2007; Mapfumo *et al*., 2010). Access to climate information and services has the potential to enable farmers to make informed farm management and adaptation decisions in the face of this global challenge (Stone and Meinke, 2006; Challinor *et al*., 2007). Work by the Soil Fertility Consortium for Southern Africa (SOFECSA) in Malawi, Mozambique, Zambia and Zimbabwe in the past five-to-six years has shown the importance of information and knowledge exchange platforms in enhancing crop productivity among farmers differing in resource endowments through introduction of integrated soil fertility management (ISFM) learning centres (Mapfumo *et al*., 2008; Kanonge *et al*., 2009; Kabuli *et al*., 2010). The 'learning centre' approach has to date influenced >10 000 farmers in the four southern African countries who have either adopted or taken up adaptive testing of a number of ISFM technologies (Mapfumo, 2009).

In developing countries, and for smallholder farmers in particular, an important issue is whether farming households have access to climate information that is appropriately packaged and useful in aiding adaptation pathways by farmers. Experiences in Southern Africa over the last two to three decades of severe climate extremes characterised by droughts followed by flooding in successive seasons have shown how vulnerable farmers can be to variations in climate (Matarira *et al*., 2004; IPCC, 2007). To help mitigate the negative impacts of climate variability and associated threats to food security and environmental integrity (Zhakata, 2004), there is need to build capabilities of households, communities and relevant institutions to appropriately respond to these changing conditions. One of the ways to addressing food insecurity challenges could be through enhanced use of agro-meteorological data which can be used to prepare and manage climate-related risks (Alliance of CGIAR centres, 2009). Moreover, an assessment of the level of awareness to climate change and variability among different farming households may contribute towards formulation of adaptation strategies designed to improve rural livelihoods and reduce vulnerability. This paper examines the current level of understanding of climate change and variability in two distinct smallholder farming systems of Zimbabwe. Specific objectives of the study were to investigate farmer perceptions on climate variability and change, establish sources and degree of access to agro-meteorological information in the wake of climate change and variability, and establish current responses by smallholder farmers to cope with climate change and variability in two agro-ecological zones of Zimbabwe.

MATERIALS AND METHODS

The study was conducted in two smallholder areas of Nyahava ward, in Makoni District and Ushe ward, in Wedza District in eastern Zimbabwe. According to CSO (1985), a ward is a local government administrative unit with between 1,000-1,500 households. Each of the two study sites represented a typical post-independence resettlement area (Nyahava), and a typical old communal area (Ushe) driven by different production systems with diverse socio-economic characteristics.

Nyahava, in Chinyika Resettlement Area, Makoni (18°12´S: 32°24´E), lies in Zimbabwe's in Natural Region (NR) II, approximately 250 km east of Harare. Mean annual precipitation for NR II is ~750 mm. The soils range from coarse sands to sandy clay loams, inherently low in nitrogen, phosphorus and organic matter (Anderson *et al*., 1993). Prior to Zimbabwe's independence in 1980, Chinyika was dominated by extensive large-scale livestock rearing and tobacco farming, and was only opened by the Government of Zimbabwe for resettlement between 1982 and 1983, following a Government policy to acquire land for resettlement to relieve pressures to overpopulated areas (Mtambanengwe and Mapfumo, 2005). Under-utilised large scale commercial farms were acquired for this purpose and Chinyika was part of this. While Manicaland is the most densely populated province in Zimbabwe with an average of 43 people km^{-1} (CSO, 1998), Nyahava, because of its resettlement status, has a low population density of <20 people km^{-1}. Average landholding is 6 ha household^{-1} with maize and tobacco being the main cash crops grown under rainfed agriculture.

Ushe ward, Wedza (18°37´S: 31°34´E), on the other hand, is in NR III, receiving between 650-750 mm year^{-1} between November and March. Ushe is situated approximately 150 km south-east of Harare and has a history of over 75 years of smallholder farming. The soils are generally coarse sands derived from granite. Wedza has a medium to high population densities of 32 - 40 people km^{-1} (CSO, 1998). Average landholding is <3 ha household^{-1}, usually around the homestead and no more than <0.025 ha near water sources for vegetable production. Maize is the major crop grown through rain-fed agriculture, although a wide range of food crops mainly for subsistence are also produced.

The study took advantage of existing work by the Zimbabwe chapter of the Soil Fertility Consortium for Southern Africa (SOFECSA), which had been conducting research on integrated soil fertility management for sustainable food security and enhanced livelihoods in the two districts. Farmer participatory methodologies, which included focus group discussions, key informant interviews, open dialogue, direct observations and informal interviews were initiated in 2007 as part of the on-going action and reflection processes of the SOFECSA initiative. These methods were used to inform our enquiry on farmer perceptions of the causes and impacts of climate change as well as examine related constraints to agricultural productivity. The relative importance of emerging issues that included farmer access to information, current understanding of the causes of climate change, local knowledge and existing coping mechanisms was then quantified through a formal questionnaire survey.

The questionnaire was administered to 108 households in Makoni, and 100 in Wedza in October 2007 before the onset of the rainy season. Households for each ward were randomly selected from a list compiled and provided by the local extension supervisor from Agritex, the national extension branch of the Zimbabwe's Ministry of Agriculture, Mechanisation and Irrigation Development. Apart from household characteristics, key questions arising from the farmer participatory workshops included whether the respondent had noticed any significant changes in weather patterns over the years in relation to agriculture; perceived indicators and causes of climate change; level of access to weather forecasting data/information and subsequent use of meteorological information to plan agricultural activities; key indicators for different weather patterns; vulnerability and climate risk management and degree of institutional support within the community.

Data were analysed using the Statistical Package for Social Scientists (SPSS) for Windows version 13.0 to come up with descriptive statistics representing the two distinct smallholder communities. Cross tabulations were performed and associations between categorical variables assessed using Chi-square tests as appropriate.

RESULTS

Characterisation of communities. The series of farmer workshops in Makoni and Wedza attracted the participation of at least 800 farmers drawing from adjacent wards covered by previously SOFECSA-trained national extension staff. About 60% of the farmers who attended the meetings and workshops in Makoni men while in Wedza, attendance was dominated by women who constituted at least 70% of the participants. Local leadership was well represented by Headmen, village heads (*Sabhukus*), ward Councillors, a national legislature (Wedza) and national field extension officers. Survey results indicated that >60% of households sampled were male-headed, and about a quarter of the surveyed households in both sites were *de facto* female headed (Table 1). The main cause of the high prevalence of *de facto* female-headed households was cited as deaths of spouses. *De jure* female headed households were more apparent in Wedza (13.1%) compared to Makoni (6.5%). Child-headed households constituted <2% of the total sampled households across the sites. Literacy level for both communities was high and comparable to national average of ~92%. The data further indicated that at least 66% household heads in Makoni and 58% had attained primary level education. However, the proportions decrease towards tertiary level education, described by having attained a diploma or certificate from either a training college (e.g. teachers and nurses), agricultural college or polytechnic, which had a dominance of <4% in both areas (Table 1).

Farmers' understanding of climate change. The communities drew most of their livelihoods from smallholder agriculture with farming experience ranging from 1 to >50 years. The farmers felt that agriculture as their source of livelihood, was under threat citing unavailability of inputs (particularly seed and fertiliser), unproductive soils and rainfall variability as being among the major constraints to cropping activities. Over 95% of farmers in both Makoni and Wedza indicated that they had observed changing trends in weather patterns. At least 67% of respondents in Wedza and 75% in Makoni singled out increasingly unpredictable trends in rainfall distribution as the major change they had witnessed during their lifetime. The rainy season was said to be now characterised by prolonged dry spells, increased incidences of flash floods, longer intra-season dry spells, a general delay in on-set of rains and an abrupt

TABLE 1. General characteristics of household heads in the two study areas of Chinyika and Wedza in Zimbabwe

Household head	% of total sampled households	
	Makoni (n=108)	Wedza (n=100)
Male-headed	64.5	60.6
De facto female headed[1]	27.1	25.3
De jure female headed[2]	6.5	13.1
Child headed	1.9	1
Total	100	100
Highest level of education of household head		
Primary level (Grade 1-7)	66	58.4
Junior Secondary level (Form 1-4)	29	37
Senior Secondary level (Form 5-6)	1	2.3
Tertiary level	4	2.3
Total	100	100

[1] – *De facto* female-headed households are defined by the absence of a male figure through design e.g. death or divorce; [2] – *De jure* female-headed households are characterised by the absence of a male figure for a least part of the year

end to the season (Table 2). These trends could be observed when analysing rainfall data over a six-year period in Makoni where effective rains (>25 mm) were realised by end of October in the early 2000s (Fig. 1a); while in 2007, rains did not start until mid-November, and much later, early-to-mid December in 2008 (Fig. 1b). Another commonly held view included increased drought incidences, citing the 1991-92 drought as the worst in their memory, temperature extremes (very hot summers and very cold winters) and unpredictable wind movements bringing in cyclones (Table 2). The significant changes in daily temperatures in the past few years, starting from the 1991-92 drought, prolonged winter seasons, and a marked delay in the on-set of rains were attributed to climate change. Another significant observation, particularly in Makoni, was the non-occurrence of previously known rainfall events often marking either the beginning of winter (*mavhurachando*), end of winnowing of small grain cereals (*gukurahundi*) or the beginning of spring (*bvumiramitondo*). These rainfall events were often used as a planning tool to map out cropping calendars.

Perceived causes of climate change and variability. Results from interaction with the two communities showed a varied appreciation of the causes of climate variability. Nearly 40% of respondents in Makoni attributed changes to weather patterns to natural causes (Fig. 2), which could be separated into either dwindling of water reservoirs due to diminishing rainfall, the will of God, or the result of changing times (unexplained). While there was great conviction that climate was changing, approximately 35% of respondents in Wedza could not align the perceived changes with any external force (Fig. 2), although ~30% believed the changes in weather patterns were being caused by unexplained natural forces. More than 20% of the respondents in Wedza believed that cultural forces, which included lack of respect of sacred places such as traditional prayer shrines and mermaid pools in local rivers, rise in Christianity, random cutting down of sacred trees, non-performance of rain-making ceremonies, among other cultural beliefs were the root causes of low rainfall and droughts. However, <10% in Makoni aligned climate change with tradition (Fig. 2). Although ozone depletion

TABLE 2. Farmers' perceptions and general indicators of climate variability and change in two smallholder farming communities of Zimbabwe

Perceived change in weather patterns	Specific indicator	% of respondents	
		Makoni	Wedza
1. Poor rainfall distribution	Delay in on-set of rains Abrupt end to rainfall season Longer within-season dry spells Increased incidences of dry spells Increase in frequency of flash floods	75	67
2. Increased drought incidences	More poor seasons since 1992 drought Abrupt end to rainfall season (rains now end in February or early March) instead of mid – April/early May January continually emerging as the driest month	10	14
3. Temperature extremes	Prolonged winters (May to September) More areas now witnessing frost incidences than before Hotter temperatures than before for October and November Warm winters Cold summers	9	18
4. Other	Occurrence of cyclonic rains Drying of wetlands and river beds before season end Dry season one-off rains no longer experienced (previously at least 3 rainfall events were experienced between May and October)	6	1
Total		100	100

came up as a cause for changing weather patterns during farmer workshops, this was apparently perceived as being brought about by the increase in industrialisation of nearby towns and cities, and not a global issue. The mention of the ozone layer was mainly by wealthier sections of the community among whom were retrenchees and retired teachers who were apparently better informed. Other perceived causes of poor rainfall included rampant deforestation, veld fires and poor farming practices.

Access to agro-meteorological information by smallholder farmers. In Zimbabwe, agro-meteorological information is provided by the Meteorological Services Department in the Ministry of Transport, through the radio, television and daily or weekly newspapers. Using weather forecasting data or information as a proxy for accessing climate information, farmers ranked agricultural extension services (national and private), as the major source, averaging 62% of respondents in Makoni and 49% in Wedza (Fig. 3). The media (radio, television) ranked second in both sites, with ~47% in Makoni and 35% in Wedza. This, therefore, may imply that the existing flow of agro-meteorological information to farming households makes its access a preserve of few who own electronic media. Farmer-to-farmer extension was more significant in the newly resettled area of Nyahava, with about 11% of respondents, but played a limited role in the old communal area of Ushe averaging only 4%. Between 8-10% of farmers indicated that they obtained information from several undefined sources including newspapers, church leaders, community gatherings, or *via* school children (Fig. 3). Given that the acquired information was

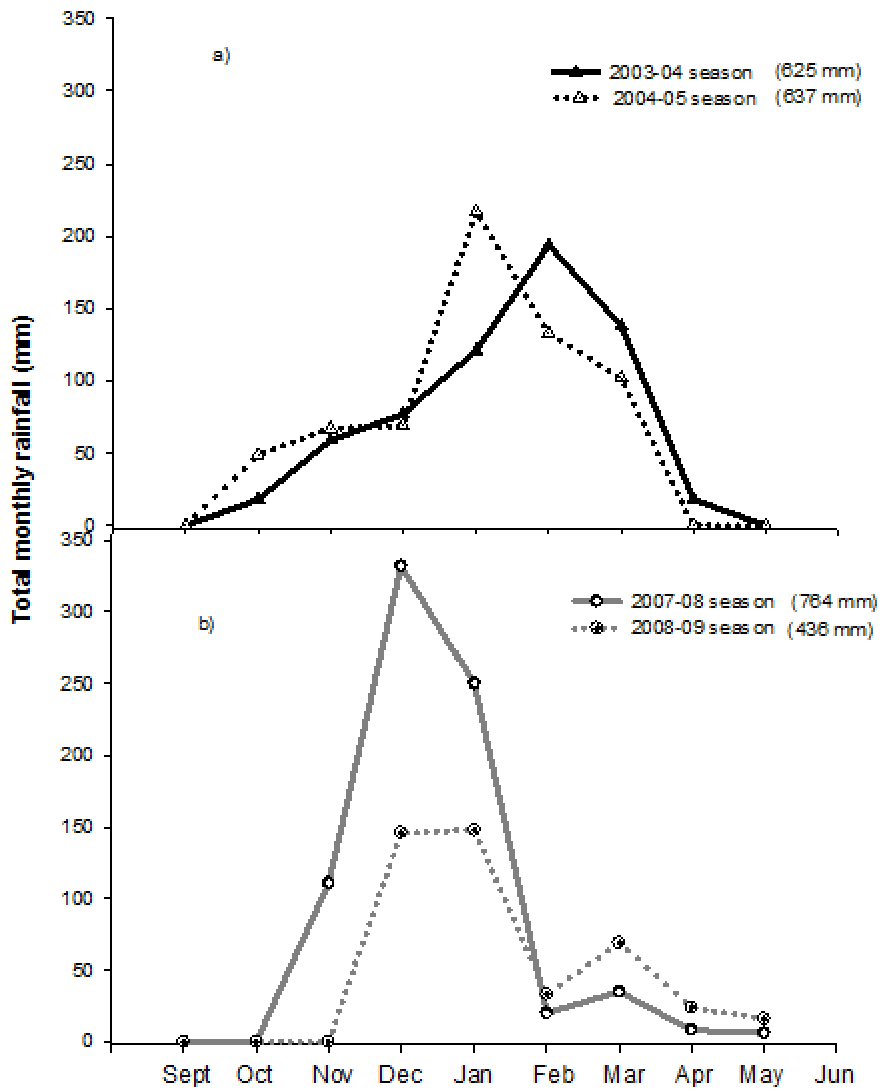

Figure 1. Variability in seasonal rainfall in four seasons (2003-05 and 2007-09) observed within a six-year period in Chinyika smallholder farming area, Makoni, in Zimbabwe.

used for planning of agricultural activities, approximately 50% of the respondents indicated that the information was adequate. The remainder highlighted major flaws with available information as its unreliability and poor timing while the content and frequency of dissemination was perceived as inadequate (Fig. 4), leaving them with little choice but to rely on indigenous and local indicators for planning the season. Respondents in both sites revealed that other than SOFECSA, the farmers had no knowledge of any institution educating the community on issues of climate change.

Using local indicators to predict next season's conditions. While the survey revealed that scientific agro-meteorological information is not readily available, a significant number of farmers relied on indigenous systems to plan their cropping activities. Several indicators are used to predict season quality (Table 3) enabling the farmers to respond appropriately. For example,

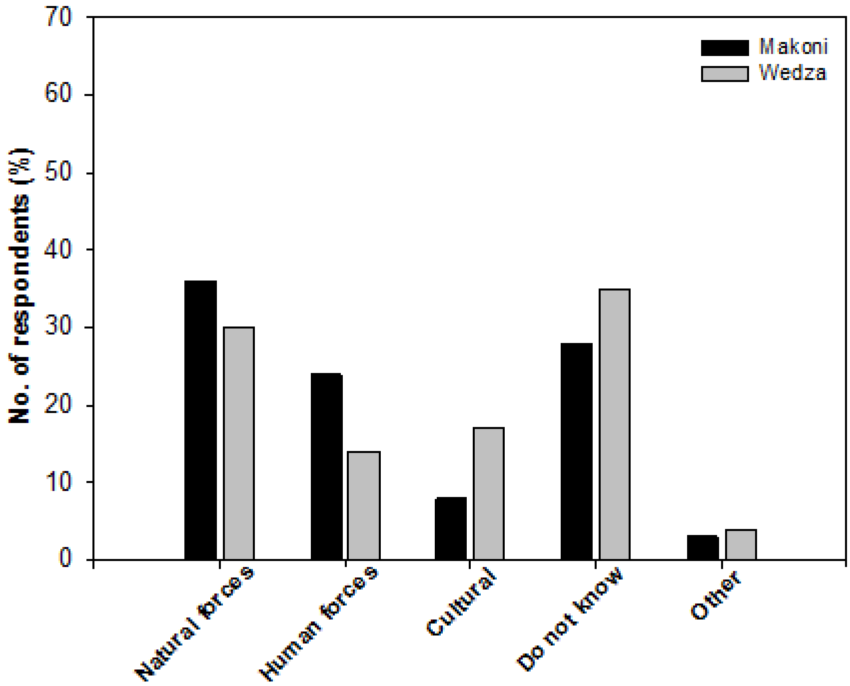

Figure 2. Farmers' views on perceived causes of climate change and variability in their localities.

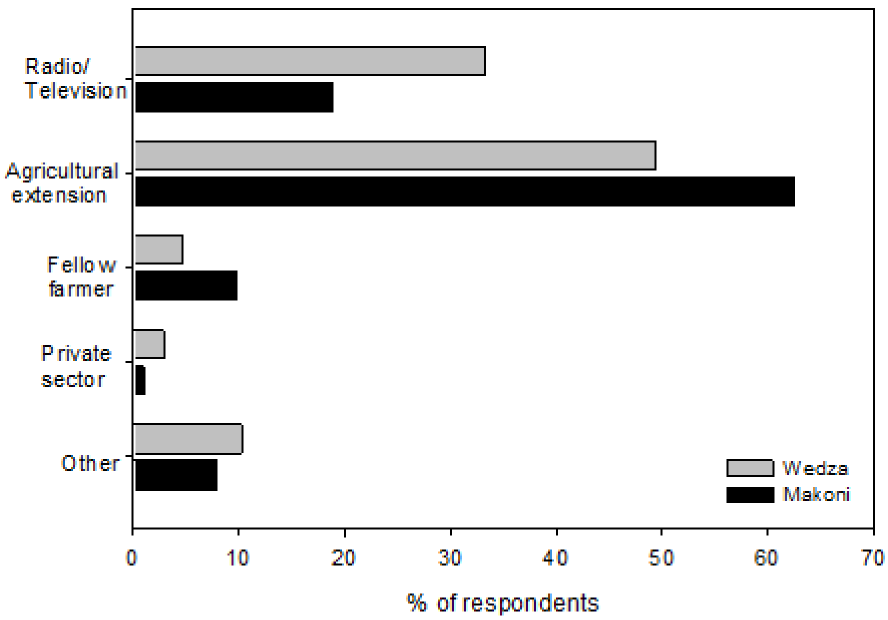

Figure 3. Major sources of weather information for smallholder farmers in Makoni and Wedza communal areas of Zimbabwe. 'Other' include newspapers; church leaders; community meetings; researchers; local leaders.

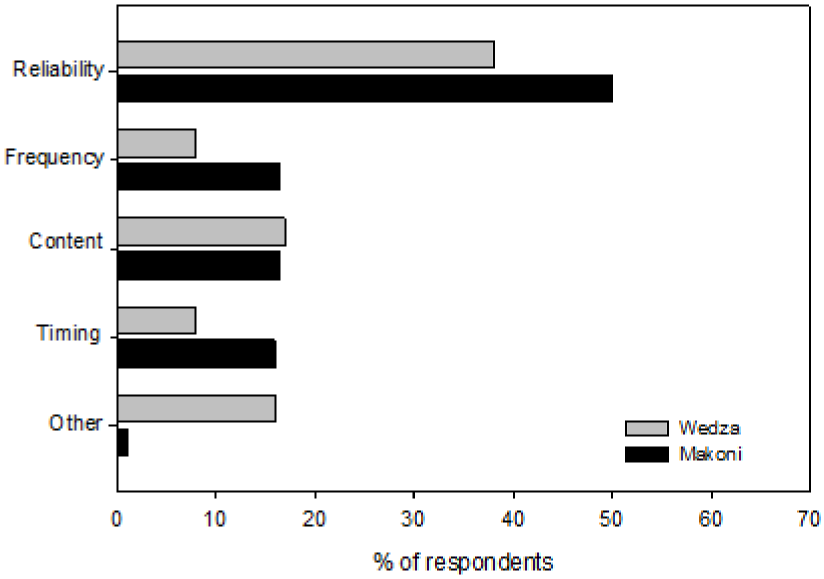

Figure 4. Limitations of available weather information as perceived farmers in Makoni and Wedza in Zimbabwe.

TABLE 3. Some local indicators used by smallholder farmers in two communities of Zimbabwe to predict season quality

Parameter	Local indicator
Good 'normal' season	General wind direction Presence of migratory birds, (e.g. swallows, black & white storks) Good fruiting of *Lannea* species Presence of butterflies flying in from the north in a southerly direction starting October A characteristic mist/ haze on hilly or mountainous terrain after the winter months a circular halo around the moon is taken to mean that heavy rains are expected Very high temperatures during the dry months of September/ October/ beginning of November
Bad/poor season	General wind direction Abundance of edible fruiting bodies of common woodland tree species (e.g. Monkey orange – *Strychnos spinosa*) Dry season skies becoming cloudy at least once every three-to-four days, means that the following rainy season is poor, with a higher frequency in cloudy days indicating a drought Warm winter months Extended winter
Season start	General wind direction Re-sprouting of certain indigenous tree and grass species Incessant noise made by some insects (crickets) Clustering of some stellar bodies signify the start of the cropping season
Impeding drought	Non sighting of migratory birds towards the end of the dry season Sighting of a rare star which is distinctly very bright in the northern skies indicates an impending good rainfall. If the star is sighted in the southern skies, it means the season will not be all that good, or even a drought A full moon during the peak of the rainy season signifies an intra-season dry spell

abundance of edible fruiting bodies of common woodland tree species (e.g. Monkey orange – *Strychnos spinosa*) is often associated with an impending poor season (Table 3). This tree species is abundant in southern African miombo woodland including Zimbabwe, and often reaches peak fruiting around August/September, one to two months before season onset. Another biological indicator common in both Makoni and Wedza is the one-off singing of particular birds species indicating season- start. The *Haya* bird,a type of cuckoo (*Cuculus solitarius*), survives on water stored in crevices within a live tree bark. Thus, it is believed that once it starts singing, it is calling for replenishment from rain water, and often, two-three days after its call, rains start falling. However, there was a general agreement that some of these indicators were no longer observed or reliable, calling for the need to improve access to scientific information.

Current coping strategies and adaptation measures to climatic variability. In response to observed changes in weather patterns and absence of previously known local indicators, farmers in both communities confirmed to having shifted their normal agricultural practices to minimise risk and maintain crop productivity. Changes in harvesting dates, crop spacing and crop diversification were also mentioned as measures put in place to cope with climatic variability. In Wedza, the most preferred coping strategy was growing more than one crop type and variety in the same piece of land (52%), followed by increasing inter- and intra-row spacing for maize and legumes to reduce competition for soil moisture, while about 12% confirmed having changed their cropping calendar, while opening new fields was a strategy adopted by about 5% of the farmers (Fig. 5). In Makoni, at least 45% of the farmer had changed their cropping calendars to include dry planting, early and late planting outside the normal planting time. Also of significance were increasing intra- and inter row spacing for different crops (25%)and combining different crop types and varieties was taken up by >20% (Fig. 5). Other options included shifting harvesting dates to include early harvesting as soon as the crop reaches physiological maturity, and late harvest to minimise post-harvest losses associated with attaining the required moisture content before marketing of produce. Early planting was perceived as being dependent on field type, and was associated with sowings before or on the first effective rains. There was,

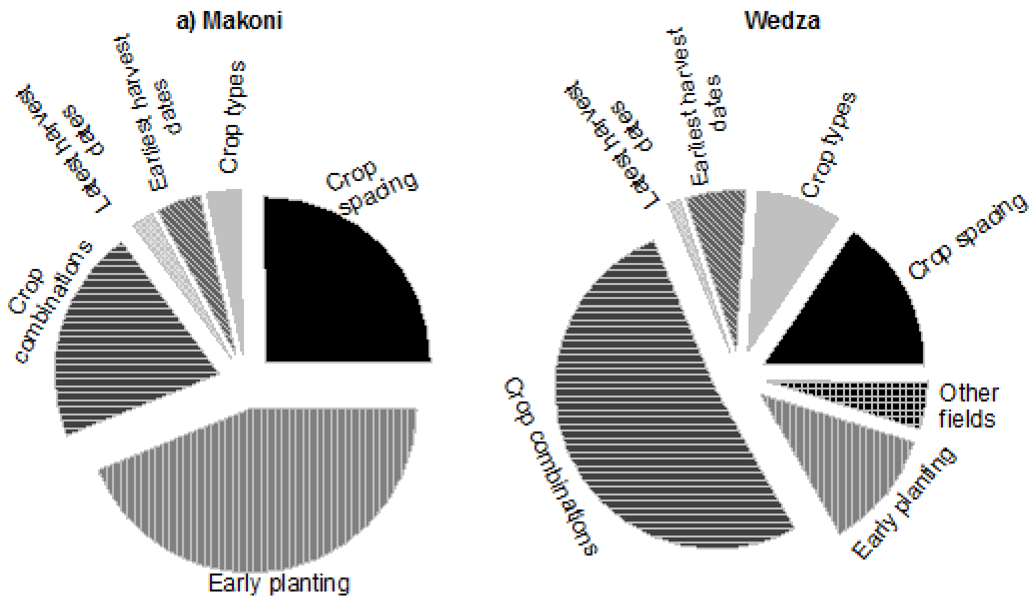

Figure 5. Coping strategies adopted by farmers in Makoni and Wedza in response to perceived changes in climate.

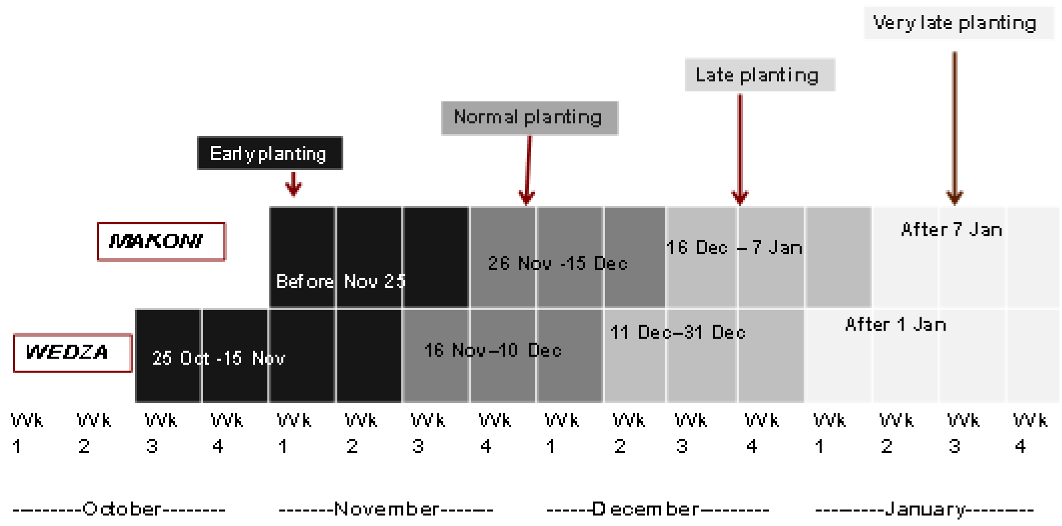

Figure 6. Farmers' cropping calendars in Makoni and Wedza smallholder farming areas.

however, a significant relationship between level of education of household head and coping strategy (χ^2 = 44.9, df = 16, P = 0.000). Farmers were able to identify windows of planting operations defined as 'early' (before the 2nd week of November), 'normal' (mid-November to mid-December), 'late' (mid-December to year end) and 'very late' (any time into the new year) (Fig. 6). There was however, a time lag in the planting windows (dates) by farmers in Makoni relative to those identified in Wedza (Fig. 6), probably due to the general differences inherent in the agro-zonation.

DISCUSSION

There was a general consensus among the two farming communities that the amounts of total rainfall received in recent years has been declining. This is consistent with scientific evidence that most of Southern Africa becoming increasingly drier with the distribution of rainfall within the season threatening agricultural sustainability (de Wit, 2006; Anderson, 2007). A seasoned farmer would be quick to notice that the season's rainfall is below normal, yields are declining, or there is an increase in crop/ livestock disease outbreaks. Maddison (2006) indicated that farmers with less than 20 years of farming experience were more likely not to notice any significant changes in normal weather patterns compared to their more experienced counterparts. The 3-4% of respondents who claimed not to have noticed any climatic shift in the two communities were most likely from among young farmers or those individuals who spend most of their time doing off-farm activities.

Farmers portrayed a varied understanding with respect to causes of climate change both within and across the study sites. Disparities between the two sites could be attributed to the inherent differences of the communities in terms to their social settings. Wedza has a long history of smallholder settlement and characterised by mature traditional institutional structures marked by dominance of defined clans and chieftainship. There is therefore bound to be strong views in traditional and cultural beliefs compared to Makoni where farmers from diverse backgrounds and cultural norms were simply brought together through an early post-independence resettlement exercise. These people do not have strong social cohesion and generally have varied socio-cultural beliefs. This could explain why 'the will of God' and 'signs of changing times' formed a significant proportion of responses in Makoni compared to 'non-performance of rain-making ceremonies' cited by a higher proportion of farmers in Wedza.

There was an apparent misunderstanding in separating local versus global causes of climate change despite the relatively high literacy levels within these communities. Just basic primary level education enables the farmer to be able to read and write, and therefore likely to increase the farmers' understanding of messages in both the print and electronic media. The study indicated that farmers' interaction with various information sources (traditional, print and electronic media) was low and thus plays a minimal role in enabling communities to make informed decisions on likely cropping and other risk management strategies. The existing chain of information flow represent a 'broken chain' scenario given that there appeared to be no direct engagement between extension and the meteorological department, although a significant number of farmers indicated extension as the major source of weather information. According to Meinke *et al.* (2006), in order to create science-user interactions, climate knowledge needs to be communicated via functional, existing communication networks of farmers, rather than pursuing climate-specific communication programmes. Moreover, the content of available agro-meteorological information was too coarse and needed to be interpreted into useful products at farmer level. Efforts also need to be directed towards the frequency of dissemination, and timing of release, implying that climate information is available when it is wanted. Currently, it appears that institutions required for linking necessary communication channel do not exist. Bridging the broken chain requires the involvement of different stakeholders in order to enhance agricultural sustainability and to increase the capacity of communities respond to climatic pressures and resource crises (Mapfumo *et al*., 2010).

The results from this study indicate that most farmers rely heavily on indigenous knowledge systems as local indicators for weather forecasting. Indigenous knowledge climate indicators may be classified either on the basis of (i) observable traits such as floral blooms, fruiting patterns/ re-sprouting of particular indigenous tree species, and presence or absence of particular animal species in an environment; (ii) observable trends such as wind movements, decrease in water tables, moon and stars and number of clear days versus cloudy days; (iii) those indicators known to exist in every community, but some are known (or available/ accessible) to anyone or can be learnt by or taught to others, details of some are usually a preserve of a few individuals, who alone, can identify or perform acts that can bring rain or even arrest a rainfall event, or characterised by some strange behaviour or some unexplained phenomena (Mapfumo *et al*., 2008). However, few farmers appreciated that climate change was a result of cumulative effects and events without borders (e.g. ozone depletion). Changes in land-use patterns, particularly land clearing, veld fires and deforestation, although perceived at a local scale, typify most of southern African farming systems, and therefore would likely contribute to global warming (Townsend *et al.*, 2000; Matarira *et al*., 2004). The real threat may be narrowness of the scope of communities' focus on impacts of climate change. Work is still needed to enable such communities to read climate change beyond the field as this has implications on their capacity to map out appropriate adaptive measures.

Common strategies adopted in response to climate change included early planting, crop mixtures, crop spacing and early harvesting. Despite the drier conditions in the already low rainfall Wedza, none of the farmers indicated use of water harvesting techniques, soil conservation methods or growing of drought resistant crop varieties. Mano and Nhemachena (2006) reported that out of a sample of 700 farmers, about one-third of them did nothing to cushion themselves against climatic risks. It is those who notice changes and do nothing about it that require institutional support. This, however, requires careful consideration since previous findings have shown that some proposed adaptation measures are not 'attractive' or they come with knowledge gaps beyond the experience of the end-user (Luers, 2005; Maddison, 2006).

Early planting in both Makoni and Wedza may not have been in direct response to climate change. Smallholder farmers in Zimbabwe have always staggered their planting dates depending on field positioning and type. For example, early or dry planting of crops in 'vlei' soils is considered a normal practice good and bad years to avert choking of plants and excessive leaching during the peak of rain season (Owen, *et al*., 1995). This raises questions as to whether observed changes in farmer management practices are direct consequences of climate change impacts or a response to other agricultural constraints. None of the respondents indicated dry-planting of upland fields as they fear losing seed should it fail to germinate. Continued interaction with the two communities indicated that all 'food security fields' were planted during the 'normal' planting phase, usually after the first effective rains. There was a general consensus among farmers that late planting was only good for legumes and not cereals, with the farmers unanimously citing complete crop failure of maize planted after December.

To improve the farm-level adaptive responses, awareness programmes could entail planting short season varieties, new cultivars, drought resistant crops or shortening of the dry season (Maddison, 2006; Mano and Nhemachena, 2006; Mapfumo *et al*., 2010). Increasing production of these crops through appropriate soil fertility management approaches needs further promotion.

CONCLUSION

The smallholder farmer remains vulnerable to climate change and variability given its dependence on rainfed agriculture. The farmers are aware of the changing weather patterns, major causes and impacts within their localities, and are attributing this to climate change. Vulnerability appears to be exacerbated by poor access to agro-meteorological which remains critical in facilitating decisions on potential coping and adaptation strategies. However, appropriate measures to adapt to climatic variability and change should factor in diversified backgrounds of communities, the levels of education, cultural beliefs and norms. Lack of ready access to modern climate information leaves farmers with little options but to rely on indigenous/local knowledge indicators to plan cropping activities and respond to weather variations. Identification of strategies to integrate local knowledge with scientific findings could enhance adaptation as farmers were already coping with climate variability through use of suitable crop varieties, staggering of planting dates, multiple crop types and varieties and use organic nutrient resources among other options. There is, however, potential to enhance the relationship between access to agro-meteorological information and coping strategy/adaptation through building the capacity of extension, who are in direct contact with farmers.

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