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Linkages of research agencies in technology transfer for sustainable agricultural development in south east Nigeria

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The study assessed the linkages that exit among research agencies in transfer of technology for continuous agricultural production in South East Nigeria. Four research questions and hypotheses guided the study. The study adopted ex-post-facto research design. The population for the study was 2,276 comprised of 112 agricultural extension agents, 393 officers of research institutes and 1,771 registered contact farmers. The sample for the study was 486 made up of 112 extension agents, 197 officers and 177 farmers. A sixty seven (67) structured questionnaire items developed from related literature reviewed and face validated by three experts was used for data collection. The reliability of the questionnaire items was determined using Cronbach Alpha method and a co-efficient of 0.80 was obtained. Three research assistants helped to distribute and retrieve the copies of the questionnaire which were analyzed using mean, t-test and Analysis of Variance (ANOVA) statistical tools. The findings of the study revealed 12 mechanisms adopted by each agency for agricultural technology transfer. 09 delivery channels; 36 constraints and 13 strategies for effective technology transfer. It was therefore recommended that the agencies should formulate and pursue the same objective; government to formulate policies for uniform implementation of technology transfer, establish and equip research institutes with infrastructural facilities, provide adequate training and retrain extension agents and farmers to enhance technology transfer linkages using the identified strategies.

Key words: Agriculture, technology transfer, linkages, research, agencies, extension.

INTRODUCTION

Agriculture occupies a strategic position in the economic development of any country. Agricultural development is driven by the dynamics of demand and supply of farm knowledge among research institutes, extension agents

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and farmers (Dimelu and Emodi, 2012). To achieve a high standard of agricultural development a nation is expected to have strong research and extension system for advancement in agricultural technology with continuous upward shifts in the production and distribution of agricultural produce. Okey and Joel (2014) noted that advancement in agricultural technology has resulted in continuous upward shifts in the production, distribution and consumption of agricultural produce worldwide. Such increase in technology transfer bridges the gap between countries because of differences in environments. The challenge is how to improve agricultural production and rural income without irreparably damaging the natural resources on which production rests through technology transfer. One of the most urgent challenges in the next several decades is feeding the growing world population without irreparably damaging the air, land or water systems (Paul, 2017). The major instrument to success of feeding the hungry mouth is effective and efficient technology transfer.

Technology transfer refers to deliberate, goal-oriented relationship between two or more persons, groups or organizations who exchange technological knowledge (Autio and Laamanen, 1995). Technology transfer refers to movement of ideas, inventions and prototypes within companies, from research producers to a wide group of users including government departments and non-profit agencies, such as industries and universities (Harman and Harman, 2004). Technology transfer requires research stations to disseminate information through extension agents and others to ensure that target audience receive the innovation through media and other means. Stock and Tatikonda (2000) described technology transfer as the act of conveying and utilizing technological innovation by the recipient to achieve set objectives, within cost and time targets. Technology transfer is, therefore, the movement of relevant specialized knowledge or innovations from research institutes to farmers for adoption with the help of extension agents and providing feedback to researchers in order to achieve the intended objectives

The objective of any technology process as indicated by Wang (2003) is the successful adoption of innovation or research findings by a significant majority of clients. Technology transfer is a critical process in transforming agricultural research innovations into applications for end users. Technology transfer helps to improve economic growth, transform lives and boost outputs. The rate at which technology transfer is accepted for adoption depends on the effectiveness of the linkages.

Linkage implies the communication and working relationship established between two or more organizations pursuing common objectives in order to improve productivity. Linkage as a term indicates connection between systems so as to form a greater system (Havelock, 2006). The author further stated that if the barriers between two systems are permeable enough for messages and responses to flow out of each to the other, then, a link is created. It therefore, means that research institutes and extension services are two systems connected by information flow and feedback (Agbamu, 2000). The poor coordination and linkage mechanisms in innovation and adoption have become a recurrent problem (Madukwe, 2008). So, effective interaction of agricultural research scientist, extension agents and farmers as key components of agricultural technology transfer must have a strong linkage to increase production and the standard of living.

Innovations are derived through careful experiments conducted by researchers domiciled in research institutes departments and, faculties of agriculture across the country. Government established these agencies and institutions to generate and circulate innovations needed for increased production (Joans, 2013) Presently, there are twenty two (22) research institutes in Nigeria, each with specific mandate in crop, animal or other commodities and fields (Nigeria webmaster, 2017). There are also 23 faculties of agriculture across Nigerian universities and one international institute for tropical agriculture (IITA), at Ibadan. Their research efforts give rise to a body of knowledge, technologies, practices and system which form the basis for agricultural innovations. Agricultural, research institutes in Nigeria are managed by the Federal Government. The Federal Agricultural Coordinating Units are expected to work with collaborating institutions in technology transfer linkage activities. This is because research is carried out annually by staff of research institutes, universities, colleges of agriculture and state Agricultural Development Programmes. Therefore, to train a researcher, an extension staff or farmer demands that universities must understand the activities of each group and link strongly but each is on its own. Universities in Nigeria are under the National University Commission (NUC); colleges of agriculture under National Commission for Colleges of Education (NCCE); agricultural research institutes autonomous and extension under the ministry of Agriculture (ADP). In practice, there is need for linkage between the ministry of agriculture and the commissions.

In South East Nigeria, the researchers observed that over 70% of the population are farmers but the teaming population are hungry. This is because beaurocratically the innovations are not timely delivered to the target audience. Furthermore, the expected linkages among the commissions, research institutes and extension agents are either weak or not in existence. Agricultural research system is characterized by a top-down, centralized, linear, and isolated structure with weak linkages and often non-existent (Dimelu and Emodi, 2012). Majority of agricultural innovations in the study area arise from publicly sponsored research centers or universities, which typically are unprepared to engage in formal mechanisms of technology transfer. Generally, studies have shown poor technology transfer linkages and collaborative

attitudes among agencies involved in agricultural and rural development (Uzuegbulam, 2001). Despite the availability of highly productive and remunerative technology, a wide gap exist between what researchers have achieved in their experimental farms, research institutes and education and the average yield obtained in farmer's field. Many factors responsible are ineffective system of linkages and transfer of improved farm practices, farmers' inadequate knowledge and meager support from government for innovations in the agricultural sector (Uzuegbulam, 2001).

It therefore means that weak linkages in technology transfer to the farmers result in distortions and gaps in derivable advantages; leading to unsustainable agricultural development. This study assessed linkages in technology transfer for sustainable agricultural development in South East Nigeria. Specifically, the study sought to:

1. Identified mechanisms in transfer of technology for sustainable agricultural development.
2. Examined the delivery channels within the service agencies in technology transfer linkages for sustainable agricultural development.
3. Identified constraints to effective linkages in technology transfer for sustainable agricultural development.
4. Determined strategies for enhancing technology transfer linkages by relevant agencies for sustainable agricultural development.

METHODOLOGY

The study adopted ex-post-facto research design. Ex-post factor research design is a non-experimental research technique that compares pre-existing groups on some dependent variables (Lammers and Badia, 2005). The design was considered appropriate for this study as the different research agencies were compared on their roles in technology transfer linkages for sustainable agricultural development in South East Nigeria. South East Nigeria has five states which are Abia, Anambra, Ebonyi, Enugu and Imo States.

The population for this study was 2,276 made up of 112 agricultural extension agents, 393 officers of research institutes and 1,771 registered farmers. The sample for the study was 486 made up of 112 extension agents, 197 officers and 177 farmers. The entire population of extension agents was studied because of the manageable size while proportionate random sampling technique was used to pick 50% of the officers and 10% of farmers based on their experience. The justification for the use of the entire population, 50 and 10% was based on the suggestion by Gall et al. (2007) that for a population of 2000 to 5000 a minimum of 10% may be used while 50% may be used in respect of hundreds.

The instrument for data collection was a 67 item structured questionnaire developed from the literature reviewed for the study. The instrument was made up of four sections (A-D). Each of the sections addressed a specific research questions with each questionnaire item assigned a four point response options of strongly agree, agree, disagree and strongly disagree with values of 4, 3, 2 and 1 respectively. The questionnaire items were face validated by three experts; two from National Root Research Institute Umudike-Abia State and one from University of Nigeria Nsukka, To determine the internal consistency of the items, 12 copies of the questionnaire were sent to four each of officers, extension agent and farmers in Kogi state (a near-by state with same characteristics as the study area). The copies were retrieved and analyzed using Cronbach alpha method and an overall coefficient of 0.80 was obtained. The researchers with the help of three assistants selected based on their familiarity with the study area collected the data from the three groups of respondents. Out of 486 copies of the questionnaire distributed 484 were retrieved and analyzed (112 from extension, 197 from officers and 175 from farmers). Mean was used to answer the research questions, standard deviation for checking the spread of the respondent from the mean while t-test *and* Analysis of Variance (ANOVA) statistics were used to test the null hypotheses at the probability of 0.05. In taking decision on the agreed item, any item with a mean value of 2.50 or above was regarded as agreed while any item with a mean value below 2.50 was regarded as disagreed. With reference to the hypotheses tested; any item with a value greater than 0.05 was accepted but not upheld if otherwise.

RESULTS

The results of the study were presented in Tables 1 to 8. Table 1 indicated that all the 12 items were mechanisms in technology transfer while the corresponding hypothesis in Table 2, revealed a significant difference in the mean ratings of the two groups of respondents (officers and extension agents). Table 3 indicated that all the nine items were the channels of linkages for technology transfer and the tested hypothesis in Table 4 showed a significant difference. With reference to constraints to technology transfer, the three groups of the respondents agreed that 35 of the items in Table 5 were constraints that hinder linkages in technology transfer for sustainable agricultural development. The corresponding hypothesis in Table 6 indicated that no significant difference exists among the three groups of respondents on the constraints to the linkages. The three groups of respondents agreed that the 13 items in Table 7 were strategies for enhancing technology transfer linkages for sustainable agricultural development. The corresponding hypothesis in Table 8 indicated that there was a significant difference in the mean ratings of the three groups of respondents on the strategies for enhancing linkages in technology transfer for sustainable agricultural development in South East Nigeria.

DISCUSSION

The findings of the study revealed that 12 mechanisms for technology transfer linkages were to combine research and extension functions into one unit, fieldwork by subject-matter specialists in extension, create inter agencies committee, farmers' participation in research and extension activities, establish job descriptions to strengthen agencies' relationships and redefine roles and responsibilities between research and extension units. The study also revealed that constraints such as limited ICT resources for effective linkages, insufficient flow of

Table 1. Mean ratings of respondents' on the mechanisms in technology transfer linkages for sustainable agricultural development [N = 309 (112 extension agents and 197 officers)].

S/N	Item statements	$\bar{X}$	SD	Decision
1	Combining research and extension functions into one unit	2.90	0.90	Agree
2	De-centralizing research and extension activities into regions	3.20	0.80	,,
3	Fieldwork by subject –matter specialists in extension	3.10	0.61	,,
4	Starting extension liaison positions in research institutions	3.20	0.80	,,
5	Domicile communication/information departments in institutions	3.20	0.80	,,
6	Redefining roles and responsibilities between research and extension units	3.10	0.67	,,
7	Creating inter agencies committee	2.51	1.05	,,
8	Locating research unit adjacent to extension units	2.80	0.67	,,
9	Farmers' participation in research and extension activities	3.10	0.67	,,
10	Establishing job descriptions to strengthen agencies' relationships	3.10	0.67	,,
11	Establishing joint reviews of research and extension activities	3.70	1.28	,,
12	Promotion of formal and informal linkages	3.10	0.67	,,

Table 2. t-Test analysis of the responses of extension agents and officers on the mechanism in technology transfer linkages for sustainable agricultural development.

Occupation	Group statistics at 0.05 level of significant							
	N	Mean	SD	df	Std. Error	t-cal	Sig*	Remark
Officers	197	3.04	8.37	307	0.81	-0.20	0.00	S
Ext. agents	112	3.20	5.91					

Table 3. Mean ratings of respondents on delivery channels in technology transfer linkages for sustainable agricultural development [N = 309 (112 extension agents and 197 officers)].

S/N	Item statements	$\bar{X}$	SD	Decision
1	Publication in journals/bulletins	2.9	1.02	**Agreed**
2	Conferences/workshops	2.70	0.50	,,
3	Technical reports	3.10	0.67	,,
4	Television	2.60	0.67	,,
5	Radio/posters	2.80	0.50	,,
6	Monthly review meetings	3.60	1.20	,,
7	Field projects	3.40	1.02	,,
8	Exhibitions/farmer's fairs	3.20	0.80	,,
9	Farm magazines/newsletters/hand books/leaflets	2.60	0.50	,,

Table 4. t-Test analysis of the responses of extension agents and officers on delivery channels in technology transfer linkages for sustainable agricultural development .

Occupation	Group statistics at 0.05 level of significant							
	N	Mean	SD	df	Std. Error	t-cal	Sig*	Remark
External agents	112	3.27	0.18	307	0.03	26.53	0.00	S
Officers	197	2.50	0.33					

feedback to research institutes from extension/farmers, poor communication/interaction among staff of the

Table 5. Mean ratings of respondents on the constraints to effective linkages among the agencies in technology transfer for sustainable agricultural development (N = 484).

S/N	Item statements	$\bar{X}$	SD	Decision
Organizational constraints				
1	None assigned to specific functions such as adaptive research or provide feedback to researchers	2.10	0.50	Disagree
2	Linkage activities assigned inappropriately to institutes or departments	2.60	0.50	Agree
3	Assign inappropriate linkage activities to institute or department	2.90	0.50	,,
4	research activities by individual agencies reduce effectiveness	3.40	1.02	,,
5	Insufficient coordination among research institutions	3.00	0.50	,,
6	Institutional incompatibilities in conducting needed research	3.20	0.80	,,
7	Different time schedules for planning and budgeting	3.60	1.28	,,
8	Overlapping mandate/objectives	3.60	1.20	,,
9	Limited qualified human resources in the agencies for linkage	3.50	1.11	,,
10	Poor logistics support and incentive for linkages	3.50	1.11	,,
11	Administrative bottleneck associated with public agencies	3.20	0.92	,,
12	Excessive organizational fragmentation of research agencies	3.50	1.11	,,
Communication				
13	Poor access to knowledge and information on new technology	3.60	1.20	,,
14	Limited ICT resources for effective linkages	3.10	0.06	,,
15	Traditional public characteristics of most extension information	3.20	0.80	,,
16	Different educational backgrounds and communication patterns of researchers extension agents and farmers.	3.30	0.92	,,
17	Value system may differ between researchers	3.20	0.80	,,
18	Weak or non-existent of communication in critical areas of research linkages	3.40	1.02	,,
19	Insufficient flow of feedback to research institutes from extension/farmers	3.20	0.80	,,
20	Inefficient utilization of existing ICT resources	3.50	1.11	,,
21	Poor communication/interaction among staff of the agencies	3.10	0.67	,,
22	Loss of messages/information in the transfer process	3.10	0.67	,,
23	Inability to understand nature of linkage patterns by each agency	3.10	0.67	,,
Logistics				
24	Weak legal framework	2.70	0.80	,,
25	Poor macro system linkages	3.20	0.80	,,
26	Inappropriate government policy in agriculture	3.40	1.02	,,
27	Influence of international/donors mandates	2.90	0.80	
28	Lack of farmers interest in extension	2.50	0.60	,,
29	Gap in qualification and salary of staff of the agencies	3.10	0.80	,,
30	Poor training opportunities for professionals	3.50	1.11	,,
31	Poor government commitment to extension	3.10	0.67	,,
32	Little incentive from management to perform linkage functions	2.90	0.80	,,
33	Financial resources may be scarce for linkage functions such as testing of research results and training of extension staff	3.10	0.67	,,
34	Overloading few employers in the agencies for linkages	2.30	1.20	,,
35	General poor attitude and low morale of extension workers	3.40	1.02	,,
36	Lack of adequate source of finance for research and linkages	3.80	1.36	,,

agencies, inappropriate government agriculture policies, influence of international/donors' mandates and lack of farmers participation and interest in research and extension. The hypothesis tested revealed significant difference in the opinions of the three groups of respondents in each case.

The findings of the study were in line with the findings of Uzuegbulam (2001) that there is poor technology transfer, linkages and collaboration altitudes among agencies involved in agricultural development. The findings of the study were further in conformity with the findings of Dimelu and Emodi (2012) that the system is characterized by a top-down, centralized, linear, and isolated structure with weak linkages as result

Table 6. Analysis of Variance (ANOVA) of the three groups of respondents on the constraints for effective technology transfer linkages among the agencies for sustainable agricultural development.

Constraints	ANOVA					
	Sum of squares	Df	Mean square	F	Sig.	Remark
Between groups	6.01905	2	3.0095238	4.069217	0.040.	S
Within groups	601.8285	482	2.9002801			

Table 7. Mean ratings of three groups of respondents on the strategies for enhancing technology transfer linkages for sustainable agricultural development [N = 484 (112 extension agents, 197 officers and 176 farmers)].

S/N	Item statements	$\bar{X}$	SD	Decision
1	Evaluating research and development results in terms of the whole farming system	3.30	0.92	Agree
2	Recognizing the linkages of sub-systems within the farming system	3.20	0.80	,,
3	Forming coordinating units among the agencies	3.40	1.02	,,
4	Adopting practice of shearing research information among the agencies,	3.30	0.92	,,
5	Regular training of extension agents and contact farmers	3.50	1.11	,,
6	Linkage with research to impart farmer orientation to research	3.40	1.02	,,
7	Allocating operating funds for linkage with other agencies	3.00	0.92	,,
8	Forming field/group teams and committees for linkages	3.10	0.67	,,
9	Increasing access to individual and agencies; use of information and communication technology	3.10	0.67	,,
10	Planned orientation programme for extension professionals on linkages	3.50	1.11	,,
11	Adopting comparative advantages approach to extension outreaches and programme	2.90	0.67	,,
12	Building linkage responsibilities into job description	3.10	0.67	,,
13	Allocating time to linkage activities among staff.	3.30	0.92	,,

Table 8. Analysis of variance (ANOVA) on the strategies for enhancing technology transfer linkages for sustainable agricultural development.

Strategies	Sum of squares	df	Mean square	F	Sig.	Remark
Between groups	165.385	2	82.692	3.51179	.037	S
Within groups	847.692	482	23.547			

available and highly productive and remunerative technology, wide gap in findings of research stations on their experimental farms and the average yield obtained on farmer's field. The authors observed that there are inadequate knowledge and managerial ability of farmers, little support from government for the agricultural sector resulting in failure to transfer new technologies and innovations to farmers. The respondents indicated that they carry our mechanisms identified by the study independently thus the significant difference in their opinions. The finding of the study was against the University of Montana's report (2011) that many individuals and organizations participate in the technology transfer strategic planning process, both in private conversation and structured discussion sessions. The findings of this study was also in disagreement with the findings of Laamanem (1995) that the innovations' focus on shifting towards networking which is component dependent.

RECOMMENDATIONS

Based on the findings of the study, it was recommended that the agencies should have uniform objectives and form committees and monitoring teams for proper linkages for the achievement of set objectives. Government should improve elements of technology areas in which the agencies are found weak, by utilizing the strategies identified by this study. Furthermore, there should be policies that could bring effective technology transfer linkages among the agencies for sustainable agricultural development.

Conclusion

It is the wish of each agency to perform needed activities or functions to enhance agricultural development in the study area but the problem is that these agencies are

working independently. Despite the need for successful transfer of technology which can only be achieved by generating innovations and subsequent transfer to the end users; the agencies work in isolation. Technology transfer is an end in itself but a means to increase the rate of technological innovation and stimulate innovation transfer. Thus, today's recipients can be tomorrow's donors through a successful transfer of technology. To be a donor of technology, the recipients need to possess the capacity to assimilate, adapt, and modify the imported technology through education and training. It is necessary that research institutes, educational institutions and extension departments collaborate effectively for effective technology transfer to the end users for agricultural development in the study area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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