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Constraints to the Development of Technological Capabilities of Climate Change Actors in Agricultural Innovation System in Southeast Nigeria

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Abstract
Effective climate change adaptation and mitigation requires actors who have acquired requisite technological capabilities to efficiently use climate change equipment/information to counter the ravaging impacts of climate change. The study identified the constraints to the development of technological capabilities of climate change actors in agricultural innovation system in Southeast Nigeria. Five sub-systems (education, technology transfer, policy, research and farmer) that constitute an agricultural innovation system were identified and the staff in each system served as actors. Both interview schedule and structured questionnaire were used to collect data from a sample size of 176. Exploratory factor analysis was for data analysis. Statistical analyses of the data show funding/manpower (0.959), organizational (0.785) and weak policy (0.916) related factors constrained the development of technological capabilities of the actors. The study recommends adequate funding to enable the actors enhance and develop their technological capabilities.
Keywords: Climate change, technological capabilities, actors, agricultural innovation system, southeast Nigeria.

1. Introduction

In Nigeria, there is glaring evidence of climate change and its impacts are already occurring and touching lives (Medugu, 2009). The declining rainfall in areas prone to desertification in northern Nigeria is causing increasing desertification; people in the coastal areas of Nigeria who used to depend on fishing have seen their livelihoods destroyed by the rising waters (Medugu, 2009). In the southeast, empirical evidences of the unpleasant impact of climate change abound; these include increased cases of flooding and numerous gully erosion sites which have resulted to loss of farmlands, farm stead, biodiversity etc (Agwu and Okhimamhe, 2009). The gradual fading away of the 2 to 3 weeks traditional break in rainfall ''August break'' and its replacement by 2 to 3 days break in the eastern humid zone of Nigeria is also attributed to climatic change (Chineke et. al. 2010). Just recently, many parts of Southeast Nigeria and its borders close to major rivers in Anambra, Imo and Kogi States were submerged by flood during the raining season between the months of July and October, 2012. This caused a great national concern as farmers' homes and farms were submerged.

For effective adaptation to climate change, it is pertinent that climate change actors should acquire requisite technological capabilities. Technological capability is the skills (technical, managerial, organisational) and knowledge that enable firms (farm or actors) to efficiently use equipment/information and improve technology. Ernst, Mytelka and Ganiatsos (1994) defined it as the variety of knowledge which firms need so that they can acquire, assimilate, use, adapt, change and create technology.

Technological capabilities are built through interactions both within the firm (farm) and with external actors (Malerba, 1992). Following this, they are the result of interactive learning processes and linkages between a number of actors such as firms, universities and research centers through collaborations both complementary and competing ones (Bell and Pavitt, 1993; Szogs and Mwantima, 2010). Technological capabilities cover a wide spectrum of technical efforts undertaken by firms/actors. Consequently, to make their analysis manageable, technological capabilities are commonly categorized into six, namely: investment capability, production capability, minor change capability, major change capability, strategic marketing capability and linkage capability (Ernst *et al*. 1994). However, Biggs, Manju and Srivastava (1995) in their study identified learning capability/mechanism as a seventh category.

The interactive learning processes and linkages that result due to technological capabilities do not occur in a vacuum, rather, they occurs within an innovation system. An innovation system is defined as a complex, open and dynamic human activity system in which actors (individuals, groups, and organisations) apply their minds, energies and resources to innovation in a particular domain of human activity (Daane, 2009). Innovation systems do not exist 'out there' as objective entities or realities – they only exist 'in the minds of those who define them', i.e. as social construct, or as a heuristic device for analytical purposes. An implication of this definition is that innovation systems are defined in relation to a particular domain of human activity. Thus, one can for example define a system of innovation in a specific commodity, value chain or business cluster, or in specific (agro) eco- or farming systems (Daane, 2009), hence, the agricultural innovation system.

An agricultural innovation system is defined as a set of organizations and individuals involved in generating, disseminating, adapting and using knowledge for socio-economic significance and the institutional contexts that govern the way interactions and processes take place (Hall, Bockett, Taylor, Sivamohan *et al.* 2001). In the Agricultural innovation system, the following sub-systems could be identified- education, policy, technology transfer, research and farmer. The workers/staff in each sub-system are regarded as actors.

As the challenges such as those posed by climate change grow, technologies, knowledge and practices that simultaneously increase productivity, resilience to climate change (i.e. climate change adaptation) and green house gases reduction (i.e. climate change mitigation) are needed (Alcadi, Mathur and Remy, 2009). According to Oruwari, Jev and Owei, (2002), it is crucial to acquire and strengthen technological capabilities to produce technologies, policies and synergies needed to effectively address climate change. Inter alia, for actors to respond effectively to climate change, they must have the requisite technological capabilities (skills and knowledge) required and the learning ability to upgrade these when needed. Because capabilities are driven by knowledge acquired through linkage and learning, the different actors in the agricultural innovation system must have the capabilities to learn and share lessons for scaling up successful strategies for effective climate change adaptation and mitigation. Hence, there is need to address the following research questions- Who among these actors are involved in the development of these capabilities? What factors constrain the actors from developing their technological capabilities? Based on these, the study specifically aims to ascertain the factors that influence the development of climate change technological capabilities of the actors.

2. Methodology

2.1 Area of study

The study was carried out in Southeast Nigeria. The Zone is located between Latitudes 04° 30′ N and 07°30′ N and Longitudes 06° 45′ E and 08°45′ E. 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.

It is primarily 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.

2.2 *Population and sampling procedure*

All climate change actors (i.e. farmers and staffs of faculties/universities of Agriculture, Agricultural Development Programme, Ministry of Agriculture and research Institute) in AIS in Southeast Nigeria formed the population. Five sub-systems (education, technology transfer, policy, research and farmer) that constitute an agricultural innovation system 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.

2.3 Instrument for data collection and measurement of variables

Both 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 devoted to information on factors that constrained the development of technological capabilities of the actors.

The respondents were asked to respond to possible factors/constraints using a four-point Likert-type scale of "to a great extent (4)", "to some extent (3)", "to a little extent (2)" and "to no extent (1)". The mean value of 2.5 was used to determine the factors. Variables that have a mean value of 2.5 and above were considered as factors that constrained the development and those below 2.5 were not. Data were further subjected to exploratory factor analysis procedure using the principal factor model with varimax in grouping the influencing factors. Only variables with loadings of 0.4 and above (10% overlapping variance) were used in naming the factors while variables that loaded high in more than one factor were discarded (Comrey, 1962).

2.4 Data analysis

Information on factors that constrained the development of climate change technological capabilities of the actors was analysed with mean score and exploratory factor analysis. Version 16.0 of the Statistical Package for the Social Science (SPSS) software was used for the analysis.

3. Results and Discussion

3.1 Factors that constrain the development of technological capability

Table 1 shows varimax rotated factor on factors constraining the development of technological capability. Based on variable loading, three factors were identified and named. Factor one was named funding/manpower related factors, factor two was named organizational related factors while factor three was named weak policy related factors.

Entries in the Table show that factors that loaded high under funding/manpower related factors (factor 1) were poor funding to research (0.959), poor funding to teaching (0.770), lack of manpower (0.471), unavailability of technology (0.495), unavailability of equipment (0.567), lack of training opportunity, (-0.652), lack of competent staff i.e. climate change experts (0.760). Lack of skilled human resource has been identified as important factors for the low-level of technological capability development in many firms in developing countries (Panda and Ramanathan, 1997). Poor funding will not allow actors to invest in training, research and development, or state-of-the-art technology acquisition. Unavailability of equipment needed for teaching and research in the education sub-system will imply that the university will be incapable of transferring needed climate change adaptation skills to her students and the surrounding communities. With adequate funding into teaching/research, teachers/researchers will have enough machines and other technology needed for their researches and this will bring technological change. Technological change itself stimulates capability accumulation and will directly and indirectly enhance teachers/researchers capabilities.

Culture of firm (0.482), bureaucracy (0.755), poor remuneration (-0.689), poor motivation (0.785) and lack of interaction between actors i.e. poor linkage (0.740) loaded high under organizational related factors (factor 2) (Table 2). Interaction between actors will allow them swap information and enhance learning (Dominguez and Brown, 2004). Such learning will permit the actors to accumulate technological capabilities in adapting to the challenges of climate change. Lack of interaction hence implies there will be no opportunity of learning and development of climate change technological capabilities. This inability to learn or link could retard efforts towards addressing the problems of climate change.

Table 1 equally shows the factors that loaded high under weak policy related factors (factor 3) as poor fiscal government policies (0.453), policy dynamics (0.521), poor access to knowledge and information on new technologies (0.475), poor government commitment to climate change issues (0.916) and lack/weak legal framework (-0.470). Government can be instrumental in stimulating technological capability enhancement through a number of fiscal incentives (Porter, 1980). Aderemi, *et. al* (2009) maintained that government has the roles of setting priorities, participating and enacting laws that could enhance technological capabilities' development and accumulation. Technological capabilities of farmer actors could be enhanced if government makes it a law that all financial institutions (banks) must give low interest loans and demand very affordable collateral from farmers.

However, inadequate finance/credit loaded high under funding/manpower (0.521) and organizational (0.470) factors. Subsequently, it was not considered in naming the extracted factors.

4. Conclusion

The study concludes that in the agricultural innovation system in south east Nigeria, the technological capabilities of the actors are constrained by certain factors. These factors include funding/manpower factors (factor 1) which consists poor funding to research and teaching, lack of manpower, unavailability of technology and equipment, lack of training opportunity and competent staff i.e. climate change experts.

Unavailability of technology needed for proper adaptation to climate change was one of funding/manpower related factors which constrained the development of technological capabilities. To provide solution to this, government should make it a policy issue that adequate technology/information gets to the actors such as providing quarterly meteorological information and research-oriented adaptation strategies to the farmer actors, also adequate funding should made available for all the actors.

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Table 1: Varimax Rotated matrix of Factors that Constrain the Development of Technological Capabilities

Constraining factors	Factor 1	Factor 2	Factor 3
Poor funding to research	0.959	0.367	0.359
Poor funding to teaching	0.770	0.280	-0.250
Lack of manpower	0.471	-0.344	0.209
Unavailability of technology	0.495	0.319	0.301
Unavailability of equipment	0.567	0.123	0.279
Size of firm	-0.329	0.026	0.319
Culture of firm	0.390	0.482	0.254
Firm organisation strategy	0.215	-0.191	0.375
Lack of training opportunity	0.652	0.254	0.354
Lack of competent staff(climate change experts)	0.760	0.297	0.191
Bureaucracy/organisational bottleneck	0.351	0.755	0.250
Poor fiscal government policies	0.252	0.362	0.455
Policy dynamics	0.344	0.289	0.521
Farmer's conservatism	0.301	0.233	0.280
Market forces	0.312	0.375	0.148
Poor access to knowledge and information on new technologies	0.008	0.321	0.475
Poor remuneration	0.371	0.689	0.362
Influence of donor agencies	0.364	0.254	0.301
Poor government commitment to climate change issues	0.258	-0.098	0.916
Poor motivation	0.208	0.785	0.206
Lack of interactions among actors/poor linkage with other actors	0.287	0.740	0.328
Inadequate finance/credit	0.521	0.470	0.365
Lack /weak legal framework	0.367	0.319	0.470

Note: **Factor 1**= funding/manpower related; **Factor 2=** organizational related; **Factor 3:** weak policy related.
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization (loading at .4 and above)
Bold type is used to highlight high factor loads.
Source: Field survey, 2012