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LINKAGE LEVEL AMONG CLIMATE CHANGE ACTORS IN AGRICULTURAL INNOVATION SYSTEM IN SOUTHEAST NIGERIA

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ABSTRACT

Building capacities for effective climate change adaptation and mitigation demand that climate change actors need to have strong linkages with one another. Sustainable development and sustainability in agricultural production also demands strong linkages among actors. The study examined the linkage level among climate change actors in agricultural innovation system in Southeast Nigeria. Results of the study reveal that there are generally weak linkages among the actors. Formal, informal, top down and bottom up were the major types of linkage that exist among the actors. Poor funding (M=2.8), poor motivation (M=2.5), bureaucracy (M=2.1) and inadequate finance (M=2.6) were the factors constraining linkages among the actors. The study recommends strengthening linkages among the actors by providing adequate funding to the actors. Such funds could be used in organizing workshops/conferences where actors come and learn and share lessons for scaling up successful strategies for climate change adaptation and mitigation.

Keywords: actors, agricultural innovation system, climate change, linkage, southeast Nigeria

INTRODUCTION

Linkage implies the communication and working relationship established between two or more organisations pursuing commonly shared objectives in order to have regular contact and improved productivity (Agbamu, 2000; Sadighi, 2005). Peterson, Gijsbers & Wilks (2003) defined it as the coordinated channels for exchange or flows of technology, information and resources between organizations in an agricultural innovation system. Agricultural innovation system (AIS) is defined as a set of interrelated agents, their interactions, and the institutions that condition their behaviour with respect to the common objective of generating, diffusing, and utilizing knowledge and/or technology (Spielman, 2005). In AIS, five sub-systems namely; farmer, policy, research, technology transfer and education could be identified (CTA/UNU-INTECH/KIT, 2005) and the actors in each sub-systems are farmers, staffs at the Ministry of Agriculture, Research Institute, Agricultural Development Programme (ADP) and University respectively.

Strong and effective linkages among actors in the agricultural innovation system implies that the actors must play important roles in identifying research problems and adapting the recommendations to local conditions. An example of such research problems may include those posed by climate change.

In Nigeria especially in the Southeast, there are empirical evidence of climate change; these include numerous gully erosion sites which have resulted to loss of farmlands and farmstead, the disappearance of the 2 to 3 weeks traditional break in rainfall i.e. August break (Chineke, Jagtap & Nwofor 2010) and very recently, the unusual flooding that ravaged farmlands and farm stead in July and October, 2012. These problems created by climate change could be effectively managed if the actors in the agricultural innovation system interact and learn from one another. Such interactive learning process will be facilitated and enhanced by strong linkages. Moreover, sustainable development and sustainability in agricultural production could be enhanced if there are strong linkages among actors. Consequently, it is therefore pertinent to determine the linkage level i.e. strength of linkage among climate change actors in agricultural innovation system in Southeast Nigeria and see how such linkages affect their learning/activities. The pertinent questions are; do climate change actors in AIS have linkages with one another, if they do, what is the level/strength of these linkages? What types of linkage exist among the actors? What are the linkage mechanisms through which the actors learn and interact? What factors constrain the linkages of the actors? The paper aims at (i) determine linkage level and linkage types among climate change actors and (ii) ascertain factors that constrain the linkage of the actors.

METHODOLOGY

Area of study

The study was carried out in Southeast Nigeria. Southeast is located between Latitudes 04° 30′ N and 07°30′ N and Longitudes 06° 45′ E and 08°45′ E (see Fig. 1). It covers an area of 29,908 square kilometres with a population of about 16,381,729 (Federal Republic of Nigeria. (2007). The area comprises the geographical location of the following states: Abia, Anambra, Ebonyi, Enugu, and Imo. It is bordered by Kogi and Benue States to the north, Cross River to the east and Delta to the west. The language of the people is Igbo language and the commonest religion is Christianity. Climate of the southeast Nigeria can generally be described as tropical with two clear identifiable seasons, the wet and dry seasons.

It lies within the tropical region with early rainfall usually in January/February with full commencement of rainy season in March and stopping in November of each year. The dry season lasts between four to five months. The highest rainfall is recorded from July to October with little break in August. The average highest annual rainfall is about 1952 mm. The temperature pattern has mean daily and annual temperatures as 28^{o} C and 27^{o} C respectively.

Southeast Nigeria is an agricultural zone. The soils of the region are largely sandy, mostly loose and porous. The commonest crops grown in the zone include cassava, yam, cocoyam, maize, ugu (*Telferia occidentalis)*, plantain/banana, oil palm and coconut while major animals reared include goat, sheep, poultry etc. The region is experiencing devastating impact of climate change which is well represented in the frequent cases of flooding and increased number of gully erosion sites on farmlands (see Fig 2).

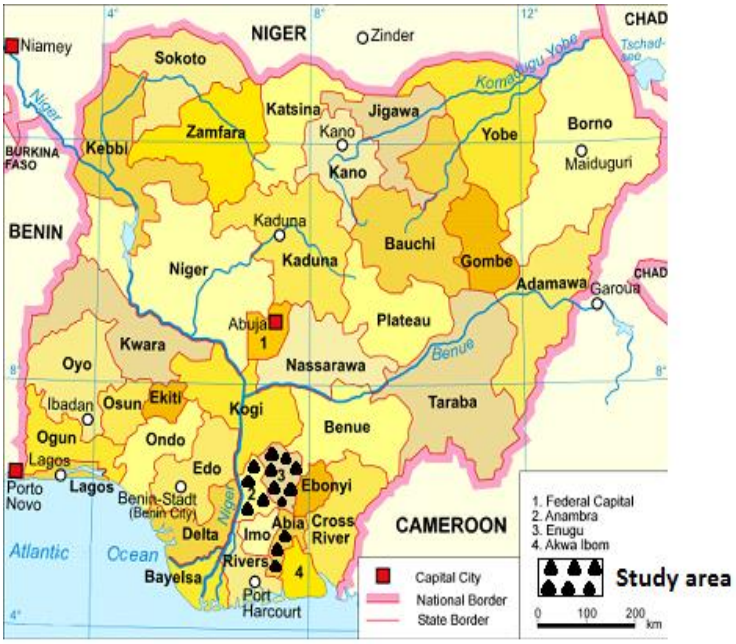

Fig 1: Map of Nigeria showing the study area

(Modified after http://en.wikipedia.org/wiki/States_of_Nigeria)

Fig 2 Gully site at Ukana, Enugu State

(Source: field work conducted in 2011)

Population and sampling procedure

The population was made up of all the climate change actors (i.e. all farmers and all staffs in the Ministry of Agriculture, Research Institute, Agricultural Development Programme and Universities/faculties of Agriculture) in the AIS in southeast Nigeria.

Five sub-systems (farmer, policy, research technology transfer and education) that constitute an AIS were identified and the staff in each system served as actors. Three states (Abia, Anambra and Enugu) were purposively selected because of high incidence of climate change related disasters (e.g. farmlands that are already eroded by gully erosion and abnormal flooding events).

For the farmer sub-system, simple random sampling was used to select forty (40) farmers from Umuahia, Aguata and Enugu North agricultural zones in Abia, Anambra and Enugu States respectively. In the Policy sub-system, twenty four (24) Directors were purposively selected from both state and federal ministries of Agriculture in Abia, Anambra and Enugu States. For the research sub-system, twelve (12) researchers at the National Root Crop Research Institute (NRCRI), Umudike were randomly selected. Twenty one (21) staff in the Agricultural Development Programme (ADP) were randomly selected to represent the technology transfer sub-system. For the education sub-system, seventy nine (79) academic staff were selected from both state and federal universities/faculties of Agriculture in the three States, namely: Abia State University and Micheal Okpara University of Agriculture, Umudike for Abia State, Anambra State University and Nnamdi Azikiwe University for Anambra State, Enugu State University of Science and Technology and University of Nigeria for Enugu State. These gave a total sample size of one hundred and seventy six (176) respondents. However, only one hundred and twenty five (125) copies of questionnaire out of 136 distributed were valid for analysis. Consequently, a total of one hundred and sixty five (165) respondents were used for analysis (i.e. 125 respondents that responded to the questionnaire + 40 farmer actors that were interviewed).

Instrument for data collection and measurement of variables

Interview schedule and structured questionnaire were used for data collection. Interview schedule was used to elicit information from actors in the farmer sub-system while copies of questionnaire were distributed to the actors in the other four sub-systems. The questionnaire was divided into two sections. Section 1 sought information on linkage level and major linkage types that exist among the actors while section 2 investigated factors that constrained the actors from linking with one another.

Objective 1: linkage level and major linkage type among the actors.

Respondents responded to linkage level using a three-point Likert type scale of ''strong linkage = (3)'', ''medium linkage= (2)'' and ''weak linkage= (1)'' The mean value of 2 was used to determine linkage level. Mean value of 2 and above were considered strong linkage while mean value of less than 2 was regarded as weak linkage.

Nominal levels of 1, 2, 3, 4, 5, 6, 7, and 8 for formal, informal, top down, bottom up, internal, external, upstream and downstream respectively were used to measure the major linkage type that exists among the actors. Respondents ticked against the major type of linkage that applied to them.

Objective 2: factors constraining linkage of the actors. From the list provided, actors selected the factors that constrained them from linking with one another. Three-point Likert-type scale of ''to a large extent (3)'', ''to a small extent (2)'' and ''to no extent (1) with mean value of 2.0 was used to determine factors that constrained the linkage of the actors. Mean value of 2 and above was regarded as constraining factors while mean value of less than two counted as non constraining factors.

Data analysis

Information on linkage level and major linkage types among the actors (objective 1) was analysed with both mean score and percentage. Actor linkage map by Biggs and Matseart (2004) was prepared and used to present the level of linkage of the respondents. Factors that constrained the actors from linking with one another (Objective 2) were analysed using mean score. Version 16.0 of the Statistical Package for the Social Science (SPSS) software was used for the analysis.

RESULTS AND DISCUSSION

Linkage level of the actors

Linkage level between research sub-system actors and other actors

There is a strong linkage between research and technology transfer sub-system actors (Fig 3). The Figure further shows that there is a weak linkage between research and policy, education and farmer sub-system actors. Strong linkages between actors are key requirement to promote innovation including climate change innovations. Strong linkage between research and technology transfer is expected to increase attention to farmers' problems in the research agenda and will also enhance the dissemination of results (Gijsbers, 2009). The weak linkage between research and other actors especially the farmer sub-system actors is worrisome because it implies that researchers are working in isolation of farmers' perception of the challenges of climate change. Applying the agricultural system of innovation as analytical framework allows one to see the relationship between research institutions and farmers as the interactive learning process governed by several institutional factors that determine the agricultural innovation from generation, acquisition to adaptation and diffusion of technologies. In this process, technologies can be developed with the active participation of

farmers and understanding of the context of their application (Adeoti & Sinh 2009). Building networks of relevant actors requires vision, funding, skills and commitment –all these may be in short supply, explaining why strong linkages may be lacking (Gijsbers, 2009).

Linkage level between education sub-system actors and other actors

Figure 3 shows a weak linkage between education sub-system actors and policy, research, farmer sub-system actors. A strong linkage however exists between education sub-system actors and technology transfer (Fig 3). The weak education-policy linkage implies that there is little interflow of knowledge between academia and policy makers. This weak linkage also implies a poor information flow with negative effect on learning and overall long-term competiveness. Weak education-farmer linkage could be caused as a result of wrong and different perception e.g. education not appreciating farmers' knowledge and farmers thinking that university lack practical and indigenous knowledge.

Linkage level between policy sub-system actors and other actors

There is a weak linkage between policy and technology transfer actors, research, farmer and education actors (Fig 3). Actors need to collaborate and link in order to build capacities and governments need to be a nurturing partner in this process (World Bank 2006). Weak policy-education-research linkage variable means that government is not a nurturing partner with them.

The weak policy-research and policy-education linkage implies among others, that there is little public industry input into research and the education. The weak linkages between the policy personnel and other actors may also imply a disconnection between agricultural policy and stakeholder practice in Nigeria. It portrays a situation in which stakeholders are not taken into confidence in policy formation. This runs contrary the requirement of the innovation system perspective (Emodi &Madukwe, 2010).

Linkage level between technology transfer sub-system actors and other actors

Figure 3 shows a strong linkage between technology transfer actors and research, education, policy and farmer sub-system actors (Fig 3). This result shows that actors in the technology transfer sub-system have strong linkages with all the other actors. Strong linkage between technology transfer actors and other actors will help them learn and share lessons for scaling up successful strategies for capacity strengthening within agricultural innovations systems to adapt to climate change and variable climate conditions. The strong linkage between technology transfer actors and others implies strong technical base for the technology transfer sub-system.

Linkage level between farmer and other actors

Figure 3 shows a strong linkage between farmer sub-system actors and technology transfer sub-system actors. The Figure also shows a weak linkage between farmer and education, policy and research sub-system actors. The weak linkage between farmer and other actors will retard learning and also result in building inadequate capacity for climate change adaptation. Importantly, strong farmer-technology transfer linkage need to be strengthened as it will strengthen farmers' capacity to access and use quality information, training and products in order to adapt to climate change. Weak linkage between farmer and education implies a slowdown of information and knowledge flow to farmers.

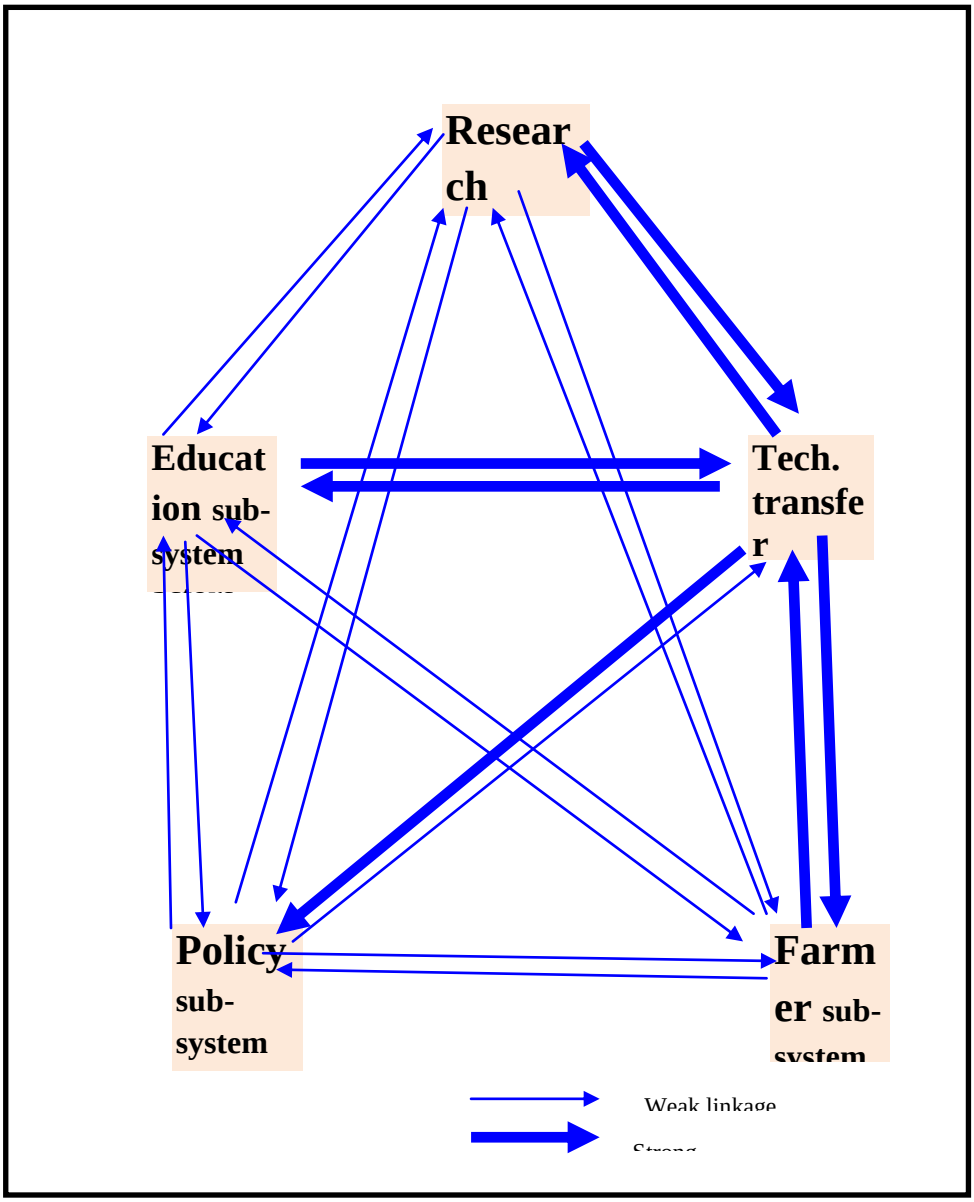

Fig 3: Actor Linkage Map showing linkage level among the actors

Linkage type among the actors

Linkage type between research and education sub-systems actors

Table 1 shows informal (65.0%) as the major linkage type between research and education sub-systems actors. Informal linkages are direct person-to-person contacts based on the need for collaboration between individuals (Stoop, 1988). This informal network will help actors to build trustworthy relations/confidence and strengthen linkage; such strengthened linkage will help to boost the learning and capacity building between the actors. Furthermore, person-to-person contact can encourage strong levels of linkage which will also enhance learning and diffusion of climate change adaptation innovation.

Type of linkage between research and policy sub-systems actors

Table 1 indicates informal linkage (40.5%) as the major type of linkage between research and policy sub-systems actors. The informal linkage type could foster strong level of linkage as informal relations help to build trust.

Type of linkage between research and technology transfer sub-systems actors

Entries in Table 1 show top down linkage (55.5%) as the major linkage type between them. This result is supported by Sadighi, (2005) where he noted that research–extension system is such that decision-making power is concentrated at the top.

Type of linkage between research and farmer sub-systems actors

Between research sub-system actors and farmer sub-system actors, the result portrays top down linkage (45.8%) from research to farmer as the major linkage type between research and farmers (Table 1). With top down linkage, information flows from scientists to extension and then to producers (farmers). The result which shows top down as the major type of linkage between the actors is not surprising because the national agricultural research system perspective which emerged in the late 1980s tended towards linearity in movement of knowledge from known source (formal research) and flowing to some end users (the farmer) (World Bank, 2006). Top down linkage type between research and farmer actors implies that there may be weak linkage between them since information is flowing from the 'superior' to 'inferior'.

Type of linkage between education and research sub-systems actors

Entries in Table 1 also show that the major type of linkage between education and research actors was formal linkage (60.7%). According to Stoop (1988), formal linkages refer to linkages that are specified and agreed to by organizations. Formal linkage between education and research actors implies that flow of information between the actors is specified and agreed upon by both parties. This type of linkage may retard learning and diffusion of climate change innovation because of bureaucracy associated with formal activities.

Type of linkage between education and policy sub-systems actors

Table 1 further shows informal linkage (40.1%) as the major type of linkage between them. This implies that actors relate based on mutual trust and this can help strengthen linkages between actors. When linkages are strengthened, learning capability will also be positively influenced.

Type of linkage between education and technology transfer sub-systems actors

Entries in Table 1 show top down linkage type (40.5%) as the major type of linkage between them. This implies that information on climate change related issues flows from education to technology transfer sub-system. This may not allow technology transfer actors to make input to information produced.

Type of linkage between education and farmer actors

The result indicates informal linkage type (40.5%) as the major type of linkage between the actors (Table 1). Informal linkages are direct person-to-person contacts based on the need for collaboration between individuals. Such person-to-person contact can encourage strong levels of linkage.

Type of linkage between policy and research actors

Entries in Table 1 present informal linkage type (25.5%) as the major type of linkage between policy and research actors. This implies that actors relate based on mutual trust and this can help strengthen linkages between actors. When linkages are strengthened, learning will also be enhanced.

Type of linkage between policy and education sub-systems actors

Table 1 also presents informal linkage (57%) as the major linkage type between them.

Type of linkage between policy and technology transfer sub-system actors

The result depicts formal (55.9%) and top down (55.5%) as the major linkage types between the actors (Table 1). Formal linkage type between the actors implies that flow of information between the actors is specified and agreed upon by both parties. This type of linkage may retard learning and diffusion of climate change innovation due to bureaucracy associated with formal activities.

Type of linkage between policy and farmer actors

Entries in Table 1 also indicate informal (45.5%) linkage as the major type of linkage between policy and farmer actors.

Type of linkage between technology transfer and research actors

Entries in Table 1 also show external (75.2%) linkage type as the type of linkage between the actors. External linkage type between the actors could imply that these actors will have better opportunity of exchanging knowledge of climate change issues with other actors who may have new innovation/knowledge different from what they already have. Adeoti & Sinh (2009) noted that inter-farm relationships could be avenues for learning and diffusion of new knowledge on agricultural practices. These new knowledge could include those needed for effective adaptation to the impact of climate change. External linkage between the actors implies that learning and diffusion of such new knowledge could be facilitated.

Type of linkage between technology transfer and education actors

The result shows formal (54.6%) linkage type as the major type of linkage between them (Table 1).

Type of linkage between technology transfer and policy actors

It indicates informal linkage (55.5%) as the major type of linkage between the actors (Table 1). This implies that the actors interact/relate with each other on familiarity base. Familiarity may help to build and strengthen linkages.

Type of linkage between technology transfer and farmer actors

Bottom up (50.5%) linkage type is the major linkage type between the actors (Table 1). This implies that information flow from farmers to technology transfer actors. Information from farmers is based on their practical knowledge and could help to strengthen the capabilities of the other actor.

Type of linkage between farmer and research actors

Table 1 shows top down (70.1%) linkage type from research down to farmer as the type of linkage between the actors. Farmers' indigenous knowledge/experiences could be used in developing technologies needed for effective climate change adaptation and mitigation but this top down linkage arrangement implies that farmers' indigenous knowledge could be neglected.

Type of linkage between farmer and education sub-systems actors

Table 1 reveals informal linkage (67.5%) as the major type of linkage between the actors.

Type of linkage between farmers and policy actors

Entries in Table 1 show top down linkage (44.4%) from policy to farmer is the major type of linkage between the actors. This implies that any new knowledge on climate change adaptation and mitigation must flow from policy down to farmer resulting to negligence of farmers' indigenous knowledge.

Type of linkage between farmers and technology transfer sub-system actors

Table 1 indicates bottom up (51.5%) linkage type as the major linkage type that existed between the actors. Bottom up linkage refers to the flow of information from producers (farmers) to scientists. This bottom up arrangement implies that farmers' opinions are highly regarded by the technology transfer sub-system. However, this is not surprising because technology transfer sub-system has the obligation to take feedback from farmer to research. Taking feedback from farmers will naturally encourage bottom up arrangement.

Table 1: Percentage distribution of actors based on the linkage type among the actors

Linkage type	Research **n=12** **(%)**	Education **n=68** **(%)**	Actors Policy **n=24** **(%)**	Tech.transfer **n=21** **(%)**	Farmers **n=40** **(%)**
Research					
Formal		**60.7**	5.3	60.0	60.4
Informal		45.9	**25.5**	70.4	65.3
Top down		15.3	5.3	40.9	**70.1**
Bottom up		8.2	5.1	75.1	40.2
Internal		40.1	-	60.1	50.0
External		40.9	10.4	**75.2**	50.4
Upstream		15.0	-	10.4	40.3
Down stream		15.7	-	-	20.2
Education					
Formal	60.2		12.8	**54.6**	64.5
Informal	**65.0**		**57.0**	40.1	**67.5**
Top down	30.1		48.6	43.3	65.1
Bottom up	28.8		40.3	29.0	60.1
Internal	45.0		-	37.9	60.6
External	50.2		5.9	39.6	60.2
Upstream	4.9		-	15.3	25.1
Down stream	3.4		-	15.8	25.1
Policy					
Formal	35.8	37.0		52.9	28.7
Informal	**40.5**	**40.1**		**55.5**	40.5
Top down	35.9	29.9		48.5	**44.4**
Bottom up	-	27.6		35.8	30.0
Internal	35.6	25.3		40.0	26.5
External	32.2	28.2		40.6	20.0
Upstream	29.9	10.4		-	15.0
Down stream	29.1	6.3		-	3.5
Tech. transfer					
Formal	53.5	35.0	**55.9**		50.9
Informal	50.1	40.1	50.0		50.4
Top down	**55.5**	**40.5**	**55.9**		40.5
Bottom up	50.0	39.0	50.0		**51.5**
Internal	45.0	-	-		-
External	45.0	-	-		-
Upstream	42.0	-	-		-
Down stream	42.5	-	-		-
Farmers					
Formal	40.5	36.0	40.5	45.6	
Informal	40.5	**40.5**	45.5	45.5	
Top down	**45.8**	20.7	40.3	48.3	
Bottom up	40.1	-	34.0	**50.5**	
Internal	-	-	-	-	
External	-	-	-	-	
Upstream	-	-	-	-	
Down stream	-	-	-	-	

Bold type is used to highlight the major linkage type.

Grand mean for constrains to linkage

As stated in Table 2, all the actors perceived poor funding (M=2.8), poor motivation (M=2.5), bureaucracy (M=2.1) and inadequate finance (M=2.6) as factors that constrained their linkage with one another. For effective climate change adaptation, actors need to link with one another and such linkage will help to facilitate learning of the actors. Adequate funding and adequate finance is needed to strengthen links especially if formal linkage type is practiced. With adequate funding, actors in the

AIS can organise seminar/workshop on climate change. The workshop could help fasten and enhance learning on adapting with climate change issues among the actors.

Table 2: Mean distribution of actors based on factors constraining linkage of the actors

	Actors					
	Research	Education	Policy	Tech.transfer	Farmer	Grand
	n=12	**n=68**	**n=24**	**n=21**	**n=40**	mean
Constraints	**M=2**	**M=2**	**M=2**	**M=2**	**M=2**	**M=2**
Poor funding	**2.6**	**3.0**	**2.8**	**3.0**	**3.0**	**2.8**
Poor motivation	**2.5**	**2.5**	**2.2**	**3.0**	**2.5**	**2.5**
Farmers' conservatism	**2.0**	1.5	**2.2**	**2.3**	1.0	1.8
Bureaucracy	**2.0**	**2.0**	**2.8**	**2.3**	1.5	**2.1**
Inadequate finance/credit	**2.0**	**2.0**	**3.0**	**3.0**	**3.0**	**2.6**
Weak legal framework	1.5	1.8	1.5	1.5	1.5	1.6
Poor government policy	1.0	1.5	1.5	1.0	1.8	1.4
Inadequate physical resources	1.5	1.0	1.0	1.0	1.5	1.2

Bold type is used to highlight mean value of 2 and above.

CONCLUSION AND RECOMMENDATION

The study shows that there are generally weak linkages among the actors. The weak linkage among the actors will retard learning of the actors and makes sharing lessons for scaling up successful strategies for climate change adaptation and mitigation difficult if not impossible and hence the need for strengthening the linkages. Several linkage types exist among the climate change actors including formal, informal, top down and bottom up linkages. Poor funding, poor motivation, bureaucracy and inadequate finance were the factors that constrained linkage of the actors.

For a sustainable development and sustainability in agriculture with regards to climate change, the study recommends that efforts should be geared towards strengthening linkages among the actors as this will give the actors opportunity to learn from one another on how best to tackle problems posed by climate change. Also, the Federal government of Nigeria and other relevant agencies should provide adequate funding to the actors. Such funds could be used in organizing workshops/seminars/conferences were actors come and learn and share lessons for scaling up successful strategies for climate change adaptation and mitigation.

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