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Reworking the Analytical Framework for Plantain and Banana (*Musa* sp.) Innovation System in Nigeria for Improved Learning and Capacity Development

[1]B.O. Faturoti, [2]M.C. Madukwe, [2]E.M. Igbokwe and [2]A.E. Agwu
[1]SARO Agro Allied Nigeria Limited, P.M.B. 1490, Okesha, Ilesha, Nigeria
[2]Department of Agricultural Extension, University of Nigeria, Nsukka, Enugu State, Nigeria

Abstract: A framework for plantain and banana innovation system in Nigeria, where learning and capacity development will be fully realised was presented to replace the existing framework which was modelled along the now moribund top-down approach which T and V system of extension methods set out to correct. Actors in plantain and banana innovation system were classified into 5 groups based on their actions (research, technology transfer, government agencies, farmers and marketers) Data were collected in eleven Nigeria states from a total of 95 respondents, on capacity development, resource capabilities, learning and learning alliances among stakeholders in the innovation system. The result revealed IITA, NIHORT and NSPRI as the major technology generating agencies in plantain and banana innovation system In Nigeria. Above average linkage index was recorded from 7 of the 18 stakeholders IITA (57.6%), university (69.2%), ADP (65.6%), plantain and banana cooperative (53.9%), plantain and banana farmers (77.6%), plantain and banana marketers (70.1) and plantain and banana consumers (55.8%). The study concluded that a framework for plantain and banana innovation system should be that with multi-dimensional interactions among stakeholders with the end users at the centre of all actions, which will allow a demand-supply pool that will make technology so generated needed and utilised for greater social and economic benefits in plantain and banana innovation system in Nigeria.

Key words: Stakeholders, actors, resource capabilities and linkage index

INTRODUCTION

For millions of the world's poorest people, banana and plantain are an important crop, the nutritional value is high and it can be grown with minimal care; one kilogram, 1000 calories can be produced cheaper than any other important source of carbohydrate in West Africa. They are mandate crops of most national and International research Institutes both of which have developed technologies aimed at improving the production of the crop which has been on the downward trend in recent years. Despite these efforts and research breakthrough many of these technologies are yet to be made available or used by farmers (Faturoti *et al*., 2007).

Innovation system provides a key to the study of plantain and banana technology generation, dissemination and utilization. It also reveals how the systems can be strengthened for greater social benefit. Spielman (2006) asserted that Innovation systems represents a significant change from the conventional, linear perspectives about agricultural research and development (R and D) by providing a framework for the analysis of complex relationships and innovative processes that occur among multiple agents, social and economic institutions and endogenously determined technological and institutional opportunities. Rajalahti *et al.* (2008) asserted that investing in Agricultural Innovation System (AIS) requires an integrated, context-specific approach that addresses innovation and institutional capacity of the multiple interactive partners, not only that of the NARS, but in relations with the enabling environment and in tune with the national agriculture- rural development priorities and agenda. Byerlee and Fischer (2001) stated that an innovation systems approach will help policymakers, researchers', research managers, donors, entrepreneurs and others identify and analyze new ways of encouraging innovation through provision of greater insights into complex relationships among diverse actors, processes of institutional learning and change. The concept refers to the system of all actors involved in the generation, adoption, diffusion and use of knowledge. This knowledge may be brand new, but more often innovation involves the new use of existing knowledge and this

Corresponding Author: B.O. Faturoti, SARO Agro allied Nigeria Limited, P.M.B. 1490, Okesha, Ilesha, Nigeria
Tel: +234-8034105131

may involve both product and process innovations (Hall, 2006). Learning and capacity development in a contemporary sense is a multidimensional concept, that requires skills or competencies of both scientific and non-scientific kind; it requires linkages between producers and users of knowledge; it requires the types of relationships and institutional setting conducive to knowledge sharing and interactive learning and it requires a policy environment that is sensitive to the need to create the conditions needed to make productive use of knowledge rather than focusing solely on the creation of that knowledge (Hall and Dijkman, 2006). Rajalahti (2009) quoted The World Bank (2008) that, farmer productivity is still often constrained by lack of appropriate technology or access to technology, inputs, services and credit and by farmers' inability to bear risks. In addition, farmers' information and skills gap constrains the adoption of available technologies and management practices or reduces their technical efficiency when adopted. To address these challenges, we have gradually shifted from strengthening research systems and knowledge transfer towards building innovation capacity, enhancing use of knowledge and creating social and economic change (The World Bank, 2008). The existing framework for plantain and banana innovation system remains a model of the now moribund top-down approach which T and V system of extension methods set out to correct. Therefore, to allow an efficient plantain and banana innovation system where learning and capacity development will be fully realised, there is a need to rework the analytical framework for plantain and banana innovation system in Nigeria (Faturoti *et al*., 2007). The remodelling of framework for innovation generation, acquisition, adaptation, utilisation and resource capability of stakeholders in plantain and banana innovation system in Nigeria is what this study set out to examine.

The general objective of the study was to examine the existing framework for analysing banana and plantain innovation in Nigeria, proposed a more efficient framework and assesses learning and capacity development of stakeholders in the innovation system in Nigeria. Specifically, the study sought to:

- Assess the existing framework for plantain and banana innovation system in Nigeria
- Propose a more efficient framework for plantain and banana innovation system in Nigeria
- Examine the capacity development of selected major actors in plantain and banana innovation system in Nigeria
- Examine the linkage existing among selected key actors in banana and plantain innovation system
- Establish the contribution of each stakeholder in technology availability and use

MATERIALS AND METHODS

Study area: The study was carried out from 2006 to 2008 in the banana and plantain growing belt in Southern Nigeria (Fig. 1) made up of 11 states (Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ogun, Ondo, Oyo and Rivers). The states were classified into four zones on the basis of agro-ecological, socio-political and socio-cultural homogeneity. Each zone has a zonal headquarter, the farmers sample were drawn from the zonal headquarters (Abia, Akwa-Ibom, Edo and Ogun) The population consisted of stakeholders from a general list of participants that were part of plantain and banana innovation system compiled from a review of study on plantain and banana innovation system in Nigeria (Faturoti *et al*., 2007). The list was revised and the agents in the innovation system were classified according to their activities within the system. The classifications revealed there were 18 stakeholders classified as research group (6) (International Institute of Tropical Agriculture, (IITA) Onne, National Institute for Horticultural Research, (NIHORT) Ibadan, Raw Material Research and Development Council, (RMRDC) Abuja, National Stored Product Research Institute, (NSPRI) Port Harcourt, Federal Institute of Industrial Research, (FIIRO) Oshodi and universities faculties of agriculture Nsukka, Ibadan, Umuahia), governmental agencies group (5) Federal Department of Agriculture (FDA) Abuja, Federal Ministry of Commerce (FMC) Abuja, Plantain and Banana Development Program (PBDP) Ibadan and National Food Drug Administration and Control (NAFDAC) Abuja and National Biotechnology Development Agencies (NABDA) Abuja and technology transfer group (5) (state' ADPs (zonal headquarters of PRTC) in the plantain-growing belt (Abeokuta, Benin, Uyo, Umuahia), Non-governmental agencies (Food for All International (FFAI) Port Harcourt, Agriculture and Impact Assessment Centre (AGRICPACT) Port Harcourt), Plantain and Banana Cooperative Growers Association west (Sagamu) and their southern (Ughelli) counterparts, Nigeria Agip Oil Company (NAOC) Port Harcourt and Shell Development Company Port Harcourt (SPDC). End users (2) Farmers (60) and marketers (20).

The plantain and banana sections of the research institutes and the faculty of agriculture of universities in the plantain-growing belt were taken as a population. Furthermore, governmental and nongovernmental agencies with related activities to plantain and banana as

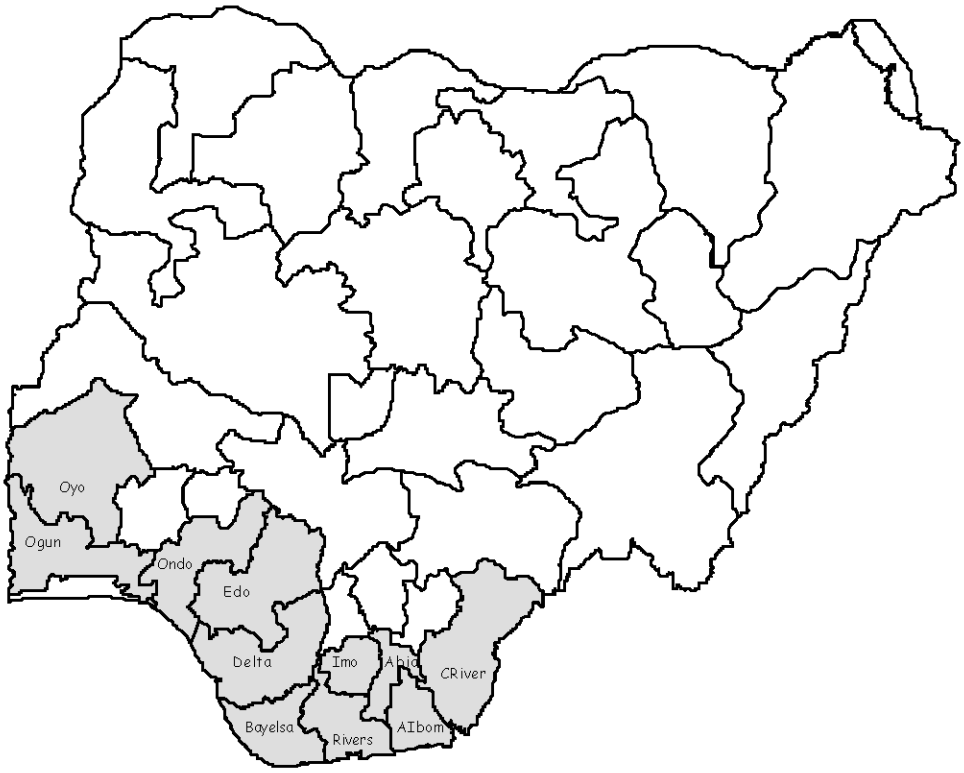

Fig. 1: Map of Nigeria showing the studied area

Table 1: Composition of population and sample

Institution	Total population	No. sampled per institution/individual
Research	6	6
Government agencies	3	3
Technology transfer	7	7
Farmers	110	60
Marketers	20	19
Total	186	95

well as plantain and banana farmers and marketers were sampled. A total of 95 respondents were sampled Table 1 and responses from the most senior and experienced officers working on plantain and banana in these agencies were recorded and analyzed, because they were better able to recall with consistency practices over a long period of time, particularly the study period of 2001-2006. For farmer's and marketer's groups 15 farmers and 5 marketers were sampled in each of the 4 zonal PRTC state.

A validated structured questionnaire and interview schedule was used for primary data collection. Data were collected on capacity development, resource capabilities, learning and learning alliances among stakeholders in the innovation system. The variables measured include manpower resources (frequency of B.Sc, M.Sc, Ph.D and other staff categories available to each stakeholder group); trainee profiles (frequency of B.Sc, M.Sc, Ph.D and other trainee categories handled by each stakeholder group); percentage contributions of each stakeholder was calculated as:

$$\text{Stakeholder} = \frac{\text{Stakeholder score}}{\text{Grand total}} \times 100$$

For

$$\text{Research group} = \frac{\text{Research score}}{\text{Grand total}} \times 100$$

$$\text{Government agency} = \frac{\text{Government score}}{\text{Grand total}} \times 100$$

while

$$\text{Technology transfer} = \frac{\text{Technology transfer score}}{\text{Grand total}} \times 100$$

Adoption was taken as acceptance and continuous use of a technology for economic return, therefore adoption status was calculated as:

$$\text{Awareness (\%)} = \frac{\text{No. with knowledge}}{\text{Total No.}} \times 100$$

$$\text{Adoption awareness ratio} = \frac{\text{Aware (\%)}}{\text{Pr atice (\%)}}$$

$$\text{Adoption (\%)} = \frac{\text{No. using technology}}{\text{Total No.}} \times 100$$

Factor analysis and probit model were used to predict the probability of association among stakeholders and their contribution to innovation availability and use. The statistical package for the social sciences (SPSS, 10) was used for data analysis.

RESULTS AND DISCUSSION

Assessment of the existing framework for plantain and banana innovation system in Nigeria: The existing framework of plantain and banana innovation system in Nigeria (Fig. 2) has five elements (Research and training, market, enterprise, diffusion and infrastructure recommended by CTA (2005), but the coherence needed to stimulate innovation is non-existent, thus leaving a major gap that needs to be filled as shown by Faturoti *et al*. (2007) in the review of policy acts and initiatives in plantain and banana innovation system in Nigeria. The framework was based on the assumptions that research develops the technologies (Technology development), sets up demonstration plots at the PRTC's from where it is expected that end-users will pick the technologies indirectly from the fallout of operations at the four Plantain Resource Training Centres (PRTC) located in different ecological zones of Nigeria (study area), the study reveals that many of the technologies disseminated to the PRTC do not go beyond their trial plots to the end users (farmers and private sectors). The assumption will only work when the difference in the technology promoted compared to existing ones are clearly evidence, as adoption is a copying process that can only be rewarding if the trial is positive and visibly superior to existing technology (Faturoti *et al*., 2006). The gap between research (technology generators) and end users was so wide that the gains of the innovation diminished before adoption especially where the demonstration plots were not well managed. The needed support to guide the stepwise adoption process is clearly not there as interactions are unidirectional and closed (Conley and Udry, 2001). The basic snag in this framework is that the diffusion of the technologies depends on the narrow actors (extension) at the PRTC, who sometimes are

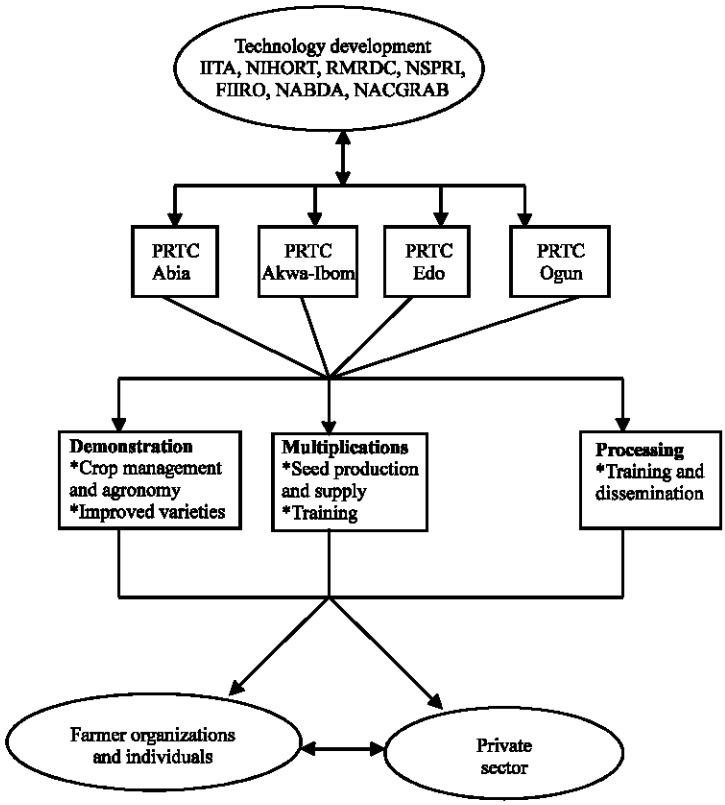

Fig. 2: Existing IITA operational frameworks for plantain and banana development in Nigeria (Field Survey in 2007)

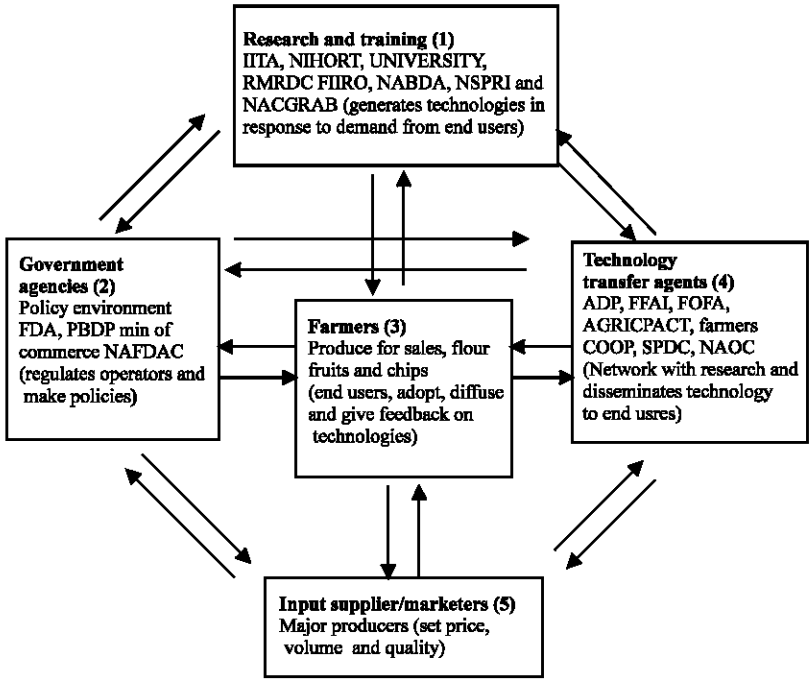

Fig. 3: Framework for analysing plantain and banana innovation system in Nigeria

not fully equipped to answer questions relating to the technicalities of the innovations. Where the PRTC operators fails to follow the package of recommendation and organise field days to showcase the technologies at the boom stage then the whole dissemination process gets stocked.

Remodelled framework for plantain and banana innovation system in Nigeria: This model (Fig. 3) is concerned with the development and operations of interconnectivity among the stakeholders in shaping plantain and banana innovation in Nigeria, (learning alliances, competition and complementarities). It also has the five elements (Research and training, market, enterprise, diffusion and infrastructure) recommended by CTA (2005), for innovation studies.

The framework is based on the understanding that demand for technology by end-users (farmers/marketers) stimulates innovation generation by research institutes who have the mandate to generate technologies that will be adaptable to farmers (who are the major agents in the innovation system). Thus, an increased potential for generated technology adoption since the felt needs are addressed. The multi dimensional arrows signified that assistance on technology usage can be sought from any stakeholders in the system without any mandate restriction which hampers technology progression in on farm delivery approach of REFILS. Technology generation and use in the concept involved more than the researchers and farmers, it includes government agencies, whose duties are to make policies and regulate commercial activities resulting from the innovation system while technology transfer agencies play advisory roles within the system, they are responsible for technology acquisition and dissemination. The input suppliers/marketers also set price and stimulate volume of production through their feedback to farmers and other agents in the system. Here, technology is viewed within the system as commonwealth as such, adoption process receives a boost through the multi-stakeholders approach where all members of the framework can relate with each other and obtain the needed help, without location barrier (Hall *et al*., 2003).

The multi directional arrow is indicative of unimpeded interactions among stakeholders unlike the unidirectional arrow of the existing framework, which is indicative of top-bottom approach which Benor and Cleaver (1989) sought to reverse with training and visit approach of extension delivery. The strategic positioning of the end-users of technology (farmer) in the centre is indicative of innovation demand drive originating from the end users to which research and extension (innovation supply group) will respond. Thus, innovations are generated based on demand which will facilitate immediate adoption and diffusion of technology in the innovation system.

Capacity development and stakeholder technological capability potentials in plantain and banana innovation system

Manpower resources: Table 2 shows the categories and academic levels of staff in the various organizations that comprised the stakeholders' groups in banana and plantain innovation system. A breakdown of staff and categories revealed that IITA (20.1%) had the highest number of workforce engaged in plantain and banana among the stakeholders, followed by Akwa-Ibom ADP in the technology transfer group (12.1%). Other stakeholders also contributed various categories of workforce as shown in Table 2. Contribution of the research group to the workforce was 43.1%, technology transfer group 47.1%, while the government agencies involved in plantain and banana innovation system contributed 9.8% of the total workforce in the innovation system. Assessment of the resource availability in terms of innovation generation and development, as revealed by data in Table 2, showed that the research agencies had the highest number of staff with Ph.D (61%). These are capable of stimulating, designing and generating innovations on plantain and banana. The percentage of staff with Ph.D in the system from technology transfer group was 26% while government agencies contributed 13% of staff with Ph.D. The result shows that there is high probability for new technologies in the system to originate from research. The result though expected, will need to be applied with caution as Hall *et al.* (2001) had indicated the need to avoid the pitfall of on farm technology delivery system characterized by top-down approach.

The trend is a little different in terms of availability of middle level manpower with B.Sc and M.Sc degrees in the innovation system. The technology transfer group (61%) had the highest number of staff in this category. The research group had 31%, while government agencies had 8%. This result suggested that for massive learning and adaptation in plantain and banana system, the technology transfer agents have to be strengthened as they are the links between technology generation and utilization and therefore has a major role in generating cohesion in the system (Adesina and Baidu-Forson, 1995; Monge *et al.*, 2008). For other categories of staff in the system, research agencies provided 67.5%, technology transfer (20%), while government agencies provided 12.5%. IITA was identified as the principal contributor of technological capability of the research group; the Institute alone contributed 47% of the total workforce in the research group, which included 29% of the scientist in the system and 50% of staff in the middle level manpower group. This higher percentage contribution of staff in plantain and banana innovation system by IITA may not be unconnected with the high level of funds available to the

Table 2: Distribution of respondents according to technical capability and capacity building

	Staff profile							Trainees profile						
Institute	B.Sc	M.Sc	Ph.D	% Ph.D	Others	Total staff	% total staff	B.Sc	M.Sc	Ph.D	% Ph.D	Others	Total trainee	% total trainee
IITA®	10	7	4	17.4	14	35	20.1	0	8	2	67	2	12	1
MOCA®	1	1	1	4.35	2	5	2.9	0	0	0	0	4	4	0
RMRDC®	0	1	1	4.35	3	5	2.9	0	2	1	33	0	3	0
UI®	4	0	2	8.7	0	6	3.4	0	0	0	0	0	0	0
NIHORT®	3	2	3	13	8	16	9.2	35	10	0	0	17	62	3
UNN®	2	3	3	13	0	8	4.6	2	3	0	0	0	5	0
Total®	20	14	14	60.9	27	75	43.1	37	23	3	100	23	86	4
NABDA(G)	0	3	1	4.35	0	4	2.3	0	0	0	0	0	0	0
PBDP (G)	2	3	0	0	2	7	4.0	0	0	0	0	0	0	0
NAFDAC (G)	0	1	2	8.7	3	6	3.4	0	0	0	0	0	0	0
Total G	2	7	3	13	5	17	9.8	0	0	0	0	0	0	0
Abia ADP (T)	4	1	0	0	1	6	3.4	0	0	0	0	5	5	0
Agripact	4	1	1	4.35	0	6	3.4	0	0	0	0	5	5	0
Akwa Ibom ADP	19	1	0	0	1	21	12.1	130	0	0	0	875	1005	46
Edo ADP	3	2	0	0	2	7	4.0	20	0	0	0	980	1000	46
Ogun ADP	0	9	0	0	1	10	5.7	5	0	0	0		5	0
FFAI	11	0	3	13	0	14	8.0		0	0	0	45	45	2
NAOC	11	2	2	8.7	3	18	10.3		0	0	0	40	40	2
Total T	52	16	6	26.1	8	82	47.1	155	0	0	0	1950	2105	96
Grand total	74	37	23	100	40	174	100	192	23	3	100	1973	2191	100
% Research contribution	27	38	61	61	68	43	43	19	100	100	100	1	4	
% Govt agency contribution	3	19	13	13	13	10	10	0	0	0	0	0	0	
% Tech.transfer contribution	70	43	26	26	20	47	47	81	0	0	0	99	96	

Source: Field Survey in 2007

institute and its international status which gives it the global recognition for plantain and banana work in tropical Africa. Also, the need to justify donor's funds and mandates contributed to the Institute's leading role in the innovation system and technological capability (Ortiz, 1997).

Identification and examination of the levels of adoption of technology developed in plantain and banana innovation system in Nigeria: A sample of innovations developed and disseminated revealed that 15 technologies were developed and widely disseminated among the stakeholders in the innovation system (Table 3). The data also revealed the innovations developed, institution of development, year of first dissemination, year of awareness, awareness status and adoption status as well as awareness/adoption ratio. The results in Table 3 revealed that there was a time interval between innovation development, dissemination and awareness; it also showed marked difference in awareness and adoption status. Furthermore, the table revealed that extension (ADP/NGO) was the highest disseminating agents of these technologies. This result is in agreement with many authors on the facts that technology goes through a period of acquisition, adaptation, dissemination, adoption and diffusion; it also confirms the stepwise nature of adoption (Longo, 1990; Lindner *et al*., 1979; Rogers and Kincaid, 1981). The highest adoption level 82 and 62% recorded for new varieties and pruning may not be unconnected with the degree of need of the stakeholders for black sigatoka resistant varieties which was noted to be massively disseminated in the innovation system, in the same vein black sigatoka symptom is basically visible on leaves and spread from leaf to leaf, hence any technology that will slow down or presented to reduce the disease spread had a better potential for adoption in the system.

Stakeholders classification based on their actions in the innovation system: Factor analysis was carried out to see the classification and loadings of each stakeholder on the innovation system as regards technology generation. Analysis of data shows that 18 stakeholders exerted varying degrees of variance on the system. IITA had the highest variance 38.63%, NIHORT 12.08%, NSPRI 10.13%, FIIRO 5.52%, NABDA 4.68%, university 4.23%, FDA 3.88%, FMC 3.72%, PBDP 3.06%, NAFDAC 2.52%, RMRDC 2.42%, NGO 2.09%, plantain and banana coop 1.79%, ADP 1.56%, NAOC 1.10%, SPDC 0.78%, plantain marketers 0.14% and plantain consumers 0.10%. The result revealed IITA, NIHORT and NSPRI as the major technology generating agencies in plantain and banana innovation system In Nigeria. Though all the stakeholders have some degree of variance, some were not strong enough to foster cohesion (Table 4).

The component classification shows that the agents in the innovation system were grouped into 5 classes according to their activities in the system. The 5 classes and agents were; class 1-IITA, NIHORT, NABDA, FIIRO, RMRDC, NAFDAC and university. Majority of the agents in this class are research stakeholders that generate technologies, though NABDA and NAFDAC were hitherto classified as government agencies for policy regulation, they nonetheless participate in technology generation. Those in class 2 (FDA, PBDP, NSPRI and FMC) are basically government agencies responsible for policy formulation and regulation, they loaded together showing similarity in their actions. The third class which included NGO's, plantain and banana cooperative, plantain and banana consumer, basically were consumer of technologies. While NGOs were involved in technology transfer, the others are end-users of technologies. The fourth class included, plantain marketer, NAOC and SPDC, the group comprised mainly oil-producing companies whose efforts were directed

Table 3: Technology development, awareness and dissemination/adoption status

Innovations developed	Institution of development	Dissemination year	Main agency of dissemination	Main year of awareness	Awareness (%)	Adoption status (%)	Adoption/ Awareness ratio
New varieties	IITA	1999	Extension	2001-2007	85	82	0.96
Planting time	NIHORT	1999	Extension	2001-2007	67	32	0.48
Type of sucker	NIHORT	1997	Extension	2001-2007	92	50	0.54
Hot water treatment	IITA	1999	Extension	2001-2007	92	27	0.29
Spacing	NIHORT	1999	Extension	2001-2007	82	56	0.68
Pruning	IITA	2000	Extension	2001-2007	72	62	0.86
Mulching	UNIVERSITY	2000	Extension	2001-2007	73	35	0.48
Fertilizer	UNIVERSITY	1999	Extension	2004-2007	38	29	0.76
Post harvest	IITA	2000	Extension	2004-2007	58	30	0.52
Weeding	UNIVERSITY	1996	Extension	2004-2007	35	15	0.43
Sucker multiplication	IITA	2003	Extension	2004-2007	68	47	0.69
Debudding	IITA	2000	Extension	2004-2007	55	48	0.87
Desuckering	IITA	2000	Extension	2004-2007	55	28	0.51
Herbicide	UNIVERSITY	2000	Extension	2004-2007	52	35	0.67
Staking	NIHORT	1996	Extension	2004-2007	50	45	0.90

Source: Field Survey in 2007

Table 4: Stakeholders contributions to technologies generation in the system

	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
Stakeholder	Total	Percentage of variance	Cumulative (%)	Total	Percentage of variance	Cumulative (%)	Total	Percentage of variance	Cumulative (%)
IITA	7.340	38.633	38.633	7.340	38.633	38.633	6.402	33.693	33.693
NIHORT	2.296	12.084	50.717	2.296	12.084	50.717	2.350	12.370	46.062
NSPRI	1.925	10.130	60.846	1.925	10.130	60.846	2.169	11.413	57.476
FIIRO	1.050	5.526	66.372	1.050	5.526	66.372	1.690	8.896	66.372
NABDA	0.889	4.681	71.053						
University	0.805	4.236	75.289						
FDA	0.737	3.880	79.169						
FMC	0.709	3.732	82.901						
PBDP	0.582	3.063	85.964						
NAFDAC	0.479	2.520	88.483						
RMRDC	0.460	2.423	90.906						
NGO	0.398	2.092	92.998						
P and BCOOP	0.341	1.793	94.791						
ADP	0.297	1.565	96.356						
NAOC	0.211	1.108	97.464						
SPDC	0.149	0.785	98.250						
Pl/Marketer	0.143	0.753	99.003						
Pl/Consumer	0.102	0.539	99.542						
			100.000						

Extraction method: Principal component analysis

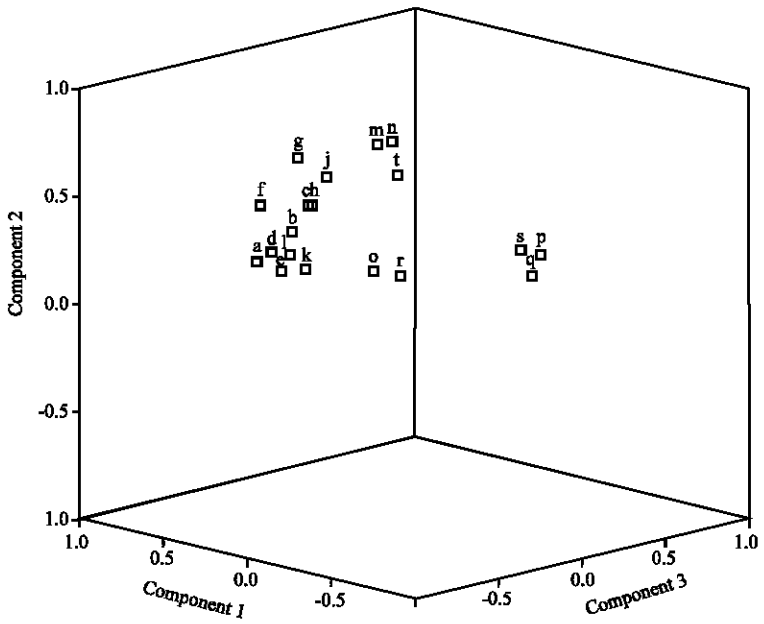

Fig. 4: Stakeholders' component plot in rotated space

towards marketing agricultural produce in their host communities. Therefore, this loading with plantain marketers was not unexpected. The last class in the series comprised the ADP and plantain farmers, whose actions too are complimentary as technologies in the innovation system are directed mainly at them (Fig. 4). This loading revealed that cohesion can be generated through improved interactions and strengthening of agents with similar actions in the innovation system. A public–private partnership can also be generated and fostered within the innovation system to stimulate its functionality and encourage complementarities (Van Der Meer, 2002).

Examination of linkages existing among key actors in plantain and banana innovation system: The 18 stakeholders identified in the study and classified into 5 categories as farmer, research, government agencies, marketers and technology transfer agents, were subjected

Table 5: Percentage distribution of stakeholders linkage strength and functional analysis

	Farmers		Marketers		Govt. agencies		Extension		Research				
Stakeholders	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	TNFT	TFT	NFTL	Lindex
IITA	45.0	55.0	26.3	73.7	66.7	33.3	100.0	0.0	50.0	50.0	288.0	212.0	57.6
NIHORT	11.6	88.4	10.5	89.5	66.7	33.3	42.8	57.2	49.9	50.1	181.5	318.5	36.3
NSPRI	5.0	95.0	0.0	100.0	33.3	66.7	72.0	28.0	33.3	66.7	143.6	356.4	28.7
FIIRO	1.6	98.4	0.0	100.0	33.3	66.7	0.0	100.0	49.9	50.1	84.8	415.2	17.0
NABDA	1.6	98.4	0.0	100.0	33.3	66.7	14.3	85.7	49.9	50.1	99.1	400.9	19.8
UNIVERS	13.3	86.7	94.7	5.3	66.7	33.3	71.4	28.6	100.0	0.0	346.1	153.9	69.2
FDA	18.3	81.7	0.0	100.0	66.7	33.3	71.5	28.6	49.9	50.1	206.4	293.7	41.3
FMC	1.7	98.3	0.0	100.0	0.0	100.0	43.0	57.0	16.7	83.3	61.3	438.7	12.3
PBDP	8.3	91.7	0.0	100.0	0.0	100.0	57.1	42.9	50.0	50.0	115.4	384.6	23.1
NAFDAC	1.6	98.4	0.0	100.0	66.7	33.3	29.0	71.0	84.0	16.0	181.3	318.7	36.3
RMRDC	3.3	96.7	0.0	100.0	33.3	66.7	0.0	100.0	66.6	33.4	103.2	396.8	20.6
ADP	86.6	13.4	53.0	47.0	33.0	67.0	71.4	28.6	84.0	16.0	328.0	172.0	65.6
NGO	15.0	85.0	6.0	94.0	0.0	100.0	85.7	14.3	66.6	33.4	173.3	326.7	34.7
P and B coop	40.0	60.0	27.0	73.0	66.7	33.3	85.7	14.3	49.9	50.1	269.3	230.7	53.9
NAOC	3.3	96.7	63.1	36.9	0.0	100.0	28.6	71.4	33.3	66.7	128.3	371.7	25.7
SPDC	0.0	100.0	89.5	10.5	0.0	100.0	14.3	85.7	33.3	66.7	137.1	362.9	27.4
P and B farm	75.1	24.9	63.1	36.9	100.0	0.0	100.0	0.0	50.0	50.0	388.2	111.8	77.6
P and B market	64.0	36.0	89.0	11.0	33.3	66.7	100.0	0.0	64.0	36.0	350.3	149.7	70.1
P and B cons	58.5	41.5	32.0	68.0	33.3	66.7	72.0	28.0	83.2	16.8	279.0	221.0	55.8
	454.0	1446.0	554.0	1346.0	733.0	1167.0	1059.0	841.0	1064.0	836.0	3864.0	5636.0	772.8
Stakeholders lindex	23.9	76.1	29.2	70.8	38.6	61.4	55.7	44.3	56.0	44.0			40.7
Stakeholder contributions	4.8	15.2	5.8	14.2	7.7	12.3	11.1	8.9	11.2	8.8			

Source: Field Survey in 2007. FT: Functional links, NFT: Non functional links, TFT: Total functional links, TNFT: Total non functional links. Lindex: Linkage index, L

to statistical linkage analysis to ascertain the linkage between them and the major stakeholders groups. The linkage categories were strong, medium, weak, informal and no link. Functional links are those that can facilitate positive result in the innovation system (strong and medium links). Total functional links was 40.7% (Table 5) contributed by all stakeholders in the system. However, contributions from different stakeholders group were as follows; farmers (4.8%), marketers (5.8%), government agencies (7.7%), extension (11.1%) and research (11.2%). The highest contributions were recorded from the research group who was the main technology generating group in the system.

Above average linkage index was recorded from 7 of the 18 stakeholders IITA (57.6%), university (69.2%), ADP (65.6%), plantain and banana cooperative (53.9%), plantain and banana farmers (77.6%), plantain and banana marketers (70.1) and plantain and banana consumers (55.8%). This result suggested that the 7 were the principal stakeholders on which the success and existence of the innovation system rested, the findings confirms (Hall, 2002; Hall *et al*., 2002), that functional innovation system requires principal promoters within the framework.

CONCLUSIONS

The study concluded that an unimpeded interaction by stakeholder in the system is needed to trigger and sustain learning, with the complementarities of technological resources of all stakeholders pooled together for a common goal of technology generation and usage. However, for massive learning and adaptation in plantain and banana system, the technology transfer agents has to be strengthened as they are the links between technology generation and utilization and therefore plays a central role in generating cohesion in the system. A major area of focus is the paucity of high level trainees (0.13%) in the study, this is not supportive of plantain and banana innovation system and thus deserves attention if technology generation will have to continue in the system. IITA, NIHORT and NSPRI were identified as the major technology generating agencies in the plantain and banana innovation system. Though all the stakeholders have some degree of variance, some are not strong enough to foster cohesion in plantain and banana innovation system.

It was concluded that cohesion can be generated through improved interactions and strengthening of agents with similar actions in the innovation system as a result of the reclassification of the 18 stakeholders into five classes according to their actions in the system. Finally, a framework for plantain and banana innovation system should be that with multi-dimensional interactions among stakeholders with the end users at the centre of all actions, this will allow a demand-supply pool that will make technology so generated needed and utilised for greater social and economic benefits in plantain and banana innovation system in Nigeria.

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