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## Linkages among Key Actors in the Climate Change and Food Security Innovation System in Nigeria, Sierra Leone and Liberia

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### Abstract

*The study used the innovation system approach to ascertain the intensity and trends of linkages among key actors in the climate change and food security innovation system in Nigeria, Sierra Leone and Liberia. Data were collected through the use of semi structured interview schedule, key informant interviews and focus group discussions (FGDs) and analyzed using percentages, mean scores and trend analysis. Only 1.8% of the farmers from Nigeria, 2.5% from Sierra Leone and 0.7% from Liberia possessed special training on climate change adaptation and food security issues. The presence of local collaboration among actors was higher in Nigeria than in Sierra Leone and Liberia. There was non-existence of overseas linkages with majority (89.0% for Nigeria; 98.0 for Sierra Leone and 96.8% for Liberia) of the farmers across the three countries. The intensity of linkages / collaborations existing among actors in the enterprise domain, in the three countries, outweighs that with other domains, with higher collaborations existing among the small-scale farmers and famers' associations. However, there was a perceived increase in the trend of linkage between farmers and R & D institutions in*

*Nigeria between 2007 and 2009, with a linkage index of more than 2. There was also an increasing higher linkage index (of more than 2) between farmers and technology delivery institutions in Nigeria than in Sierra Leone and Liberia, but a low linkage index of less than 2 between farmers and policy making bodies for all the countries. Poor generation of innovations over the past ten years and poor domestic support for climate change adaptation and food security in the West African sub-region were identified. The study points to the need to intensify the collaboration efforts, between local and foreign partners, as this will bring about the generation of better and improved innovations on food security and adaptive measures.*

**keywords:** agricultural innovation framework; adaptation measures; intensity of collaboration; linkage index and manpower strength.

## Introduction

Africa remains one of the most vulnerable continents to climate change because of multiple stresses (resulting from both politics and economic conditions), the continent's dependence on natural resources and its weak adaptive capacity. According to the Intergovernmental Panel on Climate Change 4th Assessment Report (2007), between 75 and 250 million people may be exposed to increased water stress due to climate change by 2020 in Africa and this will adversely affect livelihoods in the region. The area suitable for agriculture, the length of growing seasons and yield potentials, are expected to decrease due to climate change. Yields from rain-fed agriculture in some countries could be reduced by up to 50%. Thus, climate change may have particularly serious consequences in Africa, where some 800 million people are undernourished.

Africa has the highest prevalence of undernourishment. In 2004, whereas 14% of the global population was undernourished, 27.4% of the population in Africa as a whole was undernourished (Babatunde, Omotesho and Shotolan, 2007). In some countries, the rate of undernourishment is above 40% while it exceeds 50% in those countries experiencing or emerging from armed conflict (Todd, 2004). In West African sub-region, Liberia and Sierra Leone are among those with the highest rate of undernourishment in the continent with 1.4 and 2.3 million undernourished people respectively in 2002 (Babatunde *et. al.*,2007). In Nigeria, the most populous country in Africa, the majority of households are food insecure, especially the rural farming households.

In the West African sub region, report showed that agriculture is critical to the economy. While the world average contribution of the agriculture sector to the Gross Domestic Product (GDP) is only 4.5 %, the sector's contribution is about 30 % in West Africa. In addition to the above, over 65 % of the population in the region is rural, and about 90 % of the rural population directly depends on rain-fed agriculture for income and food security. Therefore reduction in rainfall as

predicted by various climate models translates to threat to livelihood of the population and the economy of the sub-region.

Unfortunately, research in Nigeria, Sierra Leone and Liberia show that the performance of the agricultural sector continues to be relatively disappointing in the sub-region as growth has been increasingly on the decline. Traditionally, the agricultural research systems in the region are characterized by a top-down, centralized, monolithic and isolated structures. Linkages, interactions and learning mechanisms among the component actors are notably weak and/or often non-existent. Empirical evidence revealed several linkage gaps and missing links among and between the actors in the systems (Agbamu, 2000; Egyir, 2009). Institutions, for example, universities and research institutes innovate in isolation and although research were taking place at various national and international organizations, the coordination is dysfunctional, and poorly linked to the productive sector. Besides, farmer innovations were not being included in the knowledge system because traditional approaches such as the NARS (National Agricultural Research System) perspective and AKIS (agricultural knowledge and information system) depict research as the sole source of innovation. Without research, it implies, there is no innovation. Consequent upon this, it is pertinent that answers be sought to the following questions: are there special training on climate change and adaptation measures in the three countries under study? are there the presence of linkages/collaborations among actors in the climate change and food security innovation systems across the three countries? and do the existing domestic environment support climate change adaptation and food security issues in these countries?

This study therefore sought to determine the presence of linkages among key actors in the climate change and food security innovation system in Nigeria, Sierra Leone and Liberia. Specifically, the study aimed to:

1. ascertain the presence/availability of special training on climate change adaptation;
2. determine the presence and intensity of linkages/collaborations among the stakeholders in the climate change and food security innovation systems in the countries;
3. ascertain the performance of the system on the basis of innovation generation and
4. determine respondents' perception of domestic environment support for climate change adaptation and food security.

## **Methodology**

### **Study Areas and Sampling Procedure**

The study was carried out in three West African countries, namely; Nigeria, Sierra Leone and Liberia. Tools of participatory research namely: structured questionnaire, semi structured interview schedule, key informant interviews and focus group discussions (FGDs) were used in data collection.

Respondents for this study were selected through a multistage sampling technique. In the first stage, thirteen states (namely: Abia, Adamawa, Borno, Cross Rivers, Delta, Enugu, Imo, Kogi, Ondo, Oyo, and Plateau states), were selected from the seven agro-ecological zones in Nigeria; In Sierra Leone, six districts (namely: Freetown Peninsula, Kailahun, Bo, Koinadugu, Moyamba and Free Town Coastal Plain districts) were selected from the four agro-climatic regions, while seven counties (namely: Nimba, Bong, Lofa, Grand Bassa, Margibi, Grand Cape Mount and Grand Gedeh) were selected from the four agro-climatic regions, in Liberia.

In the second stage, using the delineation by the different states' Agricultural Development Programmes (ADPs), in Nigeria, two agricultural zones were randomly selected from each state giving a total of 26 agricultural zones in Nigeria. From each of the selected zones, 25 farming households were randomly selected for interview. This gave a total of 650 farming households from Nigeria. In Sierra Leone, a sample size of 70 farming households were randomly selected from each of the six districts giving a total of 420 households; while in Liberia 60 farming households were randomly selected from each of the counties surveyed, giving a total of 420 farming households.

The sample of farming households for this study was selected through a combination of strategies that recognized the social component of indigenous knowledge and practices. Criteria used for selection included age (for historical insight on indigenous knowledge), farming experience and interest. In all, a total of 1,490 farming households were interviewed. However, 1,424 (624 from Nigeria); (400 from Sierra Leone) and (400 from Liberia) completely filled interview schedules were used for analysis.

On the other hand, data were collected from a total of two hundred (200) respondents from various organizations, covering research institutes, training and education institutions, credit institutions, policy and regulatory bodies, private consultants / NGOs, farmers' associations and public services delivery organizations in Nigeria, Sierra Leone and Liberia. However, only 164 completely filled questionnaires, consisting of 124 from Nigeria; 20 each from Sierra Leone and Liberia, respectively, were used for analysis.

### **Measurement of Variables**

The intensity of collaboration was measured on a five point Likert-type scale of “None”, “Weak”, “Average”, “Strong” and “Very strong”, with nominal values of 1, 2, 3, 4 and 5, respectively. These values were added to obtain 15, which was further divided by 5 to get a value of 3.0, which was regarded as the mean. Collaborations with mean scores of less than 3.0 were regarded as showing weak intensity while those with mean scores of greater or equal to 3.0 were regarded as showing strong intensities. Respondents were also asked to indicate how collaborations with the various organizations have changed over the past five years. To measure this trend, each respondent was required to indicate his/her responses by ticking any of the options namely “Decreasing”, “Remained the same” and “Increasing”. Values assigned to these options were 1, 2 and 3; these values were summed to obtain 6.0 and was divided by 3 to obtain 2.0 which was regarded as the mean. Collaborations with mean scores of less than 2.0 were regarded as showing decreasing intensities over the past five years with, while those with mean scores of above 2.0 were regarded as showing increasing intensities over the past five years.

### **Data Analysis**

Data relating to farmers’ profile, manpower and specialization were summarized using percentages and mean scores. Also, mean scores and trend analysis were used to summarize information on manpower trend, climate change trend and intensity of collaborations among key stakeholders in the climate change /food security innovation system in the last five years.

### **Results and Discussion**

#### **Possession of Specialized Training on Climate Change Adaptation and/or Food Security Issues**

Table 1 shows that only 1.8% of respondents from Nigeria, 2.5% of respondents from Sierra Leone and 0.7% of respondents from Liberia possessed special training on climate change adaptation and food security issues. It can be inferred from the above findings that majority of the respondents across the three countries possessed no special training on climate change adaptation and on food security issues.

The Table further reveals that only about 2% of family members or farm workers from Nigeria, 1% from Sierra Leone and 0.2% from Liberia possessed a specialized training on climate change adaptation and food security issues. On provision of opportunities for training for staff or family members on climate change adaptation, 3.0% of respondents in Nigeria reported to have provided such opportunities, while 0.2% of respondents from both Sierra Leone and Liberia agreed to have also provided such training opportunities. The implication for this is that there is so much work to be done by all stakeholders involved in climate

change adaptation measures, if the issue of food security is to be achieved for the teeming population across Africa and the world at large.

**TABLE 1**  
**Distribution of rural households by training, experience and skills possessed**

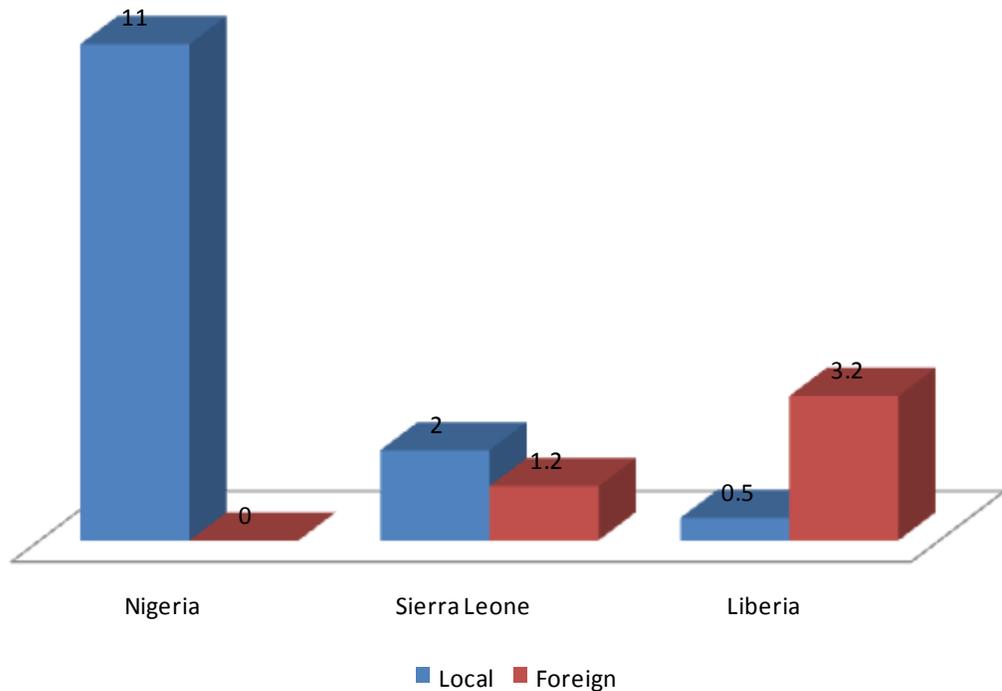
<b>Training, experience and skills</b>	<b>Nigeria (%)</b>	<b>Sierra Leone (%)</b>	<b>Liberia (%)</b>
Do you have specialized training in Climate Change adaptation and /or food Security issues			
Yes	1.8	2.5	0.7
No	98.2	97.5	99.3
Do any members of your family or farm workers have specialized training in Climate Change adaptation and /or food Security issues			
Yes	2.2	1.0	0.2
No	98.8	99.0	99.8
Does your farm provide opportunities for training staff / family members			
Yes	3.0	0.2	0.2
No	97.0	99.8	99.8

**Intensity and Trends of Linkages / Collaboration Among Key Actors in the Climate Change and Food Security Innovation System**

**Existence of Local and Overseas Collaborations in the Climate Change and Food Security Innovation System in Nigeria, Sierra Leone and Liberia**

Data in Figure 1 indicated the non – existence of overseas linkages / collaboration in the area of climate change and food security among majority of the rural households across the three countries. The presence of local collaboration was higher in Nigeria (11.0 percent) than in Sierra Leone (2.0 percent) and Liberia (3.2 percent). Collaboration among actors in the climate change and food security innovation system is essential for relevance, capacity building and increase innovative performance of the actors and the system in general. The extent of

collaboration also suggests the level of involvement in climate change and food security activities.



**Figure 1: Farmers’ reported existence of local and overseas collaborations on climate change and food security in Nigeria, Sierra Leone and Liberia**

**Intensity of Linkages/Collaborations between Farmers and other Actors in the Climate Change and Food Security Innovation System in Nigeria, Sierra Leone and Liberia**

Data on Table 2 reveal that the intensity of linkages / collaborations existing among actors in the enterprise domain, in the three countries, outweighs that with other domains, with higher collaborations existing among the small-scale farmers and famers’ associations. Nigeria tends to have higher linkages / collaborations among the actors in all the domains followed by Liberia in three out of the four major domains, while Sierra Leone only showed a higher intensity than Liberia in the area of linkage with policy makers. Collaboration among actors in the climate change and food security innovation system is essential for relevance, capacity building and increase innovative performance of the actors and the system in

general. The extent of collaboration also suggests the level of cohesion and/or involvement of the different actors in climate change and food security activities.

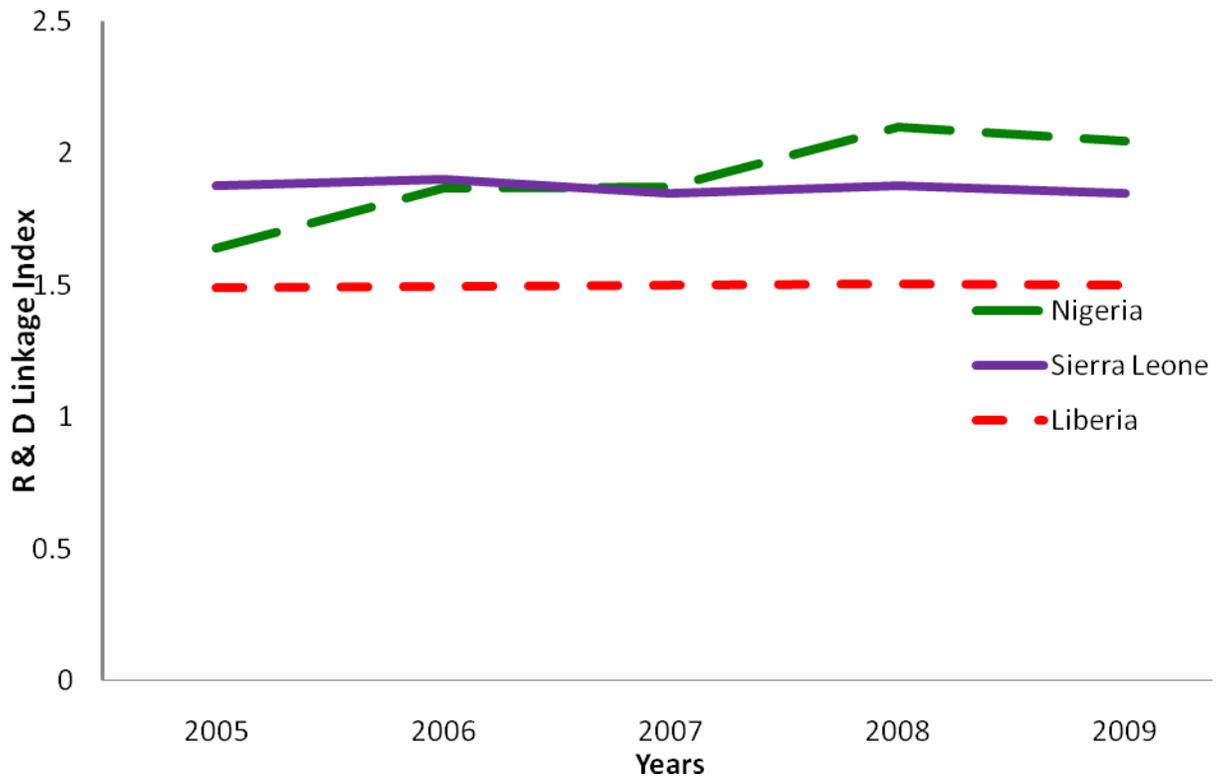
**TABLE 2**  
**Mean scores of intensity of linkages / collaborations between farmers and other actors in the climate change and food security innovation system**

Collaborating Actors	Nigeria		Sierra Leone		Liberia	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
<b>R &amp; D Agencies Domain</b>						
National agricultural research organization (e. g. NIHORT, FIIRO, NRCRI, IAR, etc.)	2.14	1.17	1.07	0.25	1.09	0.34
Regional agricultural research organization / network	1.36	0.66	1.07	0.25	1.13	0.44
International agricultural research organization / network (e.g. IITA)	2.21	1.46	1.05	0.22	1.05	0.22
Universities	1.89	1.29	1.09	0.34	1.21	0.42
<b>Overall mean</b>	<b>1.90</b>	<b>1.15</b>	<b>1.07</b>	<b>0.27</b>	<b>1.12</b>	<b>0.36</b>
<b>Policy Makers Domain</b>						
National agricultural research council	1.42	0.62	1.14	0.35	1.06	0.30
Policy makers	1.66	1.13	1.19	0.39	1.21	0.41
Standard setting body (e. g. NAFDAC, SON, etc.)	2.06	1.06	1.03	0.18	1.01	0.09
<b>Overall mean</b>	<b>1.71</b>	<b>0.94</b>	<b>1.12</b>	<b>0.31</b>	<b>1.09</b>	<b>0.27</b>
<b>Enterprise Domain</b>						
Small – scale Farmers	2.93	1.08	1.19	0.38	1.42	0.70
Medium – large scale farmers	2.69	1.40	1.17	0.39	1.14	0.44
Farmers Association	2.88	1.35	1.22	0.44	1.25	0.70
Agricultural cooperatives	2.37	1.09	1.22	0.44	1.19	0.49
Financing/ credit/ venture capital	2.44	1.38	1.03	0.17	1.02	0.15
Input suppliers e.g.	2.00	1.09	1.03	0.18	1.03	0.17

Seed companies						
Agricultural machinery suppliers	1.41	0.69	1.05	0.23	1.04	0.30
Agricultural produce marketers	2.39	1.21	1.09	0.25	1.18	0.48
Consumers of agricultural products	2.81	1.32	1.08	0.21	1.18	0.54
<b>Overall mean</b>	<b>2.44</b>	<b>1.18</b>	<b>1.13</b>	<b>0.30</b>	<b>1.16</b>	<b>0.44</b>
<b>Extension Agencies Domain</b>						
Extension agencies (e.g. ADPs including private extension services)	1.98	1.17	1.12	0.37	1.25	0.46
Federal / State Ministries of Agriculture	1.84	0.91	1.11	0.39	1.33	0.47
Federal / State Ministries of Environment	2.10	1.12	1.05	0.22	1.28	0.45
<b>Overall mean</b>	<b>1.97</b>	<b>1.07</b>	<b>1.09</b>	<b>0.33</b>	<b>1.29</b>	<b>0.46</b>

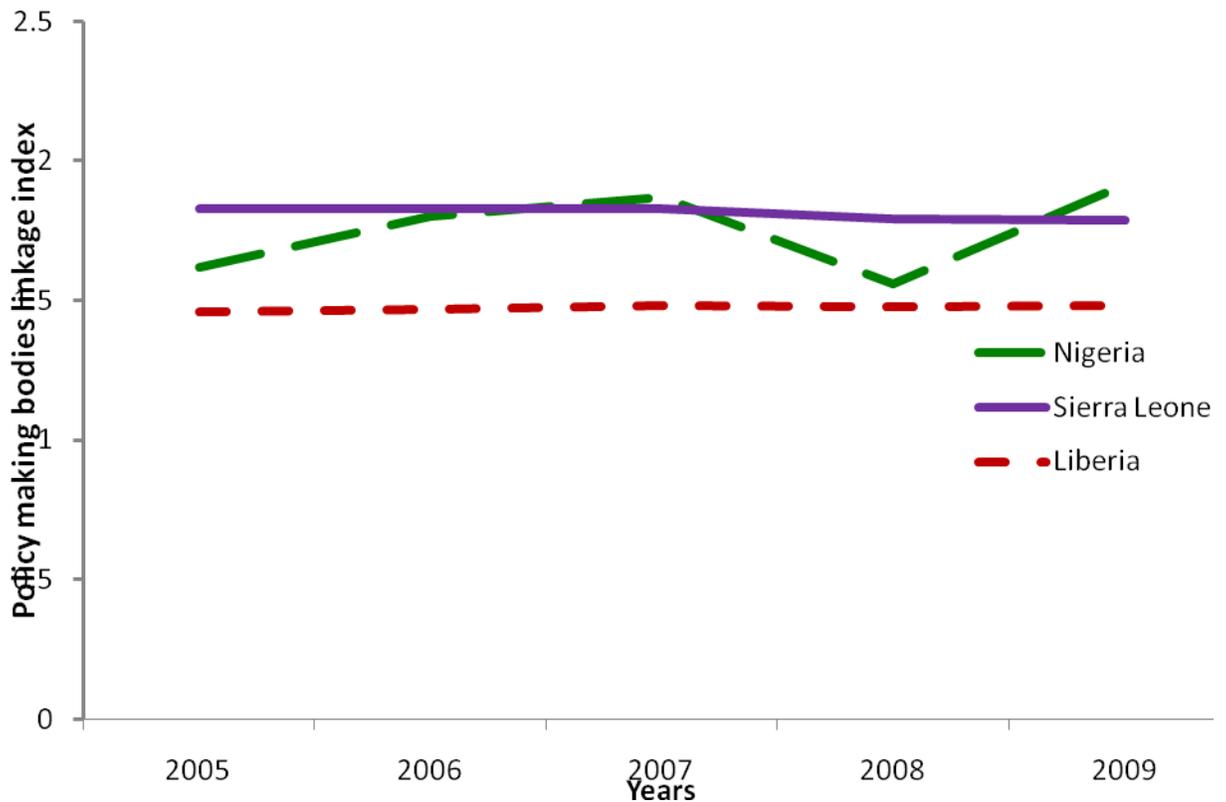
### Linkage Trends between Farmers and R & D Institutions in the Climate Change and Food Security Innovation System in Nigeria, Sierra Leone and Liberia

Figure 2 shows the perceived linkages existing between farmers and research and development institutions between 2005 and 2009 in the three countries. The data reveal a perceived increase in the trend of linkage between the farmers and the R & D institutions in Nigeria between 2007 and 2009, with a linkage index of more than 2. On the other hand, data from Sierra Leone and Liberia show a stabilized trend in their linkage with R & D institutions over the past five years (with linkage index of less than 2 each), with Sierra Leone showing a higher intensity of linkage than Liberia.



**Figure 2: Percieved trend of linkage between farmers and R &D institutions in Nigeria, Sierra Leone and Liberia**

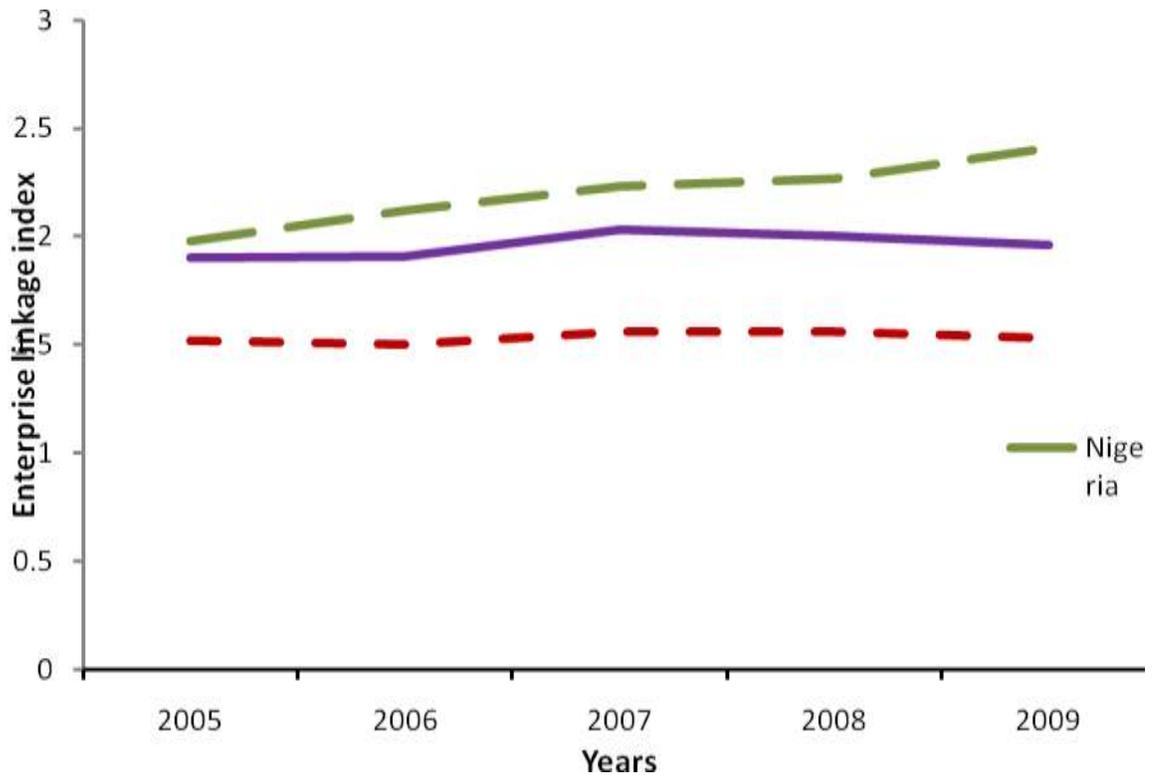
**Linkage Trends between Farmers and Policy making bodies in the Climate Change and Food Security Innovation System in Nigeria, Sierra Leone and Liberia.** Data in Figure 3 show the linkage trend between farmers and policy making bodies in the different countries. The Figure shows a low linkage index of less than 2 for all the countries. However, data from Nigeria show an unstable trend between 2005 and 2008, with an upward trend since 2008. On the other hand, data from Sierra Leone and Liberia reveal a more stable linkage between the farmers and policy making bodies, with Sierra leone having a higher collaboration intersity than Liberia.



**Figure 3: Percieved trend of linkage between farmers and policy making bodies in Nigeria, Sierra Leone and Liberia**

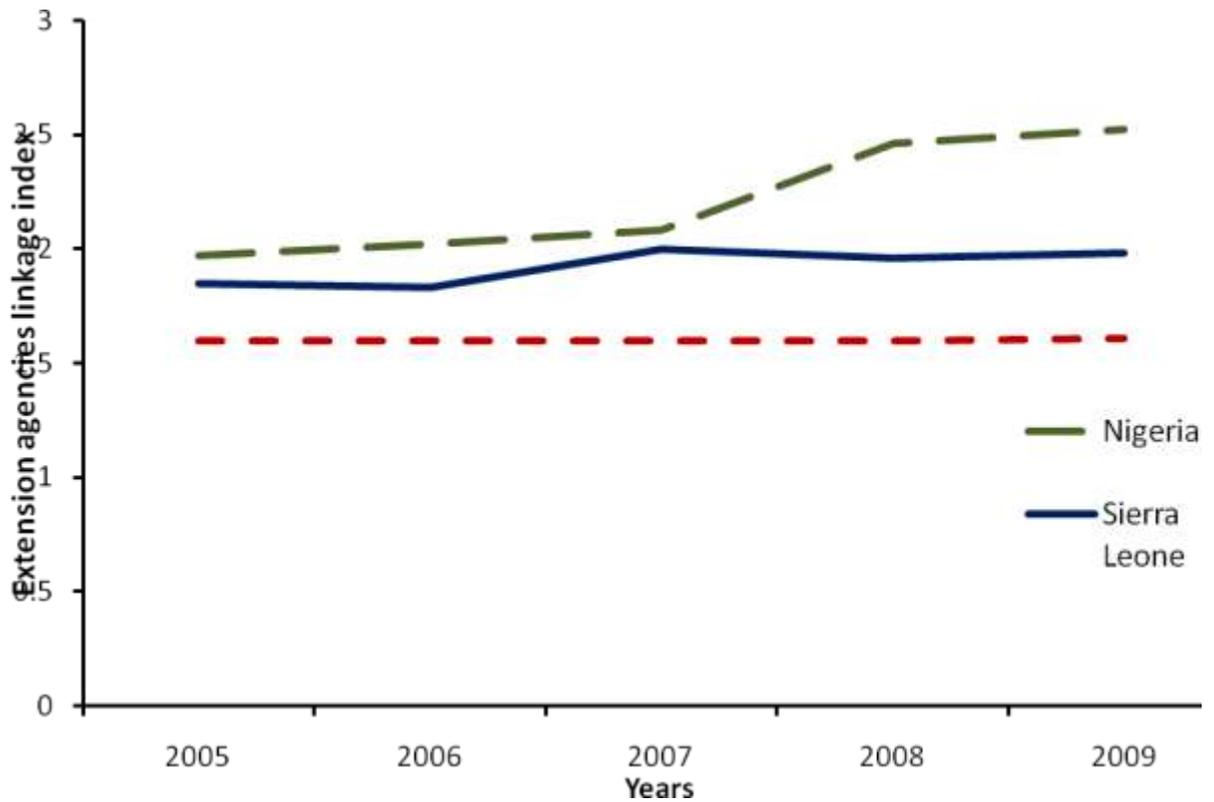
### **Linkage Trends among actors within the enterprise domain in the Climate Change and Food Security Innovation System in Nigeria, Sierra Leone and Liberia**

Data in Figure 4 show the linkage trend among key actors (which include Small – scale farmers, medium – large scale farmers, farmers association, agricultural cooperatives, financing/ credit/ venture capital, Input suppliers, agricultural machinery suppliers, agricultural produce marketers and consumers of agricultural products) within the enterprise domain. The data reveal a higher linkage index among these actors than with other actors in the climate change and food security innovation system across the three countries. The data also show an increasing linkage trend among these actors in Nigeria than in Sierra Leone and Liberia, with Sierra Leone showing a higher linkage intersity trend than Liberia.



**Figure 4: Percieved trend of linkage among actors in the enterprise domain in Nigeria, Sierra Leone and Liberia**

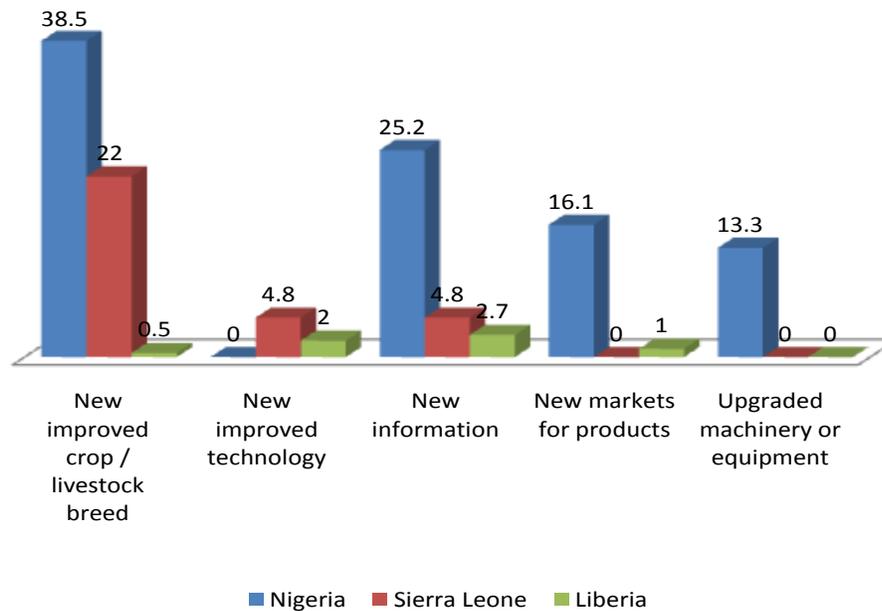
**Linkage Trends between Farmers and Technology Delivery Institutions in the Climate Change and Food Security Innovation System in Nigeria, Sierra Leone and Liberia.** Figure 5 shows the linkage trends between farmers and the technology delivery institutions across the three countries. The data reveal an increasing higher linkage index ( of more than 2) between farmers and the technology delivery institutions in Nigeria than in Sierra Leone and Liberia. On the other hand, data from Sierra Leone also shows an uneven increasing linkage trend over the past five years, with Liberia showing a more stable linkage trend between the farmers and technology delivery insitutions. The linkage index between farmers and the technology delivery insitutions in Sierra Leone and Liberia was less than 2.



**Figure 5: Linkage trends between farmers and technology delivery services in Nigeria, Sierra Leone and Liberia**

**Performance of the System on the Basis of Innovation Generation**

Figure 6 reveals the types of innovation generated by enterprises over the past ten years in Nigeria, Sierra Leone and Liberia. In Nigeria, it is evident that new improved crop varieties / livestock breeds (38.5%), new information (25.2%), new markets for products (16.1%) and upgrading of machinery were the innovation generated over the past ten years. In Sierra Leone, the innovations generated included new markets for products (16.1%) and upgrading of machinery (13.3%). For Liberia, it is evident that over the past ten years, virtually nothing has been done in the area of generating innovations by the enterprises. From this findings, it is clear that innovations are very poorly generated across the countries under study. Efforts should be channeled by the relevant government bodies e.g. Ministries of Agriculture, Research organizations etc to ensure that innovations are generated always so that the gap between the use of primitive methods in agricultural production and use of improved methods as found in other developed parts of the world can be bridged.



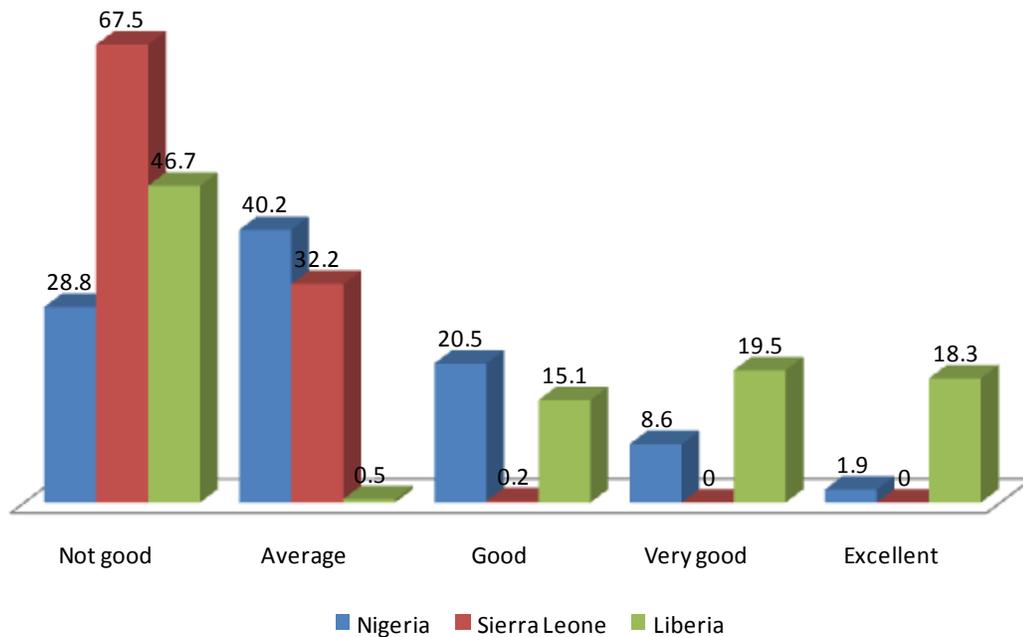
**Figure 6: Types of innovations generated by enterprises over the last ten years in Nigeria, Sierra Leone and Liberia**

### **Respondents' Perception of Domestic Environment Support for Climate Change Adaptation and Food Security**

### **Respondents' Perception of Farms Ability to Adapt to Changes in the Local or International Environment.**

Figure 7 reveals the respondents' perception regarding their farms ability to adapt to changes in their environment. Respondents from the three countries (Nigeria, Sierra Leone and Liberia respectively) noted that the ability of their farms to adapt to climate changes was not good (28.8%, 67.5% and 46.7%). On the average, 40.2%, 32.2% and 0.5% of the farmers from Nigeria, Sierra Leone and Liberia respectively agreed that their farms can adapt to these changes. This findings show that farms in these countries have very limited capacities to adapt to changes in the environment. Any differences between countries? This could probably be done to absence of policies on climate change or limited adaptive measures to the changing climate. There is need therefore to strengthen if any, existing policies on climate change adaptation and mitigation and to also

reposition research institutes in the search for innovative adaptive measures to climate change effects.



**Figure 7: Percentage distribution of respondents by perceived ability of farms to adapt to changing environment**

**Farmers Perception on Domestic Support for Climate Change Adaptation and Food Security in Nigeria, Sierra Leone and Liberia.** From Table 3, it is evident that the respondents from the countries under study perceived domestic environments support for climate change adaptation and food security to be poor. The reason for this may be due to absence of mitigation measures and policies on climate change that cater for the rural poor in the fight against the dangerous consequences of climate change.

**TABLE 3**  
**Farmers' perception of domestic environment support for climate change adaptation and food security in West Africa**

Statements	Nigeria		Sierra Leone		Liberia	
	M	SD	M	SD	M	SD
Government incentives for innovation	1.73	1.06	1.16	0.44	1.18	0.41
Availability of trained and experienced scientists	1.76	1.07	1.18	0.48	1.34	0.53
Local universities responsiveness to needs of the sector	1.60	1.23	1.15	0.65	1.19	0.39
National R & D organizations responsiveness to needs of the sector	1.39	0.78	1.07	0.26	1.06	0.27
Standard setting bodies and laboratory infrastructure	1.44	0.90	1.10	0.37	1.02	0.14
Intellectual property protection to support innovation	1.50	0.99	1.14	0.43	1.01	0.11
Availability of financing / venture capital	1.51	0.90	1.23	0.57	1.02	0.20
Information and telecommunication infrastructure	1.79	1.07	1.34	0.73	1.10	0.35
State of power supply	1.49	0.74	1.26	0.61	1.01	0.10
State of water supply	1.72	1.01	1.30	0.60	1.04	0.11
Road, rail, air and sea communication infrastructure	1.63	0.92	1.24	0.55	1.34	0.30
Supportive policies for science and technology and agriculture	1.61	0.98	1.16	0.48	1.07	0.68
Marketing infrastructure and supportive policy	1.59	0.94	1.12	0.37	1.24	0.35

### Conclusion and Recommendation

At the moment, there seems to be no specialized trainings on climate change adaptation and food security issues in the West African sub region. This has a direct effect on the adaptation options available to the farmers. It is obvious that farmers are innovating through indigenous adaptive measures. Though efforts are presently being channeled into more scientific ways of adapting to climate change, these are not yet accessible or available to the farmers who are the end users of such innovations. A possible reason for this could be that research has not adequately covered the issues of climate change adaptation and food security or that the available information is yet beyond the reach of the farmers. This points to

the poor agricultural extension contacts the farmers have had with agricultural extension outfits of the different countries.

Another factor directly connected to the issue of innovative adaptive measure is the extent of collaboration existing among the different stakeholders. Studies on innovation indicate that the ability to innovate is often related to collective action and knowledge exchange among diverse actors, incentives and resources available for collaboration, and having in place conditions that enable adoption and innovation e.g., by farmers or entrepreneurs. However, there was a poor intensity of collaborations with foreign partners across the three countries, even though there appeared to have been more collaboration with local institutions, especially in Nigeria. Foreign collaboration is needful to bridge the gap in knowledge and experience on innovative adaptive measures to climate change and food security. Collaboration with foreign partners will also help in the transfer and build up of strong teams of experts which could pull resources together towards the generation of more innovative ways of adapting to climate change and also ensuring that the sub region has better chances of being food secure.

The performance of system based on innovations generated does not reflect adequate research efforts. The weak domestic environment support for climate change adaptation and food security could possibly be a reason for poor ability of farms in the three countries studied to adapt to the changing climate. In the transfer of knowledge or innovation, locally available innovations are almost inadequate. Hence, there is need to generate innovations blended with modern knowledge in order to increase the performance of systems.

The following were recommended:

1. Formulation of a comprehensive climate change policy at the a global level and within Africa and especially in the West African sub region will be a necessary first step towards dealing with the challenge of climate change within the West African sub region. A number of climate change conferences have been held in recent years all over the world. Such conferences are platforms which provide necessary input into a global climate change policy, which would in turn be translated or domesticated in the respective countries taking cognizance of their varying agro-ecological and climatic characteristics.
2. A conference on formulation of climate change policy in West Africa is proposed; the essence of this is to solicit for political support from the various governments of countries in West Africa.
3. There should be increased and improved funding and training on climate change and food security issues to boost manpower skill which will subsequently lead to increase in productivity.

4. Collaboration efforts, between local and foreign partners should be intensified. This will bring about the generation of better and improved innovations on food security and adaptive measures.
5. The various systems / Ministries / Parastatals involved in innovations generation should work closely with research institutions and foreign partners to enhance the generations of innovations and also, to blend locally available adaptive measures with those generated over time.
6. There is need to revisit the existing research reward system, which favours the publication of research endeavours in peer reviewed western journals and link rewards to impact on the productive sector in order to achieve functional coordination of research efforts.

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