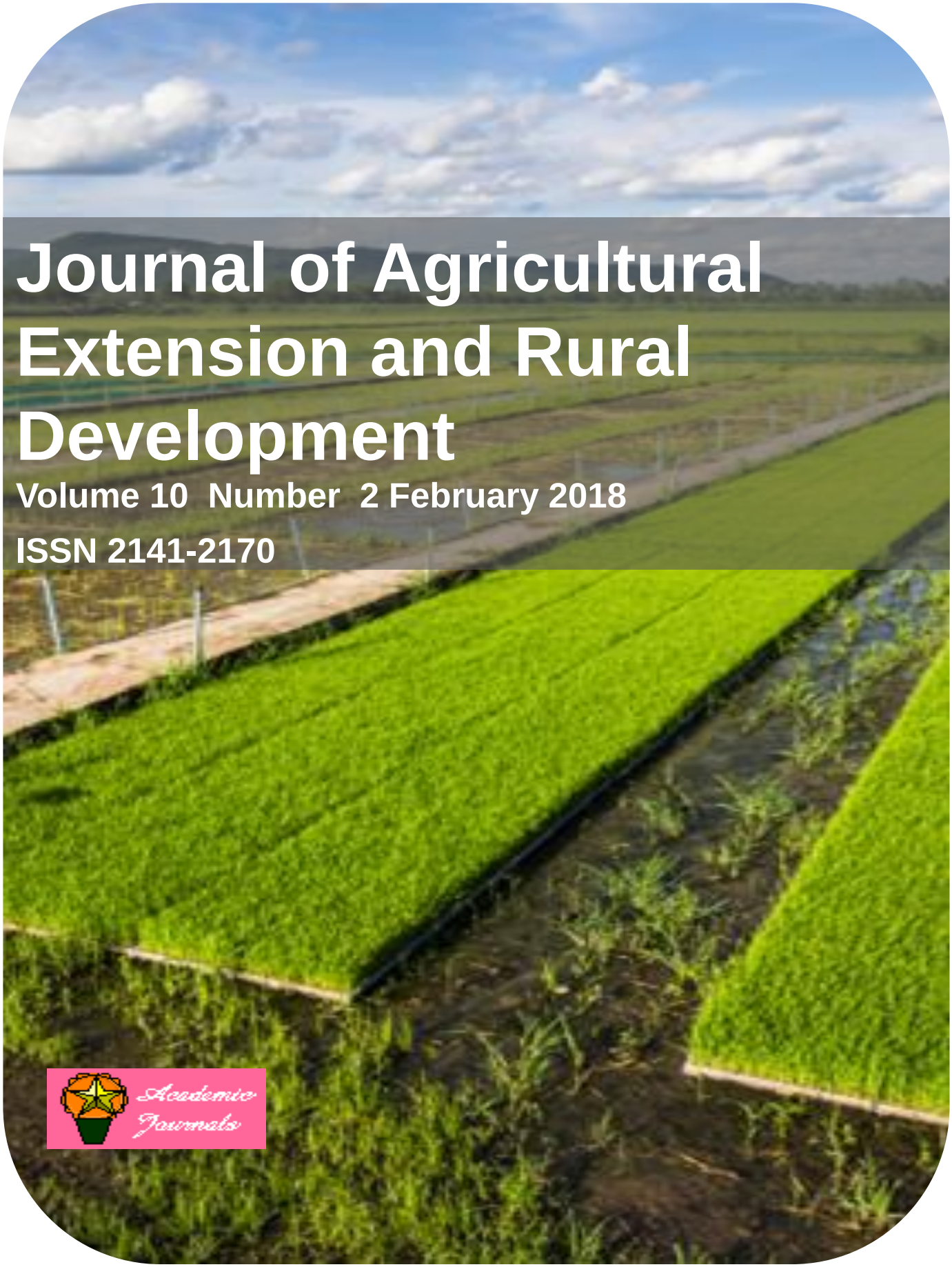

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Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Agricultural knowledge, source and information system in central highland of Ethiopia

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The study aims to assess the effectiveness of the current agricultural information management system and communication, and the gap between required and available information to extension personnel at central highland of Ethiopia. Consulting with head of districts agricultural office, 5 to 6 farmers training center (FTC) from Welmera and Ejera districts were selected randomly. 92 development agents and eleven subject matter specialist who were working in each FTC and bureau of agricultural were interviewed. And researchers also collected qualitative data. For data analysis, descriptive statistics tools were used. In the study area, 75% of development agents (DAs) and subject mater specialist (SMS) got new and updated information frequently and occasionally. Even though, more than half of the respondents know the current extension packages that are developed by Ministry of Agriculture (MOA), they lack documentation. Moreover, development agents and subject matter specialist are less satisfied on promotional opportunity and rewarding system in their organization. The overall finding of the study underlined less availability of regular trainings on new agricultural technologies, less availability of promotional opportunities and rewarding system to DA and SMS, documentation and fewer office equipment problems at FTC level in the area. Therefore, agricultural research center and Ministry of Agriculture should provide problem solving trainings on new agricultural technologies and media design techniques regularly, reconsider salary, promotional opportunities and rewarding system of DA and SMS, supervision of documentation system at FTC level, and furnishing FTC office would help to improve the current agricultural information system in the area.

Key words: Development agents, agricultural knowledge, farmers training center, source of information.

INTRODUCTION

Agricultural information system can influence agricultural production and productivity in different ways. It can help inform decisions regarding land, labour, livestock, capital and management. According to Rolling (1998), an agricultural information system is generated, transformed, transferred, consolidated, received, and fed back in such a manner that these processes function synergistically to underpin knowledge utilization procedures.

Agricultural productivity can arguably be improved by relevant, reliable and useful information and knowledge.

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Hence, the creation of agricultural information (by extension services, research, education programs and others) is now often managed by agricultural organizations that create information systems to disseminate information to farmers so that farmers can make better decisions in order to take advantage of market opportunities and manage continuous changes in their production systems (Demiryurek et al., 2008). Supporting this, Vijayaragavan and Singh (1997) and Halim and Rosa (2017) consider that management information system in the agriculture can help farmers to:

(1) Plan the effective resources to cultivate the land and its crop
(2) Choose the best alternatives to produce and take part in the cultivation
(3) Manageable day to day operations for processing the land.

Ethiopia is one of the developing country; agriculture is seen as the backbone of the economy. The government of Ethiopia has planned different strategies to improve the agriculture sector in the country. Some of the strategies are opening vocational agricultural training centers, recruiting different field development agents in each peasant association and building the capacity of agricultural officers are some of the strategies to improve the agricultural sector in a country.

Development agents and subject matter specialist personnel can get agricultural information from different source and use it to improve the production system of farm households. Agricultural productivity can arguably be improved by relevant, reliable and useful information and knowledge (Demiryurek et al., 2008).

To manage and improve the current agricultural information system there is a need to understand the source, availability and use of agricultural information. So, this study deals with assessing the effectiveness of the current information management system and communication, the gap between required and available information to extension personnel, major bottlenecks in the process of agricultural information management, and to suggest possible options on how effective and efficient information management and chain could be developed in welmera and Ejera districts.

METHODOLOGY

A multi stage sampling procedure was employed to select respondents. Welmera and Ejera districts were selected purposively. Consulting with head of districts agricultural office, 5 to 6 farmers training center (FTC) from Welmera and Ejera districts were selected randomly. The questionnaire was pre-tested before administering on the selected sample agricultural personnel's. Depending on the findings of pre-tests, some modification was made on the final version of the interview schedule. Nineteen two development agents and eleven subject matter specialist who are working in each FTC and bureau of Agricultural were interviewed. By using descriptive statistics, quantitative data types were analyzed and qualitative data also interpreted.

RESULT AND DISCUSSION

Required and available information to extension personnel

In the study area, 75% of development agents (DAs) and subject mater specialist (SMS) had new and updated information frequently and occasionally (Table 1). Specifically, all respondent got information on new varieties, crop protection, agronomic practice, acid soil and saline soil management, watershed management, harvesting and post-harvest tools, and marketing respectively. On the other hand, 86.2, 90.3, 85, and 77.7% of respondents got information on relevant trainings, agricultural research station, non-governmental organization (NGO) and agricultural offices. In addition to that, 82.7 and 51.5% of respondents mentioned that the information gotten were not relevant, and were not available. However, 71.2, 63.6 and 52.5% of them revealed that the information gotten was easy to understand, delivered on time and relatively complete (Table 2). From this study, it was observed that development agents are working in an office that is not well furnished. And they lack the necessary skill to prepare materials that will be easily understood by farmers. Generally, the collected information's from different development agencies are less valuable to change the agricultural practice of farm households.

Information storage and processing

To sustain the agricultural information and knowledge transfer among experts, each information should be filed and documented in an appropriate way. Even though more than half of the respondents knew the current extension packages that are developed by Ministry of Agriculture (MOA), they lack filing in an organized ways (Table 3). According to Table 3, 58, 41.1 and 20.7% of the respondents response were documented in a note book, filed in FTC, and the original publications from the source were kept. Consequently, the aim of achieving fast agricultural development in a country would become lager and inconsistence. The aim of organizing consecutive training to development agents is to equip them to change the living standard of farm households. And it is assumed that each development agents transferred the knowledge they acquired by using different teaching methods. According to Table 4, more than 90% of agricultural experts used training, demonstration, field visit and village meeting as methods of information sharing to farmers. More frequently, they used village meeting as information sharing methods per season. Using village meeting more frequently would encourage farmers to accomplish each activity through participation and with common understanding.

Table 1. Type of information's available.

Information about	Almost always	Frequently	Occasionally	Rarely	Almost never
New varieties, seed and seed management	16	1	12	1	-
Major crops protection	13	15	1	1	
Agronomic practices	12	7	10	1	-
Animal husbandry	10	6	8	5	1
Forage production	5	3	17	3	2
Disease control	3	6	15	3	3
Use of AI	1	5	7	14	3
Cross-bred cows	4	6	8	9	3
Fattening	6	13	8	2	1
Soil conservation practices	5	15	5	2	3
Irrigation management	3	14	10	2	1
Acid soil management	10	6	4	10	
Saline soil management	2	12	4	12	
Vertic soil management	3	8	9	5	5
Seedling Nursery management	5	13	9	2	1
Forest Plantation management	2	11	15	1	1
Forest utilization	2	8	11	5	4
Water shed management	3	12	6	9	
Natural Resources management	6	14	8	1	1
Pre-harvest farm tools and use	2	9	6	9	4
Harvest farm tools and use	6	9	9	6	
Post-harvest tools and use	7	5	12	6	
Prices of commodity	2	8	9	6	5
Market demands	6	6	9	9	
Promotion of group marketing	3	4	12	5	6
Marketing strategies	3	3	6	12	6

Table 2. Methods of getting new information about agricultural technologies.

Source of information	Frequency (%)	
	Regularly	Irregularly
Do you get trainings relevant to your job?	24.1	86.2
Agricultural office	22.5	77.7
NGO	15	85
Agricultural Research station	9.7	90.3
Agricultural universities	42.9	57.1
Relative quality of information	**Yes (Regularly)**	**No (Irregularly)**
Availabilities	48.5	51.5
Completeness	52.5	47.5
Timeliness	63.6	36.4
Relevance	17.3	82.7
Easy to understand	71.2	28.8

Perceptions on agricultural information management

Every professional has his own perception towards availability, access of information/training and improved agricultural technologies given by other organizations. Agricultural development and subject matter specialist evaluated the current information management system in their organization. According to Table 5, 41.7 and 75% of the respondents got adequate information for their extension work and early access to some useful

Table 3. Documentation.

Knowledge	Percentage	
	Yes	No
Do you know the current extension packages that are developed by MOA?	62.1	37.9
Do you have them in a written documents	51.7	48.3
Method of documentation		
In the note book	58	42
Information file in FTC	41.4	58.6
Keep the original publications from the source	20.7	79.3

Table 4. Methods of information sharing to farmers (2012/13)**.**

Variable	Methods (%)		If yes, how many times per year you undertake?/score /
	Yes	No	
Training	100	0	89
Demonstration	98	2	47
Field visit/days	95	5	29
Village meeting	95	5	278
Prepare poster/leaflet	40	60	22
Visual (picture, drawing)	15	85	18
Discussion with individual farmers	98	2	367

Table 5. Perceptions on agricultural information management.

Variable	Percentage	
	Yes	No
Do you think that you get adequate information for your extension work?	41.7	58.3
Do you think you can early access some of the useful agricultural information from research and other institution?	75	25
Do you think you can adapt /modify the information you got from different sources in to easy forms that can be understood by farmers?	100	-

information from research center and other institution. Even if respondents have different perception on agricultural information system, all the respondents had the ability to customize the information gotten for easy understanding. Regarding improved agricultural technologies, development agents and subject matter specialist had reflected on their attitude in different ways. According to Table 6, more than 40% of respondents had strongly agreed on issues mentioned on 2nd, 3rd and 10th. Similarly, on issues of 'using improved agricultural technologies is rewarding' and 'improved agricultural technologies fit well in our existing conditions and practices', 67.9 and 46.4% of them disagreed. On the other hand, 57% respondents disagreed on 'there are ample choices of improved agricultural technologies for farmers of the area'. Generally, agricultural experts agreed on improved agricultural technologies would help to achieve fast agricultural development. But they pointed out less availability of technologies choices in the area.

Job satisfaction, motivation and commitment

Job satisfaction

From the sampled respondents, 53.6, 57.1 and 53.6% of the respondents were highly satisfied regarding 'the recognition given to their work and profession in the work place and in the community', 'with the effective total time you devote to your profession' and 'with being recognized as professional expert in your field' issues (Table 7). On the other hand, agricultural experts are slightly dissatisfied on 2nd, 3rd and 6th issues. This issue includes being less satisfied on promotional opportunity and rewarding system in their organization.

Job autonomy

It is believed that every profession should develop their

Table 6. Extension workers perception on improved agricultural technologies.

Variable	Perception (%)				
	Strongly disagree	Disagree	neutral	agree	Strongly agree
Using improved agricultural technologies is rewarding	-	7.1	25	67.9	-
I feel that existing improved technologies play crucial role in addressing our priority problems	-	3.6	-	42.9	53.6
I feel that I know adequate improved technologies to improve production/productivity & income of farmers	-	21.4	7.1	25	46.4
Improved technologies do not incur additional cost and labour than their local counterparts	10.7	25	7.1	28.6	28.6
Improved agricultural technologies fit well in our existing conditions and practices	10.7	-	7.1	46.4	35.7
Improved agricultural technologies are within the reach of resource-poor farmers	10.7	25	7.1	28.6	28.6
Improved technologies are not technically sophisticated and difficult to put into practice	10.7	32.1	7.1	32.1	17.9
There are ample choices of improved agricultural technologies for farmers of the area	3.6	57.1	10.7	10.7	17.9
Use of improved agricultural technologies does not involve too much risk.	3.6	32.1	7.1	35.7	21.4
The use and benefits of improved agricultural technologies will be sustainable in the long run	3.6	7.1	-	42.9	46.4
Improved agricultural technologies are within the reach of resource-poor women farmers	14.3	32.1	7.1	28.6	17.9

Table 7. DAs and SMS job satisfaction.

How much satisfied are you?	Perception (%)				
	Highly satisfied	Moderately satisfied	Neutral	Slightly dissatisfied	Highly dissatisfied
With the flexibility given by your supervisors to do your job well	32.1	39.3	10.7	7.1	10.7
With your present position when you compare it to a similar other position/ profession	32.1	14.3	14.3	21.4	17.9
With the programme you are carrying out towards the goals you set for yourself in the present position	25	42.9	7.1	17.9	7.1
With the recognition given to your work and profession in the work place and in the community	53.6	28.6	7.1	14.3	
With the effective total time you devote to your profession	57.1	21.4	7.1	14.3	
With that of promotional opportunities and reward system in your job	35.7	25	14.3	17.9	7.1
With that of you being recognized as professional expert in your field	53.6	35.7	7.1	3.6	
With the present position when you consider the expectation you had when you took up this job expectation	17.9	14.3	10.7	10.7	-
With the work you are carrying out in your position	25	42.9	25	3.6	3.6

job carrier by taking different kinds of training. Trainings would help the employee to accomplish their day to day activities independently and efficiently. As shown in Table 8, 64% of the interviewed agricultural experts said something about scheduling their own work. Even if they

Table 8. Job autonomy.

Statement	Perception (%)				
	Highly agree	Agree	Neutral	Disagree	Strongly disagree
I have almost no 'say' about scheduling my work	3.6	7.1	3.6	64.3	21.4
The work and procedure of my organization are all laid down by me	10.7	39.3	7.1	35.7	7.1
I have almost 'say ' about all scheduling of my work	28.6	60.7	-	7.1	3.6
I can decide what procedures to be used	35.7	42.9	3.6	10.7	7.1

Table 9. Organizational commitment of DAs and SMS.

Issue	Statement	Perception (%)				
		Almost always	Frequently	occasionally	Rarely	Almost never
1	I am willing to put a great deal of efforts to help my organization be successful	75	25	-	-	-
2	I used to talk about my organization a great organization to work for	53.6	25	14.3	7.1	-
3	I feel little loyal to my organization	-	7.1	3.6	10.7	78.6
4	I would accept almost any type of job assignment in order to keep working for my organization	60.7	21.4	10.7	7.1	-
5	I find that my values and values of the organization are similar (I have values that are shared by my organization)	53.6	35.7	10.7	-	-
6	I am forced to tell others that I am part of my organization	75	14.3	10.7	-	-
7	I would just as well be working for a different section/department as long as the type of work is similar	60.7	21.4	10.7	3.6	3.6
8	My organization really inspires me to perform well in my job	14.3	14.3	39.3	25	7.1
9	A very little change in my present circumstances can cause me to leave my organization	17.9	7.1	28.6	35.7	10.7
10	I am extremely glad that I chose this organization to work for over others	21.4	28.6	17.9	28.6	3.6
11	There is not too much to be gained by sticking with this organization indefinitely	14.3	14.3	35.7	32.1	3.6
12	Often, I find it difficult to agree with the organization on important matters relating to it's employees	7.1	17.9	39.3	28.6	7.1
13	For me this is the best of all organizations for which to work	60.7	21.4	10.7	3.6	3.6

have a say on scheduling there day to day activities experts reported that they are a little bit overruled by assignment. This might lead the professionals to become less efficient and productive on their career.

Organizational commitment

Every organization wellbeing highly depends on the availability of committed and motivated worker. And workers commitment would lead the organization to contribute more to needy citizens in a country. Since agricultural workers are directly linked to farmers, their commitment on organization vision, mission and goal play a great role for food security and poverty alleviation in a country. According to Table 9, 75, 78.6 and 60.7% of workers are seen to be making efforts to help their organization, being loyal and working for a different section/department as long as the type of work is similar. Similarly, more than 60% of respondents always feel they are trying their best. Moreover, as indicated in the 9th issue, more than 30% of workers would not change their organization even if little change occurred in an organization. On the other hand, 39.3% of them occasionally feel their organization does not inspire them to perform well in an organization.

Conclusion

The aim of organizing consecutive training for

development agents is to equip them to change the living standard of farm households. And it is assumed that each development agents transferred the knowledge they acquired by using different teaching methods. However, training delivery system to development agents is not persistent. Even if the information's collected from different development agencies are presented in a simple manner they are still found to be less relevant to change the agricultural practice of farm households. Moreover from the study observation, majority of the development agents are working in an office that is not well furnish. And they lack the skill to prepare the information in a more easy and attractive ways to the surrounding farmers. To improve these scenarios, different media designs techniques have played a great role to transfer information's in an easier way than written and oral form of transferring information. Some development agents are also less satisfied by promotional opportunities in their organization. This disaffection made the current agricultural information system less smoother. Generally to improve the current agricultural information system conducting problem solving trainings on new agricultural technologies and media design techniques regularly, reconsider salary, promotional opportunities and rewarding system of DA and SMS, supervision of documentation system at FTC level, and furnishing FTC office would help to improve the current agricultural information system in the area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Smallholder farmers' experiences of climate variability and change on pineapple production in Ghana: Examining adaptation strategies for improved production

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Climate variability and change presents enormous risk to agricultural production globally due to the impacts on yields. While global scholarship on climate change impacts and adaptation measures on agriculture has been well-documented, little is known about climate and pineapple production. This study examined smallholder pineapple farmers experiences of climate variability and change on production, as well as ranked adaptation options using data from both primary and secondary sources. The primary data consisted of survey and focus group discussions in four major pineapple growing districts in Ghana. The analysis revealed that pineapple farmers experience climate variability and change evidenced mainly through irregular rainfall patterns and rising temperatures. These changes cause reduction in fruit size and yield, change in colour and taste, and consequently, reduction in income from pineapple production. Although diverisification of livelihood away from pineapple cultivation emerged as the main adaptation option employed by smallholder pineapple farmers studied, it has the potential to reduce pineapple production in Ghana. For improvement and sustainability of the pineapple industry in Ghana, future studies should investigate the vulnerability of the production system to changing climate to effectively identify exposure and sensitivity of pineapple production to climatic changes. This will in effect, enhance identification of measures that will improve production as well as promote adaptation of the smallholder production systems to climate variability and change.

Key words: Climate variability, change, smallholder farmers, adaptation, pineapple production.

INTRODUCTION

Pineapple is an important crop that significantly contributes to the economy of Ghana (Badu-Gyan, 2015; Whitfield, 2016). It is estimated that in 2011, about 40,000 tons of pineapples were exported from Ghana to Europe (Kleemann et al., 2014). About 10,000 ha of farm holdings were cultivated with pineapple by both rural and

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urban households (Badu-Gyan, 2015). Pineapples produced are absorbed into both the export and local markets. The promotion of pineapple production and export has been effective in improving rural livelihoods by through improved income to farmers and reducing poverty. This is despite socio-political and economic challenges including changing regulations and the shift of international demand for pineapple from the formerly dominant 'Smooth Cayenne' variety to the MD2 variety faced by the industry over the years (Whitfield, 2016; Badu-Gyan, 2015).

The pineapple industry in Ghana is made up of small, medium and large scale producers. Pineapple small-scale producers cultivate from 1 to 20 acres of land and are distinguished in Ghana based on their relationship with large pineapple companies or exporters (Danielou and Ravry, 2005).

Climate change presents enormous risk to agricultural production globally due to the impacts on yields (Moore and Lobell, 2014; Food and Agriculture Organization [FAO], 2013; Trujilo, 2011). Projections of the nature and magnitude of these impacts on agriculture require knowledge of possible adaptation techniques (Moore and Lobell, 2014). Pineapple is more sensitive to variations as impacts from excessive heat and irregular rain results in low productivity (Iwuchukwu and Udoye, 2014; Williams et al., 2017). Though pineapple crop can withstand longer periods of drought when subjected to prolonged water stress, plants cannot obtain the desired sizes needed for flower induction and growth (Tachie-Menson et al., 2014). The major pathway through which climate variability and change affects food production is increased temperatures and water stress resulting in crop failure or decreases in crop yield (FAO, 2008). Smallholder farmers have to contend with rising levels of uncertain conditions surrounding production and limited adaptive capacity (Carr and Thompson, 2014). This uncertainty as a result of climate variability and change has resulted in a plethora of adaptation measures to tackle the potential implications of climatic changes and to help farming communities to better face extreme weather conditions associated with climate variations (Ndamani and Watanabe, 2015). Studies have indicated that, knowledge of smallholder farmers on adaptation may be used as baseline information in developing planned adaptations and inform development policy and other decision making process (Fosu-Mensah et al., 2012; Nhamo et al., 2014; Burnham and Ma, 2016). Adaptation is differentiated by the space within which it is designed. Individuals within communities design some adaptation measures while others are designed from outside the community (Burnham and Ma, 2016).

Adaptation practices used by farmers emerging internally from the communities have been mostly studied (Jones and Thornton, 2003; Ndamani and Watanabe, 2015; Misra, 2016). Until recently, development programmes were without cognizance of the effects of climate, but now climate change adaptation mainstreaming into development programmes is being practised. In addition to the 2nd sustainable development goal which seeks to "end hunger, achieve food security, improve nutrition and promote sustainable agriculture", Ghana's Nationally Determined Contribution (NDC) to the United Nation's Framework Convention on Climate Change (UNFCCC) seeks to achieve "agriculture resilience building in climate vulnerable landscapes" (United Nations, 2012; Government of Ghana, 2015). The achievement of these policy objectives requires research on the prevailing challenges that confront the food value chain as well as adaptive measures that are adopted by smallholder farmers.

Although global scholarship on climate impacts and adaptation has observed significant advances, policies and programmes to enhance planned adaptation is often constrained by limited knowledge on contextual and crop-specific practices that have reduced vulnerabilities and enhanced production (Carr and Thompson, 2014). Evidence on pineapple farmers' experiences and adaptation practices are not readily known, meanwhile knowledge of the observed effects of climate variability and change on production as well as existing adaptation strategies are imperative for building resilience in the horticultural sector.

Studies done on adaptation particularly in Ghana have not adequately targeted pineapple production (Westerhoff and Smit, 2009; Boon and Ahenkan, 2012; Nyantakyi-Frimpong and Bezner-Kerr, 2015). Although there exist few literature specific on pineapple production and climate in Africa and Ghana (Williams et al., 2017; Iwuchukwu and Udoye 2014; Mugambwa, 2014), its adaptation strategies are generally inferred from other crop production adaptation measures which is not a standard way of providing adaptation measures specifically for pineapple production. Understanding adaptation measures by smallholder pineapple farmers will provide source of knowledge on adaptation practices to a changing climate regarding cultivation. This could have direct implications for future adaptation research, policy and practices. This paper adds to the research literature by examining farmers' perceived causes of climatic variability/change, perceived effect of climate variability on pineapple production and adaptation strategies used by pineapple farmers in response to climate change/variability.

MATERIALS AND METHODS

Data and method of collection

The study employed both primary and secondary data. Primary data was obtained through a survey covering four districts from four major pineapple growing regions in Ghana. Specifically, Ga East, Akatsi North, Nsawam Adoagyiri and Gomoa West districts were selected to represent Greater Accra, Volta, Eastern and Central Regions of Ghana, respectively (Figure 1).

Figure 1. Map of the study areas.

A two-stage sampling technique was used to collect cross sectional data from four hundred smallholder pineapple farmers across the four districts in Ghana. The first stage involved a purposive sampling of the study areas and the second stage was employment of random sampling technique to select the various respondents for the survey.

A sample size of 600 was obtained from the district offices of the Ministry of Food and Agriculture (MoFA). One hundred pineapple farmers were then randomly selected as proportionate to the total sample from each district making a total of 400 respondents. Data collection was with the aid of pretested structured questionnaires to correct any inconsistencies. Data collected were mainly on socio-demographic characteristics of the respondents, climate variability and its related impacts on pineapple production as well as adaptation strategies of smallholder pineapple farmers to climate variability and change in Ghana.

Focus Group Discussions (FGDs) were also conducted with ten members of cooperative pineapple growers and marketing associations in the respective districts to get an in-depth understanding on climate and pineapple production in Ghana.

Secondary data was based on review of relevant sources such as publications, journals, books and annual reports, periodicals and through web sites in order to know strategies used by smallholder farmers in adapting to climate variability in the pineapple industry.

Data analysis

Data on socio-demographic characteristics of the respondents was analyzed using descriptive statistics. Thematic analysis using qualitative responses from the FGDs was used to analyze climate variability and its related impacts on pineapple production. The study identified and analyzed adaptation strategies of smallholder pineapple farmers to climate variability and change in Ghana. The identified factors included increased production of other crops, introduction of other crops, diversion into animal production, expansion of other farming activities, diversion into other non-farming activities, reduction/increase in pineapple farms, adoption of organic farming, change of planting dates, practice of bush fallow/crop rotation among others. Perceived strategies used by pineapple farmers were ranked by the respondents using frequency or percentage (%). The rank order was given using Garett's ranking technique. The orders of merit were transformed into units of scores by using the following formula.

Percent position = 100 (Rij – 0.50) / Nj

where Rij is the rank given for the ith factor by the jth individual and Nj is the number of factor ranked by the jth individual.

The percent position was converted into scores by referring to

the Garrett's Scale Conversion Table.

According to Loganathan et al. (2009), for each factor, the scores of the individual rankers were added and the average score was estimated and arranged in either ascending or descending order to know the order of preference given by the respondents for the factors. Based on the mean score, the overall ranks were assigned for each. Garrett's rank scoring technique which has been developed for testing rankings was considered because this method allowed respondents to rank their preferences hence following the sequence from the most relevant factor allowed to find out the most important adaptation strategy which is the most preferred by the small holder farmers to the least preferred ones.

RESULTS AND DISCUSSION

Socio-demographic characteristics of pineapple farmers

The socio-demographic characteristics of the respondents are presented in Table 1. These characteristics impact on farmers' production activities, management and productivity. Majority (85.0%) of the pineapple farmers were male and about 90% of them were within the economic active age of 18 to 60 years. Only a tenth were above 60 years. This is encouraging, as it would ensure sustainability and continuous existence of the pineapple industry.

The pineapple farmers interviewed had varying levels of education that relates to farmer's capacity and willingness to adopt improved technologies including measures in adapting to changing climate. Education broadens one's outlook on life and helps to understand the social, political, economic and cultural issues in the society (Hasan et al., 2010). Only about 13% had no form of education at all.

As shown in Table 1, a little over a third (35.0%) of the pineapple farmers had more than 10 years of pineapple farming experience. According to the results, almost all the pineapple farmers had knowledge regarding pineapple cultivation apart from the few farmers who had less than one year experience in pineapple farming. Farmers' knowledge and skills of farming practices gained through production practices can influence their ability to adapt and cope with growing conditions including climate variation.

With regards to membership of farmer associations, the results show that, 71.0% of the pineapple farmers were members of an association; the rest did not belong to any association. Most (77.3%) of the pineapple farmers had extension contact but had less support from R&D institutions (31.0%). Majority (82.5%) of the farmers also had small farm size (less than 1.6 ha) indicating they operate on a small-scale level. Knowledge of the various land sizes operated by smallholder farmers is important since pineapple farm size influences the work intensive nature of production (Badu-Gyan, 2015). Other studies have found a significant positive relationship between farm size and income from pineapple cultivation implying the higher the farm size, the higher the income from pineapple cultivation (Hasan et al., 2010; Mondol et al., 2005).

Farmers' perception of the evidence and effects of climatic variation and change in pineapple growing areas in Ghana

Climatic variation poses great threat to farmers and their production activities. During discussions with the pineapple farmers, irregular rainfall patterns, drying up of streams, overflow of streams, rise in temperature and excessive heat which are indicators of climate variability/change were recognized in all the study areas as evident. Irregular rains and drying up of streams were particularly mentioned as the main evidence of climate variability/change.

A farmer from Gomoa West indicated that, "*since the last decade, this area receives less rains compared to the earlier periods and it does not rain at the expected time affecting our production plans*". In Akatsi, another farmer mentioned that, "*we (farmers) experience shorter raining period than before which is now approximately less than 3 months with yearly changes*". The farmers mentioned that, their growing areas had been experiencing periods of low rainfall as indicated by the drying up of streams especially during the past decade. Occasional cases of floods, which were evidenced by overflowing streams, were also reported. High temperature was also mentioned by many farmers as an indicator of changing climate.

In Ga West, a farmer indicated that, "*our forests are gone therefore sunshine has been intense with high temperature and consequently reduced rainfall*". Climate variability and change may have both positive and negative effects on farming in Ghana, though there are indications of more negative impact in the long run and may in effect challenge farmer's production efforts and affect sustainable production (Nyadzi, 2016).

Pineapple crop is more sensitive to variations in weather patterns brought about by changes and variability in the climate system. According to the pineapple farmers, some of the effects of the variation in climate on production include reduction in fruit size, reduction in yield, reduction of income from pineapple, change in colour and change in taste. This concurs with results of other studies that showed similar effects of climatic variation on pineapple production in Nigeria and Uganda (Iwuchukwu and Udoye 2014; Mugambwa, 2014). During the FGD, a farmer from Nsawam Adoagyiri remarked that, "*in January 2014, high temperatures together with low patterns during flowering stage of production resulted in small sized fruits affecting market price and reduced net income*". Regarding fruit quality, noticeable temperature effects that emerged in different farms included sunburn and black spot with resultant

Table 1. Socio-demographic characteristics of pineapple farmers.

Variable	Frequency	Percentage
Age		
18 - 35	124	31.0
36 - 60	236	59.0
>60	40	10.0
Educational level		
None	53	13.3
Basic	80	20.0
Secondary	257	64.2
Tertiary	10	2.5
Gender		
Male	341	85.0
Female	59	15.0
Years in pineapple farming		
<1	9	2.3
1 - 3	94	23.5
4 - 6	97	24.2
7 - 10	60	15.0
>10	140	35.0
Farmer Based Organization (FBO) membership		
Yes	284	71.0
No	116	29.0
Access to Agricultural Extension Agents(AEA)		
Yes	309	77.3
No	91	22.7
Access to Research & Development (R&D)		
Yes	124	31.0
No	276	69.0
Farm size (ha)		
<1.6	330	82.5
1.6 - 4.0	58	14.5
>4.0	12	3.0

reduction in fruit weight and size. Extended growing period that increases production cost as a consequence of drought was another effect that many farmers have observed.

In addition, farmers mentioned that, prolonged drought with unpredictable rainfall patterns mostly promote and introduce crop diseases such as heart rot and pests, which reduce crop yield and productivity. In the absence of effective adaptation measures, crop production can be severely constrained by climate variability and change (Smit and Skinner, 2002; Nyadzi, 2016). Exploring how pineapple farmers modify their farming practices in response to the changing climate is therefore very important to the development of effective policies and practices to enhance pineapple productivity in Ghana.

Adaptation strategies for pineapple production in Ghana

Smallholder pineapple farmers in Ghana have devised several practices and measures for coping with the

Table 2. Ranking of adaptation strategies by pineapple farmers (N=400).

S/N	Rank scale factors	1	2	3	4	5	Total score	Mean score	Rank
1	Increased production of crops grown earlier	63	92	104	71	68	26215	65.5375	7th
2	Production of crops not grown before	67	111	83	89	45	26368	65.92	6th
3	Movement into animal production	112	116	94	42	29	27480	68.7	4th
4	Expansion of animal farm	118	116	94	46	23	27884	69.71	3rd
5	Movement into non-farm occupations	166	115	55	48	10	28669	71.6725	2nd
6	Reduction of pineapple farm size	174	89	74	40	19	28709	71.7725	1st
7	Changing date of planting and other operations concerned with pineapple production	78	83	103	95	36	26430	66.075	5th
8	Adoption of organic farming in my pineapple production	22	118	110	35	109	25173	62.9325	11th
9	Increase pineapple production farm size	21	90	105	47	134	24841	62.1025	12th
10	Practice of bush fallow	45	111	70	64	106	25551	63.8775	9th
11	Practice of crop rotation	41	110	66	30	150	25266	63.165	10th
12	Other measures	63	92	104	71	68	26215	65.5375	7th

effects of climate variability and change in order to adapt to this phenomenon. Using Garrett's Ranking Technique, ranking results of measures used by the farmers as adaptation strategies during pineapple production are shown in Table 2. Out of the 12 factors examined, reduction in pineapple farm size (with a mean score of 71.8) was considered as the main adaptation strategy used by farmers in adapting to climate variability and change (Table 2). Movement into non-farm occupations, expansion of animal farm as well as movement into animal production were the next top three measures ranked after reduction in farm size by the farmers in the study areas (Table 2). The measure ranked as the least effective adaptation strategy used was increasing pineapple production farm size. As depicted in Table 2, other measures such as changing date of planting and other operations concerned with pineapple production, production of crops not grown before and increased production of crops grown earlier are adaptation strategies also found to be used by smallholder pineapple farmers in adapting to the effects of climate change and variability.

Smallholder pineapple farmers' most important adaptation strategies

Results from the adaptation strategies examined indicates that, the five most important climate adaptation measures employed by pineapple farmers in Ghana include reduction of pineapple farm size, movement into non-farm occupations, expansion of animal farm, movement into animal production and changing date of planting and other operations concerned with pineapple production (Table 2). Apart from changing the growing period, the other factors fall under the broad theme of crop and livelihood diversification, which is a combination of practices that seek to stabilize production and to a large extent income of farmers.

As indicated by Altieri and Koohafkan (2008) and Hassan and Nhemachena (2008), livelihood diversification as response to changing climate is related to reduction in risk associated with crop production. Deressa et al. (2009) also refers to this as risk-mitigating strategies. The pineapple farmers reported that, pineapple production is highly capital intensive, hence, effects such as reduction in fruit size and yield which result in poor economic returns due to varying climatic conditions may have contributed to some of the farmers diversifying from pineapple production. This is however not encouraging as it would affect sustainability of the pineapple industry in Ghana. Reduction in pineapple farm size, which ranked as the topmost climate adaption measure equally contributes to this future threat to the industry. Varying area cultivated as an adaptation strategy concurs with other studies (Gbetibouo, 2009; Molua and Lambi, 2006). Total area of pineapple farming has been identified by most studies as a critical factor that significantly contributes and has direct effect on the income of pineapple farmers (Badu-Gyan 2015; Hasan et al., 2010). As noted by Badu-Gyan (2015), the larger the farm size, the more difficult it is for pineapple farmers to manage production activities and as such increases the likelihood of the farmers' choice of production practices. Smaller farms were noted in the study to have greater propensity for adopting work intensive production while larger farm size is expected to have a negative influence on farmers' choices of advanced production systems. The size of land influences the level of input used and also the quantity of output produced from it which could

imply that, increasing planting area would increase production cost and subsequently reduce income due to climatic changes.

To sustain pineapple production, reduction in pineapple farm size and diversification into other livelihood activities such as production of food and vegetable crops as practiced by the pineapple farmers are response to climatic variation and change that needs to be effectively addressed. A major concern to production raised by farmers during discussions was inadequate government support to address climate related challenges during production. Almost all adaptation strategies identified were farmer initiated bottom-up practices. This type of approach depends on the farmers' own characteristics (Fujisawa et al., 2015). FAO classifies top-down adaptation strategies as government supported strategies and has even been classified as introduced adaptation strategies (Kuwornu et al., 2013). These strategies are found to enhance smallholder farmers resilience to climate change and variability and such practices include modernized irrigation system (Hassan and Nhemachena, 2008), improved meteorological forecast (Easterling et al., 2007), farm insurance (FAO, 2009) as well as good agricultural practices (Easterling et al., 2007).

A combination of farmers initiated bottom-up and institution led top-down approaches would facilitate more flexible and widely accepted adaptations practices as it involves diversity of actors that could make adaptation more dynamic and innovative (Fujisawa et al., 2015). According to the pineapple farmers, beyond their capacities, distinct measures such as introduction to irrigation systems, afforestation in pineapple producing areas, provision of modern technologies such as plastic mulching and capacity building to enhance knowledge to improve production practices would greatly enable them to deal with climate variability and change. This needs to be appropriately considered in adaptation policy for government and research institutions to intervene in the development and promotion of strategies perceived to be effective in improving production.

Smallholder pineapple farmers' least important adaptation strategies

Results of the analysis further show the least ranked measure that could also be considered as the least effective adaptation strategy for pineapple farmers (Table 2). The least ranked adaptation measure was increasing pineapple production farm size. This could be explained by the fact that, farmers reported difficulty in predicting weather pattern, particularly rainfall, affecting planning of operations during production cycle. Rainfall and temperature variation were reported to produce delay in pineapple growth stages that results in increasing cost of production and consequently significant reduction of crop revenue. For instance, it was mentioned that, production is planned such that, flower induction coincides with the minor season rains to avoid delays in production schedules and marketing arrangements as well as secure yield. Delays and variation in climate therefore negatively affects fruit quality and quantity as well as production schedules and market. The resultant effect is farmers reducing production area, which as earlier noted will not be sustainable for the sector.

Among the other least effective strategies used in adapting to the effects of climate change and variability by the smallholder farmers were practice of bush fallow, practice of crop rotation and adoption of organic farming in pineapple production. Farmers complained that, there are drawbacks in practising crop rotation and bush fallow, as more time is required in preparing the soil for new crops as well as scarcity of land to support these practices. Also, despite the importance and advantages associated with organic farming and the environmental friendliness related to it, pineapple farmers ranked it among the least effective measure against climatic changes as it is considered to be capital and labour intensive and risky. The formal organic sector in Ghana currently occupies only 0.2% of agricultural land (Badu-Gyan, 2015) implying minimal adoption of the practice. Overall, other measures such as changing date of planting and other operations concerned with pineapple production, production of crops not grown before and increased production of crops grown earlier were also found to be used by smallholder pineapple farmers in adapting to the effects of climate change and variability.

Implications for improved adaptation strategies for pineapple production in Ghana

There are varying ways pineapple farmers are using to adapt or cope with changing climate to reduce the effects of its consequences based on their own experiences. It is been generally noted that, not all observed adaptation practices by farmers are deliberately planned as adaptive actions against the climate but that, some are by-products or secondary benefits from activities unrelated to changing climate (Fujisawa et al., 2015). The strategies identified in this study therefore are not a comprehensive list of measures that may all be relevant especially for local specific adaptation decisions in addressing anticipated current and future threats resulting from changing climate to the pineapple production industry in Ghana. Climate projections in Ghana indicate that, there would be more variable weather conditions and extended periods of drought with potentially devastating implications (Allison et al., 2009).

A very recent study by Williams et al. (2017) confirms that, climate variability impacts on pineapple production in Ghana and has consequences for both fruit quality and quantity produced. Adapting to climate projections therefore will require a new paradigm, as the adaptation

actions taken so far by farmers are likely not to sustain and improve the pineapple production industry in Ghana. Adapting to impacts from projected climatic changes may even require structural changes such as irrigation facilities, which would demand government intervention. More so, adaptation strategies are becoming increasingly important issues for promoting development (Clement et al., 2011). Therefore, since the identified alternatives are not likely to be appropriate in all circumstances in Ghana, a better understanding of local awareness of climate vulnerabilities to help communities understand their sensitivity to climate will be important in informing policy for future successful adaptation strategies for pineapple production.

Fujisawa et al. (2015) argue that a combination of the farmers-initiated bottom-up and the institution-led top-down approaches would facilitate more flexible and widely accepted practices to climatic changes with the involvement of a diversity of actors making the entire adaptation process more dynamic and innovative. Importantly, there is no 'one-size fits all' approach for communities to anticipate, plan, and adapt to the changing climate (Hinkel et al., 2010). According to Ndamani and Watanabe (2017), an effective analysis of climate vulnerability in agriculture is fundamental to developing viable adaptation options to manage future anticipated climatic risks and to support adaptation planning.

Conclusion

Pineapple production is both a major contributor to the economic development of Ghana and also promiment livelihood activity for smallholder farmers. However, in addition to the constraints from the political economy of the global market, climate variability and change presents considerable challenge to farmers. Discussions with the farmers revealed that, erratic weather patterns through floods, droughts and increase in temperature affect pineapple production and yield. In response to the effects of climatic changes on pineapple production experienced by farmers, acess to weather information needs to be timely and prioritized to help farmers in their decision making processes (e.g., planting date options for farmers). The Ghana Meteorlogical Agency has agro stations across the country that can provide the necessary information to smallholder farmers.

The three most important adaptation measures employed by the pineapple farmers included reduction in pineapple farm size, movement into non-farm occupations and expansion of animal farm mainly under diversification of livelihoods. These adaptation measures can negatively impact and reduce pineapple production in Ghana.

Further drifts from pineapple production could completely annihilate pineapple as a major source of income in Ghana. This will not only affect the macroeconomy that pineapple production supports, but also the livelihoods of the individual farmers involved. Given that, the adaptation measures identified were bottom up practices initiated by farmers, intervention from other actors and institutions such as policy makers, agricultural extension services through the Ministry of Food and Agriculture and national research intstitutes support farmers. Policy strategies should be directed toward mainstreaming climate adaptation of smallholder production systems into agricultural development strategies. Agricultural extension services should ensure the sensitization and promotion of effective adaptation practices that will enhance farmer's knowledge about pineapple production.

Additionally, there will be the need for further research into development and identification of appropriate and effective technologies for climate adaptation and improvement of pineapple production in Ghana. This will require a holistic approach of incorporating policy makers, pineapple farmers and other stakeholders in developing a sustainable adaptation strategy to climate change with focus on technological innovations, socio-economic and ecological ramifications. For identifying adaptation measures that will improve pineapple production, assessment of the vulnerability of the pineapple production system to changing climate in future studies will serve as an effective approach to improve adaption of smallholder production systems to climate variability and change.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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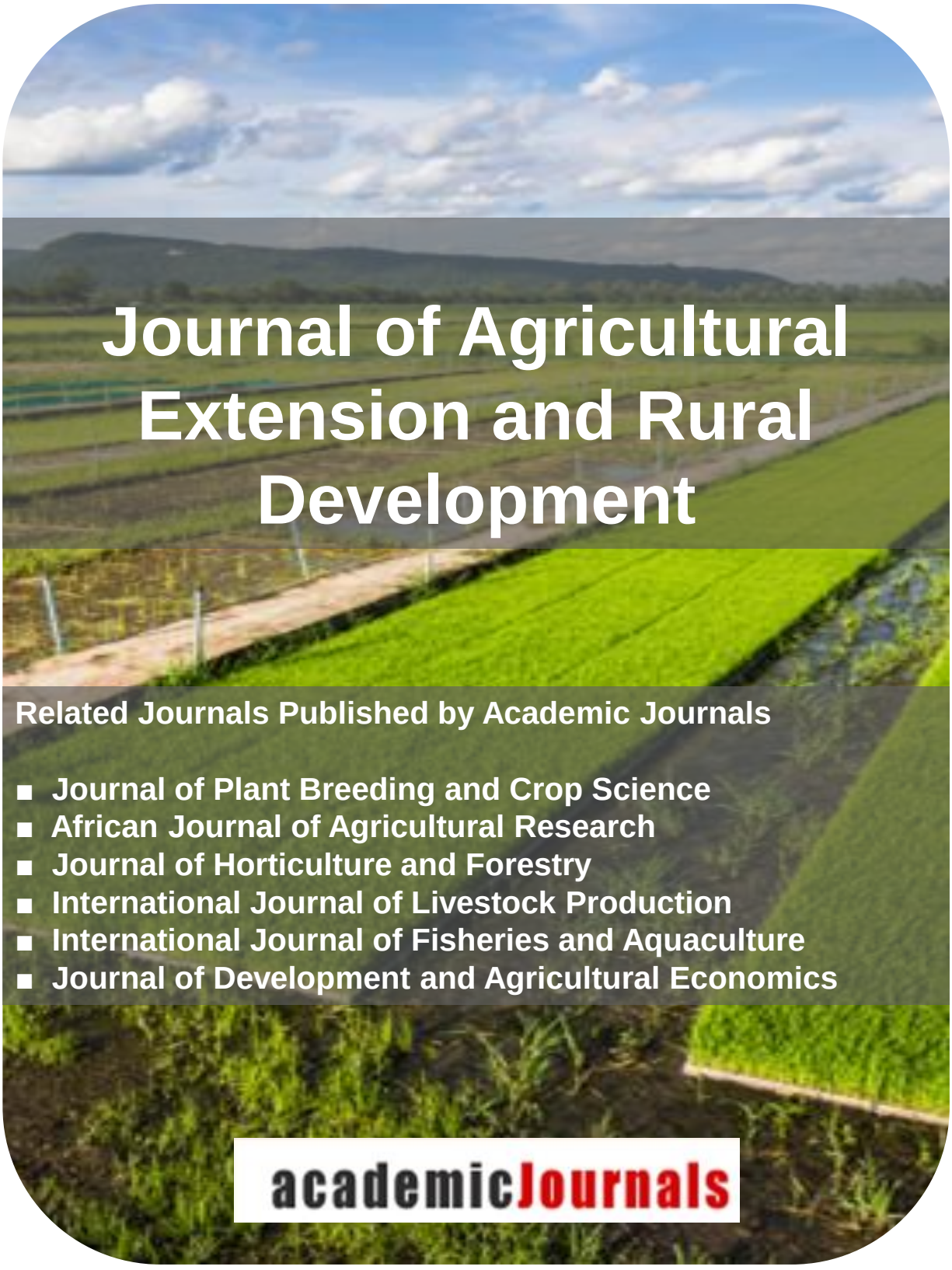
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