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PUBLIC EXTENSION AGENTS' NEED FOR NEW COMPETENCIES: EVIDENCE FROM A CLIMATE VARIABILITY STUDY IN LIMPOPO PROVINCE, SOUTH AFRICA

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ABSTRACT

Changes occurring in the Extension environment include that of climate. Reduced and sporadic rainfall is among the effects of climate change and variability with consequent negative effects on food production. Smallholder agriculture in most developing countries world-wide, including South Africa, is largely rain-fed. Extension agents, therefore, need to constantly improve their capabilities to remain useful to farming communities. The purpose of the paper is to determine Extension agents' climate variability coping competencies required to effectively support smallholder crop farmers' production. The study adopted a multi-stage random sampling approach to site and respondents' selection. Semi-structured questionnaire was used to collect data in 2014 from smallholder crop farmers in four municipalities of Limpopo province. Information was also collected from Extension managers and field-level extension agents of the Limpopo Department of Agriculture by means of questionnaires. The most popular climate variability coping strategy promoted by most extension agents was conservation agriculture. Small yield differences between Extension service-recipients and non-recipients indicate that Extension support has minimal effect on farmers' production. Agents need new competencies regarding correct application conservation agriculture. The study recommends the involvement of extension agents, scientists and farmers in adaptive trials for effective implementation of conservation agricultural practices to improve crop yields.

Keywords: Extension agents, climate change and variability, Limpopo province, small-scale farmers, conservation agriculture, adaptive trials

1. INTRODUCTION

Broad political and scientific consensus exist that climate change and variability is happening and will continue well into the future (Christensen, Hewitson, Busuioc, Chen, Gao, Held & Dethloff, 2007). The negative effects of climate change and variability on rain-fed agriculture as obtained globally and in South Africa including Limpopo province have been documented (Turpie & Visser, 2012; IPCC, 2007b). The importance of extension in change and as a 'diffusion agency and its positive effects on farmers' production are widely acknowledged (Rogers, 2010; Buyinza, Banana, Nabanoga & Ntakimye, 2008). Extension support for farmers' production and especially, smallholders is therefore, critical considering the variable climate of their production systems. Agricultural extension hence features prominently in the South African government's Integrated Food Security programme as the agency mandated to respond to the needs of small farmers (Department of Agriculture, 2002).

In many places around the world, including South Africa, public agricultural extension services however, have come to be seen as ineffective (Ragasa, Ulimwengu, Randriamamonjy & Budibonga, 2013 citing Birner, et al. 2009; Williams, Mayson, Satgé,

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Shelley & Semwayo, 2008). The lack of climate change and variability-related competencies among public extension agents for effective support to farmers, especially, smallholder producers, is a problem and seems pervasive globally (e.g. Mberego & Sanga-Ngoie, 2014; Brondizio & Moran; 2008). According to Lucia, 1999 & Lepsinger citing Parry, 1998, the most popular definition of the term competency in the literature is that, it is a cluster of related knowledge, skills, and attitudes that affects a major part of one's job. Even though much has been written about public extension agents' attitudes towards their work and agronomic skills worldwide, studies on the type of climate variability competencies needed by extension agents in South Africa, to support smallholder producers have not received the attention it deserves.

In view of the long-term continuous nature of climate change as opposed to the yearly fluctuations characteristic of climate variability and the short period of recall of weather events (10 years) by survey respondents, the analysis in this study of farmers' coping and adaptation strategies was limited to climate variability.

- **Purpose**

The purpose of the study is to determine the extension agents' competencies, regarding their climate variability knowledge and skills to support dryland smallholders' grain farmers' production and the effectiveness of strategies promoted in this regard. The central hypothesis of the study is that field-level Extension agents of the Limpopo Department of Agriculture have climate variability coping competencies to effectively support farmers' crop production. To address this hypothesis, the following questions are examined in this study:
1. Do public extension agents have the academic qualifications/training, including climate variability knowledge and skills, to support dryland smallholders' grain production?
2. What are the climate variability coping and adaptation strategies that public extension agents have been promoting to support dryland smallholders' grain production in the last five years of the study?
3. How effective is the public extension support including the climate variability information for dryland smallholders' grain production in the last year of the survey?

- **Conceptual framework**

Various definitions of vulnerability exist in the climate change and variability literature (e.g. Nelson et al. 2010a; Inter-Governmental Panel on Climate Change, IPCC, 2001 etc.) A common thread in these definitions is that susceptibility to climate change and variability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and adaptive capacity. An integrated approach to vulnerability assessment to give a complete understanding of the phenomena includes social vulnerability (adaptive capacity) and bio-physical vulnerability (exposure and sensitivity) (Gbetibouo & Ringler, 2009; Nelson et al., 2010b). For this reason, this study uses the IPCC (2001) definition of vulnerability to climate change and variability to assess smallholder crop farmers' food production system to climate variability. This is because, this definition, embodies vulnerability as a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. Given constant levels of hazard over time, (i.e. exposure) the effectiveness of al household's adaptation measures will allow a system to reduce the risk associated with these hazards by reducing its social vulnerability. Following Nelson et al., (2010b), this study uses the Sustainable Rural Livelihoods Framework (Department for International Development, 1999) as the conceptual framework to analyse the adaptive capacity and sensitivity of farmer households to climate variability and extreme weather conditions. The effectiveness of a household's adaptation measures in this study was, therefore, assessed as a function of its adaptive capacity and sensitivity to climate variability.

2. METHODOLOGY

A multi-stage random sampling approach was used to select two districts, four municipalities and smallholder maize and sorghum farmers from 20 villages of Limpopo province, South Africa, in 15-22 January 2014. Semi-structured questionnaires were used in personal interviews to collect data from 194 smallholder grain farmers selected by a random sampling process. Self-administered questionnaires were used to collect information from 24 field-level extension agents in the four municipalities investigated (13 per cent, n=179). Similarly, 11 Extension managers, one from head office and 10 from the four municipalities returned the completed questionnaires (55 per cent, n=20).

Enumerators were trained by the researcher and the questionnaires pre-tested. Data collected from farmer respondents include their demographic information, sensitivity to climate variability in the last 10 years as well as their capital assets that show their adaptive capacity in the last 10 years. Extension agents' data include their demographic information, climate variability coping and adaption strategies promoted, and channels used to promote strategies. The Managers' questionnaire included amongst others, the competence of the field-level extension agents under their supervision, in matters of climate variability coping strategies to support farmers' crop production.

The effectiveness of the coping and adaptation strategies promoted by public extension to support crop producers' food production, was measured by public extension's contribution to the household's food production. To identify the effect of public extension support, including climate variability information on household's food production, a comparison was made of the crop yields (ton/ha) obtained by respondents who received some support from public extension including climate variability and those who did not, in the last year before the study.

A linear multiple regression model was specified to study the farmers' crop yield and their capital assets and sensitivity, which are defined in Table 6. The model was specified as:

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 ... \beta n X_n + \mu i \qquad (1)$$

Where,

Z = Yield (tons/ha)

β_0 ………= the intercept

β_1 , β_2 ,.... βn = regression coefficient

X_1 , X_2..... Xn = independent variables

μi ……………… = error term.

The independent variables were specified as follows:

X_1 = Natural capital

X_2 = Social capital

X_3 = Human capital

X_4 = Financial capital

X_5 =Natural capital

X_6 = Sensitivity

Data analysis was done using SPSS software and analysis techniques included descriptive and inferential statistics.

3. RESULTS

3.1 Availability of qualified climate variability personnel and indication of support for training

To assess the human resource capacity of the public extension service in terms of field-level agents' technical competency to support smallholder farmers' crop production to better cope with and adapt to climate variability, Extension managers were asked to indicate whether or not their field-level extension agents have the necessary knowledge/information regarding climate variability issues. Findings show that the majority of the Extension managers interviewed (82%; N= 11) indicated that their agents did not have the requisite information and knowledge about climate variability to support the crop production of farmers they work with.

In a related question, managers were requested to respond to a question about whether they would support training for the field-level extension agents in climate variability issues. All the managers who responded to the question (100 per cent, N= 8) indicated they were in favour of such training.

Field-level Extension agents' were similarly questioned about the adequacy of their academic qualifications/training to support smallholder farmers' crop production system to better cope with and adapt to climate variability. The findings (Table1) show that half of the field-level extension agents who were interviewed had a diploma qualification. According to the Department of Agriculture (2005), these agents are described as Agricultural Development Officers, whose qualifications are inadequate for equipping them with the requisite skills and knowledge (competencies) to achieve the desired outputs as Agricultural Advisors.

Table 1: Percentage distribution of field-level extension agents' qualifications (N= 24)

Qualification	Percentage
Master's degree	8.3
Honours degree	33.3
Bachelor's degree	8.4
Diploma certificate	50.0
Total	100.0

Field-level extension agents also indicated their technical competency in terms of knowledge and skills of climate variability issues needed to support farmers' production. This is important because it provides an indication of their competence in this area to support crop producers so that they are able to adapt their crop production to and cope with climate variability. Agents' responses to this issue show that most of them (61 per cent; n= 18) did not possess the skills and knowledge or information to support producers' crop production.

In a related question, agents were asked to indicate their need for training in climate variability issues to equip them with skills, knowledge and information to enable them to support farmers' crop production. Most of the agents who responded (94 per cent; n= 16) said they needed such training.

3.2 Climate variability coping and adaptation strategies promoted and used

Coping strategies were defined and used in the study as short-term responses to the impacts of sudden events while adaptation was defined as longer-term responses to more gradual climatic variability (Warner et al., 2013 citing Birkmann, 2011). Based on these definitions, agents were asked to mention the measures/strategies that they have been promoting among the crop farmers they worked with in the last five to ten years (2003-2013) to help them to deal with current climate variability-related problems (coping strategies). Similarly, they were requested to mention the measures/strategies they have been promoting among the crop farmers that they worked with in the last five to ten years (2003-2013 to prepare them to face future climate variability-related problems (adaptation strategies). The strategies promoted were used to provide indications of agents' climate variability competencies (knowledge and skills). The findings show that most extension agents (92 per cent; n= 24) indicated that they were promoting climate variability coping and adaptation strategies among their crop farmers. The majority of the strategies such as zero tillage, mulching, cover cropping, build stone protection, intercropping, mixed cropping, green manuring, soil ridging relate to what is called conservation agriculture (CA) (Table 2).

Table 2: Coping and adaptation strategies promoted by public extension

Strategy	Percentage of Respondents
Coping strategy	
Conservation agriculture (n=24)	67
Use of improved/certified/hybrid seeds (24)	21
Do climate change awareness campaign (24)	08
Encourage farmers to listen to and /or watch television broadcasts on climate change (n=24)	04
Promote water harvesting (n=24)	08
Rehabilitate project structures to prevent strong winds (n=24)	04
Application of pesticides (n=24)	04
Adaptation strategy	
Discourage deforestation (n=17)	35
Plant indigenous trees/agro-forestry (n=17)	12
Control invasive, alien plants (n=17)	12
Control veld fires (n=16)	06
Discourage planting of exotic plants (n=16)	06
Construction of irrigation dams (n=17)	06

Farmers' responses, especially, of extension-support recipients, concurred with what agents promoted; conservation agricultural practices were the most common coping strategies respondents employed to combat the negative effect of climate variability. For each strategy, the total numbers of respondents as well as the actual number of respondents who used it, is provided (Table 3).

Table 3: Crop production coping strategies used by respondents

Strategy	Respondents (%)			
	Extension		No Extension	
	Respondents	Frequency	Respondents	Frequency
Early or late planting; early or late maturing varieties	69	48(70)	119	26(22)
Correct seeding rate/weeding	69	23(33)	119	39(33)
Conservation agriculture	69	52(75)	118	79(67)
Use of drought-resistant varieties	68	39(57)	119	21(18)
Use of wetlands	69	15(22)	118	2 (2)
Application of fertilizer/manure	69	45(65)	119	31(26)
Water harvesting	68	1(2)	119	9 (8)
Use of irrigation	69	15(22)	119	2 (2)

Numbers in brackets are percentages

3.3 Effectiveness of coping and adaptation strategies

The yield data from extension support-recipients including climate variability and those who did not receive such support were used to assess the effectiveness of the extension support including climate variability information. The effect of such extension support on farmers' yields is evident (Tables 4 and 5). There were more non-extension recipients than recipients in the lower yield category (less than 1 ton/ha); the opposite was the case in the higher yield categories (more than 1 ton/ha). Furthermore, the mean yield of extension recipients (.845 ton/ha) was higher than those of non-extension recipients (.548 ton/ha).

Table 4: Percentage distribution of respondents' crop yields according extension use

Yield (t/ha)	Use of Public Extension	
	Used (N= 68)	Did not use (N=113)
Less than 1	66.0	79.0
1-2.99	32.0	20.0
3-4.99	1.5	0.9

Table 5: Mean yield (ton/ha) differences according to extension support

Use of public extension for climate variability information	Number	Mean	Std. Dev.
Received climate variability information from public extension	68	.845	.747
Did not receive climate variability information from public extension	113	.548	.607

To further test the effectiveness of extension support including climate variability coping strategies promoted by public extension for survey respondents' crop production, a multiple regression technique was used. The normal P-Plot of regression standardized residual

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indicated that assumption of normality was not violated (Pallant, 2007). Similarly, the Variance Inflationary Factors (above 10) or Tolerance values (less than .1) of variables show that the multi collinearity assumption was not violated either (Pallant, 2007). There was one outlier but its standard residual value was 3.07, hence not higher than 3.3 and so this assumption was not seriously violated (Pallant, 2007). The results of the multiple regression analysis (Table 6) show that contrary to the null hypothesis, using an alpha test at 5% level of significance, receiving public extension including climate variability information, made a contribution to the yield of survey respondents (p= .011). The model is significant at 1% level (F=2.822; p= .019).

Table 6: Multiple regression estimates of the effects of the independent variables on the yield of respondents (N=181)

Predictor	Coefficient	P-value	Part
Constant		**.146**	
NATURAL CAPITAL			
Percentage of cropping land suitable for crop	**.049**	**.579**	**.048**
SOCIAL CAPITAL			
Access to markets for Production	**.132**	**.131**	**.132**
Use of extension services for climate variability information	**.227**	**.011***	**.225**
HUMAN CAPITAL			
Dependency ratio	**.114**	**.102**	**.143**
FINANCIAL CAPITAL			
Access to production credit	**.074**	**.402**	**.073**

***1% significant level** **R^2 = .107**

An independent samples t-test was conducted to compare the statistical significance between the yield differences for the survey respondents who reported receiving extension support including climate variability information and those who did not. The results show a difference in the yields for those who received extension information/service (p = .002, two-tailed). The magnitude of the difference in the mean yields was, however, small (eta squared = .05) (Pallant, 2007 citing Cohen, 1988).

4. DISCUSSION

The central hypothesis of the study that field-level extension agents of the Limpopo Department of Agriculture possess climate variability coping competencies to effectively support farmers' production was tested by examining some research questions. Amongst the recommendations by authors in human resource management and extension professionals for organisations to be effective in the 21st century is improved competency (Scheer et al., 2011 citing Stern & Kemp, 2004). One of the common threads in the definition of competency of an individual in the job situation is the underlying qualification of the person (Spencer and Spencer, 1993).

Even though only a small proportion of field-level extension agents in the four municipalities participated in the survey, the key finding in this study regarding the adequacy of agents' technical competency in climate variability issues to support farmers' crop production provides some indication that this is lacking. Half of the extension agents interviewed have only a diploma in agriculture; this supports the assertion by the extension managers that there is a dearth of adequate and technically qualified extension professionals at the field-level to support producers' production with climate variability information. Agents with this level of qualification qualify to work as agricultural development officers and not as agricultural advisors (Department of Agriculture, 2005).

The competency of field-level agricultural extension agents regarding academic qualifications seems to be a problem in most extension organizations worldwide. Our finding is, therefore, not an isolated case but is consistent with others in the literature (Mberego & Sanga-Ngoie, 2014; Brondizio & Moran, 2008; Belay & Abebaw, 2004). Other studies in Limpopo and the Free State provinces of South Africa also indicate the poor educational qualifications of extension officers (Maponya & Mpandeli, 2013; Mmbengwa et al., 2009). Findings in this study regarding the paucity of adequate and competent field-level extension agents with climate variability knowledge to support farmers' crop production are significantly important. This is because agricultural extension is a key player in achieving the government's program of food security, especially, among smallholder farming households.

The finding on conservation agriculture in this study as the coping and adaptation strategies promoted by most agents in our study is consistent with literature. This strategy is reported as some of the measures that could be promoted to help producers to cope with, and adapt to climate variability (Hobbs et al., 2008). The technical competency regarding agents' knowledge and skills in the application of conservation agriculture to support farmers' crop production to minimize the negative effects of climate variability is, therefore, critical in making a difference in farmers' production. A positive impact on extension-recipients' production over non-recipients is expected in view of the wide acclaim of the positive impacts of conservation agricultural practices on crop production in both developed and developing countries (Rochecouste et al., 2015; Knowles & Bradshaw, 2007). Our finding was however, contrary to expectation.

The controversy regarding extension impact on productivity gains and the methodological problems associated with these impact studies have been extensively discussed (Beynon et al., 1995; Gill, 1991). The general acknowledgement in the literature however, is that, agricultural extension has a positive impact on agricultural output and plays an essential role in agricultural development (Anderson, 2007). There is also evidence that extension support enhances farmers' adaptation to climate change (Ekiyar et al., 2012). The improved yields of recipients of extension support, including climate variability information, over non-recipients in this study, therefore, fits the trend in the literature (Asres et al., 2013; Boateng, 2011).

The linkage between competency and job performance is addressed by Boyatzis' "model of Effective Job Performance" (1982) and further evidence is provided by Berger and Berger (2004) and Tiraieyari et al., (2009). Since most respondents, both extension-support recipients and non-recipients employed conservation agricultural practices, the poor technical competency of extension agents in our study is reflected in the relatively small magnitude of crop yield difference between extension support-recipients including climate variability coping information and non-recipients. This finding answers our main research hypothesis regarding how effective the public extension support including climate variability information is, for farmers' crop production. Al-Sharafat et al., (2012) made a similar finding in Jordan where receiving extension support did not make a difference in olive production over non-recipients, a result, which they attributed amongst others, to a lack of competency of extension staff. These findings suggest that extension agents in our study lack appropriate climate variability coping and adaptation knowledge and skills to support farmers' crop production.

5. CONCLUSION

The study concludes that field-level agents of the public extension service in Limpopo province lack technical competency in climate variability issues to support smallholder farmers' crop production. The findings in this study have a place in, and bring new insight to the wider discussion of the effectiveness of public extension support including the climate variability strategies for producers' crop production. This is against the backdrop of the fact that mere promotion of technological innovations such as conservation agriculture, which has the potential to improve soil moisture retention and increase soil fertility, does not lead to the desired outcome, such yield improvement. This implies that extension agents need new technical knowledge and skills to show farmers the proper application of conservation agriculture in integrated management of available soil, water and biological resources if the wide acclaim benefits of conservation agriculture are to be realised. A very serious implication of our findings is that the government's plan to achieve household food security stands in jeopardy if agents' climate variability competency does not improve.

6. RECOMMENDATIONS

Given the complexity of conservation agriculture management packages, it is recommended that, to improve the climate variability coping competencies of field-level extension agents, agents need further training through adaptive research that involves scientists and farmers. The widespread agreement of findings that organizational or individual success depends greatly on their employees' competencies makes it impossible for extension human resource managers, agricultural extension curriculum developers and extension in-service trainers to ignore.

Future agents' climate variability competency studies could include issues on agents' attitudes towards farmers' indigenous knowledge about climate variability coping and adaptation strategies as well as understanding farmers' attitudes towards climate variability concept itself. This will help them develop effective climate variability training programmes for their farmers.

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