academicJournals

Vol. 10(27), pp. 2617-2625, 2 July, 2015
DOI: 10.5897/AJAR2013.8350
Article Number: F4B084353858
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

More than two decades of climate change alarm: Farmers' knowledge, attitudes and perceptions

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Received 6 December, 2013; Accepted 18 June, 2015

We conducted a questionnaire survey to assess farmers' knowledge, attitudes and perceived threats of climate change. The findings show that the farmers are generally aware of direct and observable causes of climate change and the main impacts of climate change on agriculture but are not clear about the interconnections between the natural environment and farm management activities that result in climate change. This observation maybe explained by the fact that farmers rarely obtain information from accurate sources. Analysis of results showed that knowledge and attitudes towards climate change are influenced by gender, age and education. The results suggest the need to shape farmers' attitudes/perceptions about climate change through participatory formulation and implementation of policies and the need to spread information through social networks. The roles and behaviors which individuals and organization can feasibly implement should be ascertained to increase adoption of actions that support formal and informal institutional arrangements.

Key words: knowledge, attitudes and behavior/ practices (KAP), survey, anthropogenic activities, livelihoods, climate change, agriculture.

INTRODUCTION

In the past two decades, there have been great variations and changes in global climate. Consequently, academicians, policy makers, activists, politicians and the general public have been engaged in debates about causes, impacts and solutions to the climate changes. Scientists are unequivocal that climate change is happening as a result of anthropogenic activities that have led to the increasing atmospheric greenhouse gas concentrations (IPCC, 2007a; UNEP, 2010). These atmospheric greenhouse gases trap the heat energy that would otherwise re-radiate to space, helping to rise the temperatures, a phenomenon popularly known as global warming. Climate change has been shown to have dramatic impacts on weather patterns, food production, ecosystem health, species distributions and phenology, and human health (IPCC, 2007b). It has been argued that climate change is proceeding faster, and with more unexpected manifestations, than predicted by climate

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scientists a decade ago (Rahmstorf et al., 2007; Steffensen, 2008). This has led scientists and policy makers to make a clarion call for adoption of measures that help to reduce the dangerous impacts of climate change because they will be severe and potentially irreversible (Schellnhuber et al., 2006).

On one side, agriculture is extremely vulnerable to climate variability with reductions in rainfall, extreme weather conditions, floods and drought causing significant impacts on productivity levels (Crimp et al., 2008). On the other side, agriculture is partly responsible for greenhouse gas emissions. Globally agriculture directly accounts for 14% of GHG emissions in CO_2 equivalents and additional 17% when land use and forest conversion for crops and pasture are included in the calculations (IPCC, 2007a; World Bank, 2009; Cole, 2010). Agricultural sector generates greenhouse gases through intensive use of chemical fertilizers and pesticides (Frolking et al., 1999), methane generated from flooded rice fields (Zhang et al., 2010), anaerobic animal waste processing and enteric fermentation in ruminants (Johnson and Johnson, 1995) and biomass burning (Zhang and Chen, 2010).

The threats posed by climate change to agricultural sectors need critical assessment especially in developing countries whose societies and economies are fundamentally dependent on agriculture (World Bank, 2009). This is more so because in addition to climate change, the arable land is dwindling (Roy et al., 2011) and rainfed agriculture is obviously becoming unsustainable. Using studies of agricultural water management from 1962 to 2011 (Valipour, 2014a) estimates that ratio of area equipped for irrigation to cultivated area will change from 16.5 to 83.2% from 2011 to 2060. Moreover agriculture is under more pressure to feed the world population that is expected to increase from the current 7 billion to 9 billion by 2050 (Ronald, 2011) and subsequently demanding agricultural productivity to increase by 70 to 110% by 2050 (Tester and Langridge, 2010; Tilman et al., 2011). Developing countries particularly those in South-east and west Asian countries are considered very vulnerable to climate change where farmers could suffer unstable food supply due to decline in yield, constrained income due to increased input for sustaining crop productivity and from other loss due to extreme event damage (IPCC, 2007b; FAO., 2013; Valipour 2013, 2014a, b; Valipour et al., 2014). Therefore, farmers in the developing countries are the key players in the global efforts to act against climate change.

Our current study is necessary for Chinese because agriculture in china is characterized by intensive application of chemical N fertilizers (Heffer, 2009; IFA, 2011; FAO, 2013) and mechanization both of which emit greenhouse gases. In addition, 23% of Chinese agricultural land is under rice production (Frolking et al., 2002), which has already been considered a major source of greenhouse gas (IPCC, 2007b). Furthermore, more than half of the populace live in the rural areas and depend on agriculture for their livelihood (National Bureau of Statistics of China, 2010). Thus, understanding farmers' knowledge and attitudes towards perceived impacts of climate change is critical for policy makers to design incentives for farmers to mitigate and adapt to climate change. This study explores the factors influence farmers' perceptions and knowledge about climate change and also the efficient media of conveying climate change information to the farmers.

Literature

Most studies on climate change seem to involve some aspects of knowledge, attitudes and behavior/ practices (KAP) model as described by World Health Organization (WHO, 2008). KAP surveys are conducted to get insights on what an individual or community knows, (Knowledge) how they feel (Attitude) and how they act (Practice) about certain topics or issues, in this case climate change. These surveys have been used extensively worldwide by the World Bank, United Nations agencies, and by both government and nongovernmental agencies in areas of family development, education, public health, and sanitation (Ekman et al., 2008). Recently the approach has gained popularity in the field of environment with majority focusing on one or two aspects of the KAP triad.

Knowledge/environmental awareness

Environmental awareness is the attention and concern of individuals to environmental problems. It results from understanding and appreciating the interrelatedness of humans, their culture and their biophysical surroundings (Sudarmadi et al., 2001). An environmentally aware person knows and is concerned that human behaviors that degrade environment are a threat to life and that the threat goes beyond those who pose it. In other words, people who are conscious that greenhouse gases are causing climate change are likely to support policies that are aimed at mitigating climate change. Knowledge about both the causes of climate change and means of reducing emissions is an important factor influencing pro-environmental intentions and behaviour (O'Connor et al., 2002; Maddison, 2007; Gram-Hanssen, 2009). Higher level of environmental concern has been shown to significantly and positively relate to the adoption of organic farming (Burton et al., 2003; Läpple, 2010) and water management (Wang et al., 2006; Tang et al., 2013). However, lack of awareness has been blamed for low rates of adoption of environmental innovations (Wang et al., 2010; Liu et al., 2013) and total failure to adopt tree planting in Greece (Kassioumis et al., 2004). Certainly, Climate change awareness is a major

impediment for implementation of climate change mitigation plans.

Information about climate change

Opportunities to manage agricultural risk are dependent on climate information and are yet to be fully exploited partly because of gaps in existing climate information services. The gap is increasingly widening because climate changes and variations have rendered the traditional ways of weather prediction less relevant. This role has been left to researchers, government agencies and the mass media. This is because researchers' motivation is to publish their findings in scientific journals that limit their audience to fellow researchers and scientist who can understand scientific work. Simply stated, researchers' purpose for their work is not to communicate findings to anyone outside their area of expertise (Willems, 2003; Kyvik, 2005). This disconnect has given the media a leading role in regard to disseminating information about this salient subject. In fact many studies have underscored this media role (Stamm et al., 2000; Russill and Nyssa, 2009; Sampei and Aoyagi-Usui, 2009) in informing the public about climate change.

Risk perceptions

Perception of an environmental problem is the ability to perceive environmental issues in the real world, based on memory and influenced by prior experience (Sudarmadi et al., 2001). There is a vast body of literature suggesting that individual perceptions and attitudes towards environmental awareness are influenced by knowledge, past experiences, social networks and institutional trust (Blake, 2001; Doss and Morris, 2001; Kollmuss and Agyeman, 2002; Dessai et al., 2004; Marenya and Barrett, 2007; Mwirigi et al., 2009; Liu et al., 2013). Experience of an environmental problem plays a crucial role in the process of forming environmental perception (Diggs, 1991) because experience or prior knowledge is the basis of recognition (Sudarmadi et al., 2001). According to (Burton and Kates, 1963) individuals who have had personal encounter with an environmental disaster were more likely to have positive attitude towards environmental protection because the disaster is a reality to them. The finding is corroborated other studies that show that people who had encountered extreme weather events such as floods (Spence et al., 2011) hurricanes and droughts (Woudenberg et al., 2008; Borick and Rabe, 2010) were more cognitive and perceptive of climate changes.

Studies have also shown that women express more willingness to adopt pro-environmental behaviours than men (O'Connor et al., 1999; Kollmuss and Agyeman, 2002; Sundblad et al., 2007). Social scientists attribute this to the fact that a feminine identity stresses attachment, empathy, and care (Keller, 1985). In addition, majority of women are not economically empowered and are likely to be vulnerable to the effects of climate change (Davidson and Freudenburg, 1996; Brody et al., 2008; Hemmati and Röhr, 2009).

MATERIALS AND METHODS

Study area

The study was done in Qinxi Township, Jing County, southeastern Anhui Province, located between 30.7° N latitude, and 118.4° E longitude and belongs to the northern fringe of the middle subtropical zone. Its mean annual temperature is between 15.4 and 15.9°C; mean annual precipitation is between 1143.2 and 1503.4 mm. This area is characteristically dependent on agriculture with the main crops cultivated being wheat, rice, soy beans, rape and fruits and vegetables. The main landform is a valley basin. The nearest city where market for inputs and outputs can be located is 150 km away.

Field survey

The study used both qualitative and quantitative methods to build on their complementarities for cross-checking information received from the respondents (Bernard, 2006; Mayoux, 2006). We collected data using structured questionnaire based on the research objective. Some questions were presented as a statement and put on a five point Likert scale (Marshall, 2010; Marshall et al., 2013) and other questions were closed- and open-ended. In addition, focus group discussions were conducted to give more insight to issues that were not well captured in the questionnaires and highlight the differences between participants (Silverman, 2004). For this, a checklist was used to moderate the discussions (Lloyd-Evans, 2006). The questionnaire was formulated in English and translated into Chinese by a native bilingual English speaker who also back-translated it to ensure accuracy. The Chinese version of the survey tool was then pre-tested in a different site and necessary adjustments made before the actual survey. This allowed for restructuring of questions and solving all questionnaire-related problems before the actual data collection (Simon, 2006). The questionnaires were administered to a random sample (Marshall, 1996) of 293 households. Before the commencement of interviews, respondents were thoroughly briefed about the purpose of the study and asked if they were willing to participate. After giving consent, all interviews and discussions were recorded (Bordens and Abbott, 2008).

Data analysis

Data were coded and edited to remove missing values and outliers. The data were analyzed using Statistical Package for the Social Science (SPSS) version 16.0. Descriptive analysis was used to summarize data that were then presented as means and standard deviations. Index construction was undertaken by summing up the scores for all statements relating to knowledge and perceptions to obtain a single group of variables. T-tests were used for interval variables, whereas chi-square tests were used for categorical variables.

RESULTS

Out of the total 380 households sampled, 293 were

Table 1. Farmers general information (N=293).

Gender	Percent response	Age	Percent response	Education	Percent response	Other sources of income	Percent response
Male	47	<30	25	Not educated	13	Business	23
Females	53	30-40	29	Primary school	27	Employment	16
/	/	40-50	15	Middle school	52	None	61
/	/	50-60	14	High school	8	/	/
/	/	>60	17	College	/	/	/

Table 2. Farmers' sources of information.

	Fellow farmers	Extension officers	Traditional sources	Mass media	Workshops and seminars	Internet	Friends and family	Professional publications
Never	/	13	/	/	57	81	/	93
Rarely	6	17	/	8	13	17	3	7
Sometimes	20	22	14	26	11	2	24	/
Often	31	21	12	42	11	/	33	/
Always	43	27	18	24	9	/	40	/

The frequency is presented in percentage (N=293).

interviewed. The gender composition was slightly more females than male (53:47). Majority of the farmers were less than 40 years. Barely 10% of the farmers went beyond middle school and the vast majority (61%) depended purely on agriculture for their livelihood (Table 1).

Responses to knowledge/awareness of climate change

Majority of the interviewed farmers (91%) had heard about climate change. The vast majority of farmers agreed or strongly agreed that climate change is human induced (76%), agriculture is a major cause of climate change (63%), transport sector emits greenhouse gases (65%), China is experiencing impacts of climate change (63%), fossil fuel is a major source of greenhouse gases (76%) and that greenhouse gas emissions are proportional to energy consumptions (53%). The summary of the questions on awareness and attitudes towards climate change (means and standard deviations) is shown in Figure 1.

However, the farmers appeared not to have a clear understanding of inter linkages between electricity generation and use and the potential of agriculture to mitigate climate change. The majority of the farmers (54%) and (52%) disagreed or was not sure that agriculture has potential to mitigate climate change and that electricity generation and use result in greenhouse gas emissions respectively. Statistical analysis showed significant difference between knowledge and education ($t=0.218$, $P=0.00$), age ($t=0.267$, $P=0.00$) and gender ($\chi 2=3.89$, $p=0.05$).

When asked to rate the frequency of obtaining information from the various sources, it was clear that most farmers obtained information through social networks. The results showed that farmers often or always sought information from fellow farmers (73%), friends and family (73%), mass media (66%), close to half (48%) sought information from extension officers and 30% relied on traditional knowledge. It is also clear from the results that all the farmers never or rarely sought information from professional publications, internet (98%), and workshops and seminars (70%) (Table 2).

In regards to attitudes, half of the farmers strongly disagreed or disagreed and only 19% agreed or strongly agreed that they have a responsibility to mitigate climate change while 31% were not sure. This was clearly confirmed when 72% of the farmers strongly agreed or agreed that it is the government duty to mitigate climate change and only 4% was not sure. However, the biggest proportion (40%) was not sure if the government policies can adequately address climate change. Forty two percent strongly disagreed or disagreed and 18% agreed or strongly agreed that the policies can address climate change. As regards insurance cover against climate change, 45% of the farmers agreed or strongly agreed, 27% were not sure and 28% strongly disagreed or disagreed that it is necessary to take insurance covers (Figure 1). There was significant difference between attitudes and education ($t=2.66$, $p=0.00$), age ($t=-2.09$,

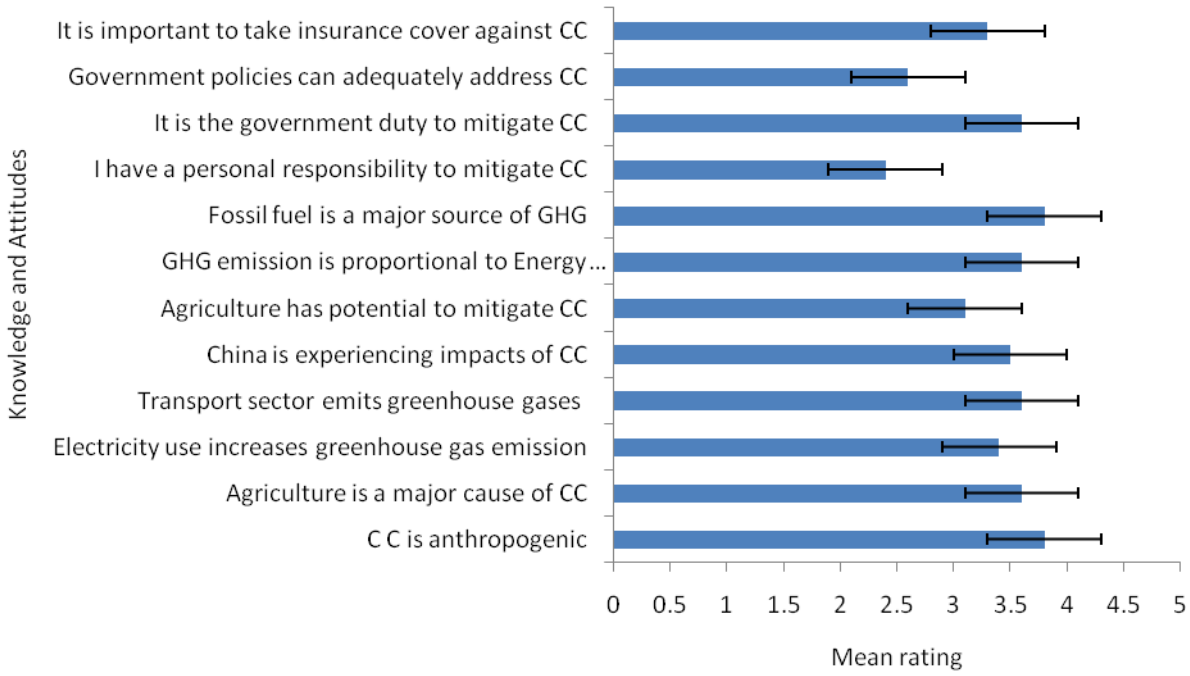

Figure 1. Knowledge and attitudes towards climate change. Statements are presented by mean level of agreement, error bars show standard deviation. Rating scale from 1 = 'strongly disagree' to 5= 'strongly agree' (N=293).

p=0.00), gender (χ^2=3.97, p=0.04).

Perceived threats of climate change

The results show that farmers are perceptive of threats posed by climate change. According to the farmers' responses, more than half of the farmers agreed or strongly agreed that adverse effects on agriculture (66%), severe hunger and malnutrition (58%), severe droughts and floods (55%), decrease in water quantity and quality (59%), change in vegetation composition (60%), increased incidences of human diseases (73%) and conflicts among communities (54%) will result from climate change. Many farmers (48%) agreed that land degradation will occur due to climate change, (37%) were not sure if climate change will result in livestock and crop diseases and only 38% of the farmers agreed that climate change will cause rise in poverty levels. The summary of the perceived threats due to climate change (means and standard deviations) is shown in Figure 2.

DISCUSSION

Literature indicates that, understanding of climate-change issues depends largely on individual characteristics such as educational level, age, gender and social networks. Our study shows that older farmers were more perceptive of climate change and had positive attitudes towards mitigating climate change. This observation is corroborated by other studies (Maddison, 2007; Nhemachena and Hassan, 2007; Lee and Zhang, 2008; Deressa et al., 2009) that age, which builds the farming experience, has positive influence on farmers' awareness, attitudes and practices towards climate change. In agreement with other studies (O'Connor et al., 1999; Kollmuss and Agyeman, 2002; Sundblad et al., 2007) our study shows that women are more aware about climate change and have positive attitudes than men. This observation has been attributed by Brody et al. (2008) to women's vulnerability to environmental hazards and that they value social relationship (Miller, 1976; Kanter, 1977) which enhance information sharing. This observation can be construed to mean that although both men and women have share sources of information; women may have a greater intrinsic value for environment. Our study also shows that higher level of education is a major tool for shaping people's attitudes and awareness about climate change. The results of this study are in agreement with other work (Schuck et al., 2002; Gregory and Leo, 2003; Sidibé, 2005; Liu et al., 2013) that the awareness created though education has influence on adoption of environmental interventions. Generally, the farmers have a relatively high level of understanding of climate change and reasons for its occurrence. Though not necessarily using scientific terminology, farmers described climate change as resultant of human activities. These findings agree with other work (IPCC, 2007a; Hofmann et al., 2009; Stern,

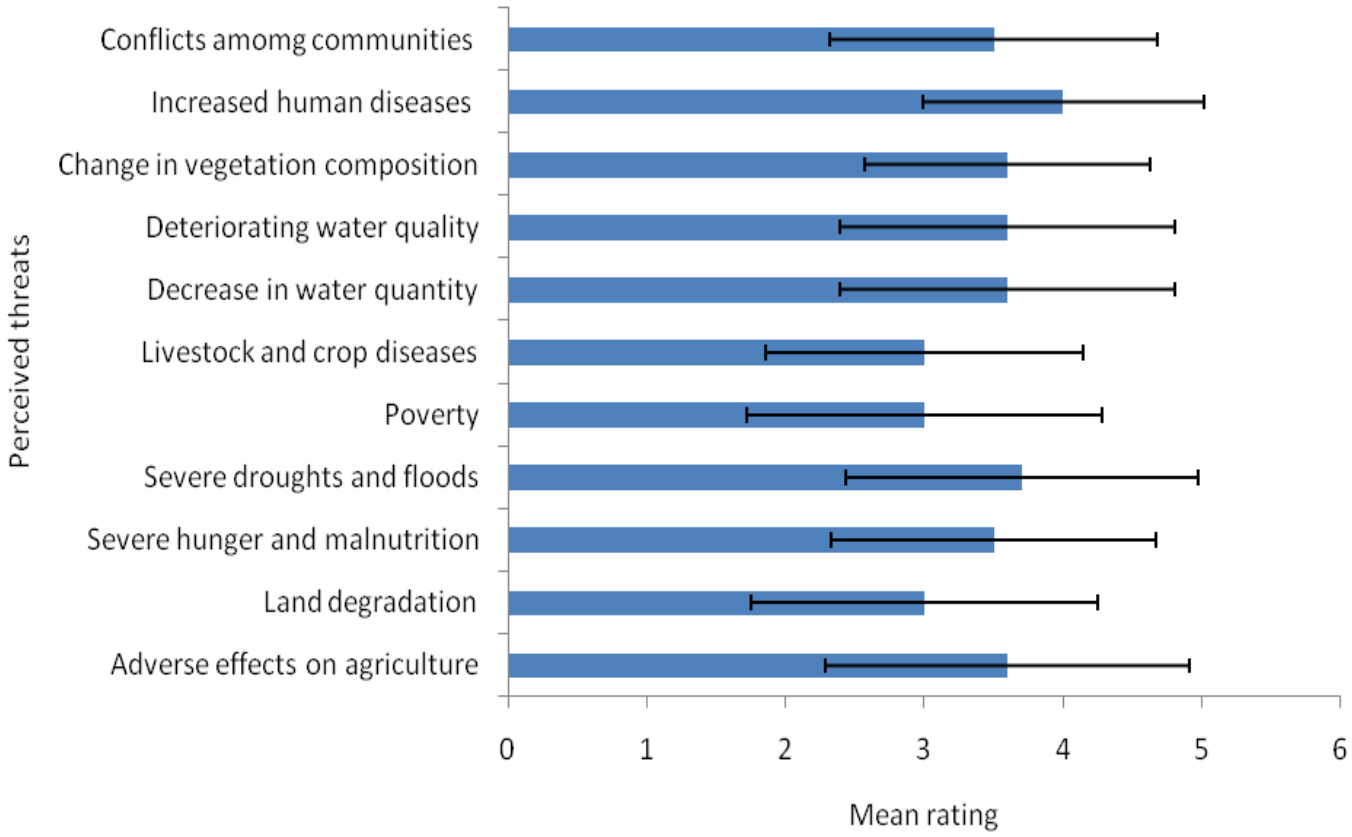

Figure 2. Perceived threats of climate change. Statements presented by mean scores, error bars show standard deviation (N=293).

2009) that have shown that climate change is anthropogenic. Discussions with the farmers revealed awareness that agriculture contributes to climate change mainly through deforestation, livestock production, inputs (fertilizers, pesticides,) and machinery and land management practices with specific reference to burning crop straws. Crop straw burning has been shown to be a big source of greenhouse gas emissions (Cao et al., 2008). Farmers recognition of the farming practices' contribution to climate change is a positive step towards solving the problems because knowledge about both the causes of climate change and means of mitigating environmental problems is important in influencing pro-environmental actions (O'Connor et al., 2002; Gram-Hanssen, 2009).

However, farmers lack detailed knowledge about greenhouse gases and their sources. In addition, most farmers did not have clear understanding about the inter-linkages between environment and human activities such as generation of electricity and the potential of agriculture to mitigate climate change. This implies that although farmers are aware and perceptive about climate change, they may not fully understand the responses needed in order to ameliorate its impacts. Our finding supports other work (Etkin and Ho, 2007; Kellstedt et al., 2008) that show that though knowledge of causes and ways of adapting or mitigating the disastrous impacts of climate change exists, there is disconnect between the flow of information from the sources and the general public. Moreover, our results show that farmers rarely or never interact with the accurate sources of information. The information they get may therefore have misconceptions of facts and sometimes cause confusion. For instance, most information in the media is based on debates between groups supporting and opposing climate change. This may in some cases, portray climate change as unsettled topic yet many researchers concur that climate change is anthropogenic and will have adverse impact on societies (IPCC, 2007b). This means that the sense of salience of the subject, one of the most important factors in determining whether people engage in pro-environmental behavior (Kaplan, 2000; Kollmuss and Agyeman, 2002; Gilg et al., 2005). As a result, farmers may under estimate the threats even in situations where they are imminent because their sources of information may not portray the threats as sufficient for farmers to take drastic actions.

The farmers recognize that the threats are real and have been experienced in different parts of China. The impacts of climate change have had far reaching implications to people's livelihoods and heath. For instance, prolonged droughts (Qiu, 2010), floods (Zong

and Chen, 2000), reduced yields and crop failure (Chen et al., 2013) and human health problems (Kan et al., 2012). However, the farmers tended to distance themselves from taking responsibility to mitigate climate change and also believed that government policies' capacity to address climate change were not adequate. This observation could hint to lack of policy implementation by relevant agencies or lack of impact where policies were implemented since the government has been enacting or amending laws to address environmental issues (Lin and Swanson, 2010). Farmers felt the need for insurance covers against climate change related damage. This is clearly because of their dependency on agriculture for livelihood and it has become reality that climate change related damages will have adverse impacts on their livelihoods. Maddison (2007) and Gbetibouo (2009) have shown that people respond to natural occurrences when they pose challenges to their lives and that people show high risk perceptions when they have encountered disasters (Woudenberg et al., 2008).

Conclusion

Farmers are aware of climate change and its impacts. However, there is clear lack of understanding of some linkages between natural environments and climate change and mitigation. This observation presents a gap that calls for concerted efforts of multiple stakeholders, including first and foremost, farmers, but also policymakers, extension agents, nongovernmental organizations, researchers, communities and the private sector. To achieve this, the government should promote climate change awareness through social networks and extension services and offering incentives for adoption of climate change mitigation practices. Studies have underscored the importance of contact with extension services and demonstration trials attendance in knowledge transfer and adoption of environmental practices (Schuck et al., 2002; Rahman, 2003; Mariano et al., 2012; Reimer et al., 2012). Moreover, the way a climate change message is designed and transmitted is important in determining people's attitudes and responses to environmental issues (Pooley and O'Connor, 2000; Nicholson-Cole, 2005). While the government can play a leading role in response to climate change, individuals and organizations must be convinced that they also have a role to play. The government should consider funding pro climate change policies, education and demonstration programmes that can provide a framework that encourages farmers to develop and/or adopt practices that ensure agricultural productivity can be maintained and GHG emissions can be reduced. The key to successful implementation is involvement in farmers not only in implementation of programs but in innovation within their farming systems.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGEMENT

This work was financed by Ministry of Agriculture, China granted in 2012. The authors are grateful to the farmers and households in Qinxi for their cooperation and assistance offered during the social survey interviews and discussions.

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