

Enhancing Farmers-Led Innovation Processes in Sub Sahara Africa: A Case Study of Nigeria

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Abstract – The literature and research on innovation have in the past mostly described innovation as a linear, top-down process where technology was considered to be generated and then transferred to farmers for adoption. This approach is being challenged recently by the idea that innovation is a non-linear process which encourages the recognition of various actors with diversified knowledge within innovation systems. The combination of the two innovation systems (exogenous and endogenous) is important in enhancing the two-way process of exchanging ideas which would make the farmer's innovation strength to be recognised and improved. Failure to recognise farmers-led innovations would make a shift from the technology transfer (linear) to innovation processes difficult. This is mainly due to better understanding of the farmers on how their environment works. This paper examines various agricultural innovation processes that have occurred five or more years in Kano, Nigeria with particular interest to farmer-led innovation and clear understanding of the sources of ideas and the benefits derived. A workshop (48 participants) and semi-structured interview (40 farmers) were used to collect data for identification of exogenous and endogenous innovations. Some of the questions raised for the actor identification exercise emanate from the Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) tools for actor and innovations identification. Representative innovations were selected out of the exogenous and endogenous innovations identified. Some of the exogenous innovations identified are; sole cropping, strip cropping, close spacing, improved storage, improved seeds, and fertiliser application. The endogenous innovations identified are; mixed cropping, wider spacing, use of pepper and ash, use of local seeds and traditional fertiliser application. Although the data was collected in the same state, there exists some variations in the use of innovation between the two areas. Apart from the exogenous innovations taken to the farmers, they were capable of developing more innovations to satisfy their ecological and economic needs. Both innovations processes were practiced by the farmers simultaneously. The ability of the farmers to modify exogenous innovations was impressive and would promote farmers involvement in various innovation processes.

Keywords- Enhancing, Farmers-Led, Innovations, Processes.

I. INTRODUCTION

The literature and research on extension and innovations have in the past mostly described innovation as a linear, top-down process where technology was considered to be generated and then transferred to farmers for adoption. This approach is being challenged recently by the idea that innovation is a non-linear process which encourages the recognition of various actors with diversified knowledge within innovation systems.

Innovation can therefore be viewed as the means through which individuals and organizations with diversified information and knowledge within the socio-economic and political context interact to develop and modify systems [1]. The conventional model of innovation that involves the generation of technologies through agricultural research and transfer to farmers through agricultural extension has been challenged by the agricultural innovation system.[2] on the other hand, defined innovation as the creation of brand new ideas of social and economic value that combines with existing elements. They also considered it as the process of technical, institutional, policy and managerial improvements in a continuous upgrading process.

In discussions on issues related to innovation processes especially at the farmers' level, reflection on different roles of National Agricultural Research and Extension Services (NARES) in agricultural development forms the basis of understanding the earlier approach in establishing a link between farmers and other actors within the agricultural sector. Agricultural development and improving the quality of people's life in Nigeria and other developing countries depends to a great extent on the viability of the NARES. The Federal Government of Nigeria's investment in NARES is tantamount to the achievement of much needed progress in agricultural development. The World Bank provide loans to Nigeria's agriculture, specifically to Agricultural Development Projects (ADPs) and research institutions for carrying out research, extension and rural development services.

In the process of explaining the consequences of agricultural changes in the global context, [2] and [3] found the challenges faced by NARS and Agricultural Knowledge and Information Systems (AKIS) in Sub-Saharan Africa due to globalized changes in agricultural and other related sectors are increasing, despite the roles they have played in improving agricultural technology. In an attempt to overcome the challenges faced by NARS and AKIS, various innovative-based groups at national and international levels within governmental and non-governmental organisations are constantly looking for alternatives to the conventional, linear process of technology transfer. This can be achieved according to [1] by emphasising the need for interactive developmental approach out of the increasing economic growth and demographic pressures, in addition to the constant entry of new market forces and actors. Moreover, creative potentials of all the research and development actors including farmers have been recognised through the opportunities provided by human behaviour and current insights into socio-cultural realities. The key to success in

agricultural research and development among individuals and organisations are centred on better understanding of the current innovation processes, in addition to identifying the ways of catalysing the processes and how they can be supported.

These transformations are supported by pointing out that the interplay of ideas from multiple sources could lead to the emergence of innovation. Generation of useful ideas across the world is increasingly important in encouraging diverse actors to work together and transform these ideas and products from different sources into innovations that are beneficial to thousands of resource-poor farmers. Innovation processes can promote agricultural sustainability in the rapidly changing agricultural conditions. Systems of interactive players and individuals are needed at the grassroots and global levels for enhancing innovation processes. For farmers to take the lead in such collaborations, their capacities need to be strengthened and changes within organisations, institutions and their policy need to be advocated at all levels [4].

[1] Argue the convergence of different agricultural components in developing countries would lead to increase in production, thereby reducing poverty among the rural people. [1] observed that despite the high engagements of rural people in agricultural activities of Sub-Saharan Africa, the contribution of agricultural components of research, extension and education are unexpectedly low. To overcome this and other serious problems facing effective performance of agricultural components and explore new opportunities, emphasis should be given to innovative systems which provide avenues for more actors, market forces and other technologies to participate with high economic drives.

It has been illustrated in various literatures that integration of different ideas about radical shifts from traditional studies of technology transfer to non-linear innovation process is important for understanding the challenges facing agricultural development of Sub-Saharan Africa. In addition to this, consideration on the high population increase and excessive competition is equally important for effective utilisation of agricultural resources. The appropriate means of achieving this and increasing productivity involves farmers in various decision making processes, and makes them realise the ways of manipulating and combining the various techniques involved in both scientific and indigenous knowledge.

According to [5] policy and institutional fields of innovation systems in Nigeria are blurred in relation to level of interactions and connectivity in the agricultural sector. The innovation potentials in Nigeria are impaired as a result of little or no interaction among the actors involved in innovation systems. In related findings [5] emphasised that Kano State (Nigeria) innovation system comprises disjointed platforms of various crop and livestock production. Linkages between various organisations like Governmental, Non-Governmental, Private sector and communities are unclear.

It is important to note that no single individual or organization can acquire all the needed resources and

potentialities in meeting the needs of society. It therefore becomes imperative for them to integrate with different actors that can bridge the gaps of knowledge and insufficient resources. Integration of various actors in establishing a strong network which is capable of providing sufficient resources and exploring different potentials determines the success to which innovation processes are accomplished. Establishing a strong network that can integrate various actors is increasingly difficult to achieve in SSA based on the diversification in resources and constant changes in agricultural policies, which result in difficulties for monitoring and evaluating the systems, consensus on trust, rules and procedures.

From the discussions above, it is clear that innovation can also be explained as the process of introducing new things into the environment, with particular interest in the social and economic process. It entails a process of incorporating new ideas into existing economic and related systems. In addition to considering innovation as new products, new processes, new forms of organisation and results of the outcome of the actor's interaction, this paper also views innovation as the way these elements are modified to suit an existing situations. This view is particularly important when considering grass root innovation that enables farmers to develop new ideas, or at least to positively change/modify and assimilate the external ideas brought to them, to be compatible with their existing farming situations.

The study of innovation processes in Nigeria and other Sub-Saharan Africa countries centred on research and development, with little or no emphasis on the farmer's innovation processes. According to [6] there exists a great disparity between the farmer (endogenous) innovation systems and science and technology based innovation systems (exogenous). Such differences led to the failures of formal (exogenous) innovation systems to recognize the ability of resource poor farmers to persistently innovate with the use of traditional resources available. The main objective of this paper is to consider the innovation processes in the area with particular interest to farmer-led innovations in the last five or more years. While the specific objectives are to;

- Identify the actors involved in innovation processes in the last 5 years or more.
- Describe the innovations that occurred in the last 5 years or more.
- Analyse the sources of innovation ideas and the benefits derived from the innovation.
- Assess the linkages among the innovation actors.

II. LITERATURE REVIEW

The two generic sources of innovation in agriculture are the informal (endogenous) system of experimentation and selection, and the formal (exogenous) system of research and development. The formal system is connected to national and international sector organisations. The key point is to consider how the two approaches to innovations (i.e. central and multiple source models) are interlinked. The central source model emphasises the theoretical and

rhetoric concepts of formal agricultural research and extension institutions, where major technical, institutional and social innovations evolved from the systematic work of international research centres. The multiple source innovation models on the other hand, embrace natural and farmer selections, and consider agricultural research and diffusion processes within various political, economic, institutional and historical contexts through which technological changes occur. Thus, innovations have evolved from various sources of farmers, international centres, extension staff, national research systems and non-governmental organisations [7].

Natural and purposive selections are the main processes through which agricultural innovation emerges [8]. Innovation is considered as a spontaneous activity through which technology is developed, adapted and transferred across producers. Human migration is another important source which enhances technologies transfer. These processes were adhered to in developing countries for centuries as the reliable source of technology innovation among small-scale farmers, with little concern about complementing this through formal systems of research-based innovation.

The formal (exogenous) systems evolved in the 18th and 19th centuries during the industrial revolution of developed nations, which encouraged the use of science and technology in agricultural research. The initiation of the Green Revolution in the mid-20th century was the turning point for the spread of organized agricultural research systems in developing countries. The Green Revolution was achieved through scientific research that facilitates the transfer of some crop varieties for adaptation from one region to another. It has recorded remarkable achievements in developing countries as research that is related to public sector [9]. The formal agricultural innovation system has been the major instrument for poverty reduction and increased agricultural productivity, achieved through the transfer of technologies, particularly new seeds and rapid changes in the public sector.

The formal and informal innovation systems discussed form the basis of understanding what is local or external within an innovation system. The combination of the two innovation systems is important in enhancing the two-way process of exchanging ideas which would make the farmer's innovation strength to be recognised and improved. Failure to recognise innovation potential of resource - poor farmers would make a shift from the technology transfer (linear) to innovation processes difficult. This is mainly due to better understanding of the farmers on how their environment works. The argument is supported by [4] who suggested that determining what is local or external is a way of understanding innovation systems within the institutional mixture. Variation in innovation systems across localities can occur within countries, but significant features of innovation systems in all countries are mainly the local variations at different innovation levels, adoption and diffusion of technology and institutional mix.

To establish a link between the two innovation systems (exogenous and endogenous), understanding the farmer's

innovation strength, clear explanation of grassroots innovation is useful which promotes the combination of the two systems in many ways. The mutual benefits of the two systems would encourage effective use of the available resources in rural communities.

[10] Describe grassroots agricultural innovation as 'interface of endogenous and exogenous innovation in the farming systems of small-holder farmers'. All interventions in the local innovation system, according to [10] that are developed and controlled by research, extension, financial organisations and the private sector (outsiders), aimed at improving environmental and local livelihoods through introducing new technology, institutional mixtures, methods, services, products, processes, are considered exogenous agricultural innovations.

[4] and [11] discuss three modes of University-Industry Linkages collaboration in Nigeria, with agro-food processing as the principal agent driver. The collaboration of universities and agro-food firms in Nigeria to enhance innovation capacity has recorded achievements in working together to promote links between research-led and community-led initiatives. The University of Agriculture Abeokuta (UNAAB) – Nestlé soybean popularisation and production project in 1999 was identified as a successful demand-driven innovation process. Although the linkages were established by the Nestlé Company, farmers were the central focus, as the main objective of the linkages was to increase the soybeans production, capacity of the farmers to meet the quality required by the industry, which would in turn improve the farmers' socio-economic status. Other specific objectives of the project were to popularise and integrate soybean production into the existing farming systems of the region; to ensure continuous production of soybeans that would meet the quality standard needed by Nestlé Nigeria and ultimately to generate income to farmers through soybeans production, thus improving their welfare.

Another university – industry linkage identified by [4] and [12] is the cassava flash dryer project which was considered as a multi-stakeholder problem-based project, involved a privately - own integrated farm, a cassava processing factory, three Nigerian universities and the Raw Material Research and Development Council. The project was designed to promote cassava production and processing through fabricating a cassava flash dryer, which would consequently improve innovation capacity in the agro industry.

In wider institutional linkages, cocoa innovation systems (cocoa re-birth initiatives) were developed to promote interactions between cocoa farmers, processing firms, cocoa research institutes and national cocoa development committee in Nigeria. Constant review of the activities of these actors and active participation in the project may strengthen value addition in cocoa re-birth innovation [12].

In addition to establishing linkages among various innovation actors through University-Industry linkages in enhancing innovation processes, capacity building is considered useful in providing opportunities for linking

research-led and community-led projects. This is relevant to agricultural development of SSA not only in encouraging farmers' participation in scientific based research but promoting grassroots innovation.

Discussions on innovation capacity according to [4] have recently emphasised the two major tasks of capacity development in many countries working to create scientific and rural actor networks around research and development themes. Those two tasks involve establishing a link between the networks to make research beneficial for rural innovation. This is based on the assumption that interventions which strengthen the links between research-led and community-led projects could be cost effective, in addition to achieving high returns and satisfying the needs of the poor.

III. METHODOLOGY

The area where the research was conducted, the tools used for collecting data, criteria and selection procedures for research participants, status of the participants and accessibility to the research area are clearly explained in this section.

3.1 Research approach/method: case study

Why use case studies?

[13] describes the following situations as appropriate to the use of case studies;

- 'how and why' research questions are being posed
- the investigator has little control over events
- the focus is on a contemporary phenomenon within a real-life context

The case study approach was used in this study, as it involves an in - depth analysis of a particular case (Kano-ADP Zones). Popular studies in the field of sociology are built on case studies. Research into a single community, school, family, organization or event is related to case study.

[13] defined case study as; '*empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life contexts, especially when the boundaries between phenomenon and context are not clearly evident*' (p.18).

He further emphasized the use of case studies as highly challenging for research purpose in all endeavors of social science. The use of case study as a research method has been expanded to contribute to understanding of individual, group and other phenomena related to organization, politics and social settings.

3.2 Description of the research area

The workshop was conducted in ADP headquarters and the semi-structured interview was carried out in the two ADP zones of Kano State. It is located in the North Western part of Nigeria on latitude 11° to 34° N and longitude 8° to 34° E, and 472.45 meters above sea level. It has a total land area of 20,760 square kilometers and is predominantly inhabited by Hausa and Fulani ethnic groups. According to [14] it had a population of 9,383,682, with 4,844,128 males and 4,539,554 females. The ecology is typically that of Sudan Savannah vegetation, with average annual rainfall of 700mm,

although the amount and frequency vary in distribution across the state. There is significant variation in temperatures in the state, with minimum of as low as 15° C and maximum of 35° C, in March/April and December/January respectively [15].

3.3 Participants Selection

The workshop held to identify innovations and actors involved, 48 participants were purposively selected and attended the workshop, 30 of the participants were farmers (25males and 5 females), 6 extension agents (4males and 2 females), 3 Agro-dealers (2males, 1 female), 4 staff of IITA and ICRISAT and 5 staff from Bayero University, Kano. Ten farmers were purposively selected from each of the three ADP Zones (I, II and III). The selection of the farmers was based on their experiences in farming practices, contacts with fellow farmers and other agricultural related organizations. Similarly, three extension agents and one agro-dealer each were purposively selected from the three zones. Inclusion of staff from IITA, ICRISAT and Bayero University, Kano was to ensure wider institutional linkages and provides inputs in discussions on the formal innovation systems in the state, the constraints on agricultural production and possible solutions. In addition, 40 farmers were randomly selected from two ADP zones for semi-structured interview to find out whether variation exists between localities.

3.4 Rapid Appraisal for Agricultural Knowledge Systems (RAAKS)

RAAKS was considered by [16] as a designed system and participatory action research method, particularly useful in bringing together issues related to social learning that are relevant to understanding innovation processes, and then designing various strategies that can be used in improving the innovations in practical situations. He further emphasized that RAAKS is designed under certain recognized principles that are mainly procedural and analytical, which in turn are characterized as a soft systems methodology. Procedural design is capable of providing relevant steps to use a soft systems inquiry in addressing beneficial issues for understanding participatory action research and rural appraisal. The analytical design on the other hand helps in studies of felt problems and social organization that surround them in innovation context. [16] therefore describes RAAKS as a useful research methodology that focuses on the social organization of agricultural innovation through explaining the status of Agricultural Knowledge Information System (AKIS) and facilitating agricultural innovation.

3.5 Procedures and tools for data collection

The workshop was organized for the purpose of identification of formal and informal innovations, in addition to the innovation actors in Kano State. Representative innovations were selected from the formal and informal innovations identified. The criteria for such selections involved ranking of the innovations based on 3 factors; their usefulness, intensity of use and modifying or changing the innovations. Some of the questions raised for the identification exercise emanate from the Rapid Appraisal of Agricultural Knowledge Systems (RAAKS)

Window A2 (A RAAKS Resource box – Tools 3) for actor identification and whether they are the key actors or not. Ranking of the key actors and the opinion of the participants formed the basis for understanding the contributions of the innovations considered for agricultural development in the state. Roles played or to be played by such innovation system actors were determined through understanding the development and/or modifications achieved and to be achieved. The process was repeated for two of the representative innovations selected.

Actor linkage matrix was used to find the intensity of contact between various actors in relation to information exchange. Scores of 1 – 5 were used, with 1 for very frequent, formal and informal and 5 for hardly any contact, neither formal nor informal.

IV. RESULT AND DISCUSSIONS

The mean age of the participants was 43 years, with majority (68%) falls within the age bracket of 40 – 50 years. Considering the age of the farmers, it was no wonder that they had a mean of 25 years of experiences in farming. Virtually all the farmers started agricultural activities at the age of 10. On the other hand, the extension agents had a mean of 18 years of working experiences which shows that most of them were engaged in extension work just few years after the organisation (ADP) was established. The educational status of the farmers participated in the workshop was very low, with only 14% had tertiary education, 37% with secondary school education. All the extension agents attended the workshop had one form of post-secondary school qualification or the other, exposed to various extension training skills. The establishment of three staff training schools in the three ADP zones of the state in 1983 provided an opportunity for the then recruited secondary schools certificate holders to have more extension skills. The mean farm size of the farmers was 3 hectares and the farmlands were normally obtained through inheritance. The farmers claimed contact with extension agents on weekly basis and had attended some trainings/workshops in the state ADP and other agricultural organisations. Although the number of women farmers in the workshop was low, they were actively engaged in the discussions.

Table I: Identification of exogenous and endogenous innovations in Kano – State in the last five or more years

Exogenous innovation	Endogenous innovation
1) Sole cropping	Mixed cropping
2) Strip cropping	
3) Close spacing	Wider spacing
4) Improved storage (PICS)	Use of pepper and ash in storing cowpea
5) Improved seeds	Use of local seeds
6) Double planting	Single planting
7) Fertiliser application	Traditional fertiliser application
8) Striga control	Planting soybean to control striga on maize and cowpea fields and Use of Powered striga to control striga
9) Compost making	
10) Use of herbicide	

Source: Survey data, 2012.

From table I above it can be seen that there were endogenous (informal) innovations in addition to exogenous (formal) innovations in the state. This is supported by [4] who states that determining what is local and what is external within the institutional mixture is the way of understanding innovation systems. He further emphasised the need for an open system which encourages constant creation, with the changing and adapting of new actors and institutions. Similarly [10] describes the grassroots innovation as a mixture of endogenous and exogenous innovations within the localities. The farmers expressed their abilities to modify/change some of the exogenous innovations to suit their farming needs and improve their livelihoods.

Improved sole cropping system as described by the farmers was introduced by the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) to enhance mechanisation and efficient commercialisation of most desirable crops. The farmers emphasised the profitability of that system when considering the amount of yield obtained from crops that are grown for cash and food like cowpea at the end of the growing season. However, some farmers argued about the need to produce other cereals like maize in large quantities for consumption, and also cereals that are economical for small holder farmers with inadequate land.

Strip cropping is practiced as an improved intercropping system for higher yields of legumes and cereals. The system facilitates intensive cultivation as well as optimum utilisation of fertiliser and insecticides. The planting pattern promoted was 2:4 cereals – cowpea, aimed at increasing farmers' income, improving soil fertility through crop rotation ensuring that crops did not fail to reach maturity. With this practice the yields were relatively higher and the land utilisation was assured.

Close spacing of 12cm within the row was recommended and encouraged by the IITA as against wider spacing of up to 26cm in traditional cropping systems. The farmers explained that the practice has doubled their yields and enhanced utilisation of the farmlands. Use of triple bagging for cowpea storage (PICS- Purdue Improved Cowpea Storage) was introduced to West Africa by Bill and Melinda Gates Foundation in 1997, aimed at providing an effective means of storing cowpea without the use of chemicals.

Other formal (exogenous) innovations identified during the workshop were the improved seeds of cowpea and cereals developed by IITA, other institutes and Universities in Nigeria. They were characterised by high yield, early maturity, being disease resistant and having market value that the cowpea thrives well in various agro-ecological zones of Nigeria. The seeds are being promoted by extension agents from ADPs, seed companies and farmer groups. The farmers were encouraged to practice crop rotation between legumes and cereals for improving soil fertility. It was further observed that some of the informal innovations identified evolve from the modifications/changes of formal innovations for increase in agricultural production. Triple bagging initially for cowpea storage was later used by the farmers for storing

maize and it was found to be effective. This may probably due to less susceptibility of maize grains to insect attack when compared with cowpea. Wood ash have been an effective means of storing cowpea by the farmers in this study area as shown by the findings of [17]. Although, the ratio of ash to cowpea varies from 2 or 3 parts ash to 3 or 4 parts cowpea, the practice according to [17] requires thorough mixture of the two and use of enclosed container. In related findings [18] argued the use of ash is effective in storing cowpea, but should be used in small quantity, as it requires more labour and cowpea stored in wood ash are not considered hygienic by some consumers. The application of herbicide for controlling striga has been

modified and extended to other farmers, while some farmers introduced the use of powdered striga for controlling striga weeds.

The following exogenous (formal) and endogenous (informal) innovations were considered by the participants as representative innovations. The selections were based on the usefulness and whether the innovations have widely been used by farmers.

1. Use of improved seeds (formal).
2. Spacing (formal and informal).
3. Improved storage (formal and informal).
4. Fertilizer application (informal and informal).

Table I (a): Description of the exogenous (formal) innovations identified

Exogenous Innovation	Description
1) Sole cropping.	<ul style="list-style-type: none"> • Devoting the whole farmland for the production of single crop. • Crop rotation practices between cereals and legumes were encouraged.
2) Strip cropping	<ul style="list-style-type: none"> • Started with 2 rows of planted maize to 4 rows of planted double cowpea in the first year. • Intra- spacing for cowpea – 20cm. Intra-spacing for maize – 25cm (under high soil fertility), 20cm (under low soil fertility). • In May/June the first cowpea was planted with maize on the same day. The cowpea was harvested in 60 days. The second cowpea was then planted in between the rows of the harvested cowpea and the standing maize. • Maize was then harvested in the late September, while the second cowpea was harvested in late October or early November.
3) Close spacing	<ul style="list-style-type: none"> • Planting the seeds 12cm within the rows. • Encourages early thinning to avoid competition. • Spacing between the rows varies between crops and soil fertility.
4) Improved storage.	<ul style="list-style-type: none"> • Entails the use of high density polyethylene bags of 50 – 100 kg capacity to store threshed cowpea. • The thickness of the polyethylene bags is 80 microns, thus highly impermeable to deter the infestation of bruchid for a year or more. • After filling the first inner bags completely with threshed cowpea, except for air pockets, it was tied carefully at the neck. • The first bag was surrounded completely by the second layer bag, which was tied accordingly and the two bags were placed inside the third polypropylene/woven nylon for absolute protection against rodents.
5) Improved seeds.	<ul style="list-style-type: none"> • The improved seeds supplied according to farmers depend on the project introduced, taste and preference, market value and location. • For strip cropping; some of the cowpea varieties introduced for first planting are: IT81D-1010, IT98K-205-8, and IT99K-1245. Maize – Hybrids, Long or medium were used. • Most of the seeds were accompanied with specific fertilizers.
6) Double planting.	<ul style="list-style-type: none"> • To ensure increased yield, the same type of seeds were planted on the edge of the same ridge. • The spacing between the plants was wider than the recommended 12cm within the rows.
7) Fertiliser application.	<ul style="list-style-type: none"> • Fertilizer was applied between the plants within the rows as against spot application. • The fertilizer was applied in a hole of 10cm and covered lightly with soil to avoid evaporation.
8) Striga control.	<ul style="list-style-type: none"> • Use of combination of different methods (integrated control methods). • Removal of the striga before it start flowering. • Burning of the striga plant. • Use of appropriate agronomic practices. • Use of striga - free planting material. • Use of post emergence herbicide, 10 days after destroying striga plant.

9) Fertiliser voucher program	<ul style="list-style-type: none"> Designed to deliver fertilizer to small holder farmers (140,000) at a subsidized rate. Farmer's groups participated in the programme were issued with one voucher for 2000NGN (£8) subsidy for three bags of fertilizer enjoyed by each member of the group. Certified agro-dealers within the farmers' local government area were responsible for delivering the fertilizer to the farmers.
10) Compost making.	<ul style="list-style-type: none"> A pit was dug depending on the amount of compost to be made. Grasses were placed in the lower level of the pit. Cow dung and/or poultry droppings were put at the top of the grasses to facilitate decomposition of the grasses. The mixtures are allowed to decompose before use.
11) Herbicide application.	<ul style="list-style-type: none"> Herbicide was used to prevent the weed growth in maize fields.

Source: Survey data, 2012

Table I (b): Description of the endogenous (informal) innovations identified

Endogenous Innovation	Description
1) Mixed cropping.	<ul style="list-style-type: none"> 1 row of maize planted to 1 row of cowpea. Sometimes the cowpea was planted between the maize stands to provide shade for the cowpea.
2) Wider spacing.	<ul style="list-style-type: none"> Intra-spacing was up to 30cm depending on the crops. The spacing was wide enough to plant another crop.
3) Use of pepper and ash for cowpea storage.	<ul style="list-style-type: none"> Dry pepper (Not powdered) was mixed with cowpea in a sealed container (Nylon bags, jars, pots, drums). The amount of dry pepper depends highly on the quantity of cowpea grain. For 50 – 100kg, half mud is used. Some farmers put the pepper on top of the grain in the container and tied up, while others mixed it up thoroughly. Farmers claimed that mixing up the cowpea with wood ash in the ratio of 4 to 1, 4 parts cowpea and 1 part wood ash was effective, while some mixed in a ratio of 4 to 2.
4) Use of local seeds.	<ul style="list-style-type: none"> Superior seeds were selected and preserved for use in the subsequent season. The seeds are mostly preserved in their original forms of cobs, stalks or pods to avoid insects' attacks.
5) Single planting	<ul style="list-style-type: none"> As against planting on the sides of the ridges, it involves planting particular crop on the ridge.
6) Traditional fertiliser application.	<ul style="list-style-type: none"> Spot application of fertilizer was practiced by some farmers. In this method the fertilizer was applied at the base of the plant. Some farmers applied the fertilizers on the fields.
7) Planting Soybean to control striga.	<ul style="list-style-type: none"> Soybean seeds were normally planted in the proposed land for maize and cowpea production. The soybean seeds were planted for two years to destroy striga in the field, prior to the use of the same land for maize or cowpea.
8) Use of powdered striga to control striga.	<ul style="list-style-type: none"> Striga plants uprooted were dried, grinded into powdered form and used for seed dressing to prevent the growth of striga in the fields.

Source: Survey data, 2012

4.1 Identification of the Key innovation actors

Key innovation actors for two representative innovations (improved seeds and storage systems) were identified in the workshop. The roles each actor played or to be played in relation to modification of the innovations

to suit their farming situations were assessed as indicated in the tables II and III below:

4.1.1 Representative innovation I: Use of improved seeds

Table II: Actor identification for improved seeds

Innovation system actor	Key actor.	Role played	
		Development/Modification achieved	Development/Modification to be achieved
Farmer	Yes	Use of innovation Spreading innovation.	Feedback to researchers.
	R F 1 18		

Researcher	Yes	R F 2 13	Sourcing innovation. Adaptation of innovation.	Use of appropriate fertiliser for introduced seeds.
Extension agents	Yes	R F 3 11	Spreading innovation. Ensure adherence to innovation specifications.	Feedback to researchers and encouraging modification of innovation.
Agro dealers	Yes	R F 4 6	Appropriate and superior quality seeds to the farmers. Information on seed planting	Monitoring the use of seeds. Feedback to seed processors

Source: Survey data, 2012.

Key: R = Ranking of the actors; 1 – considered first actor, 2 – considered second actor, 3 – considered third actor and 4 – considered fourth actor.

F = Number of workshop participants mentioning the actors.

The results for actor identification exercise shown in Table II above revealed that 18 of the participants considered farmers as the key actors in the use of improved seeds. They emphasised that farmers were responsible for the use and spread of the seeds to other farmers, and were providing feedback to researchers about the complexity and or compatibility of the innovation. Researchers were ranked as the second key actors, liable for sourcing and adapting of the innovation (improved seeds). Some of the improved seeds according to the farmers were accompanied with specific fertiliser and the recommendation of such fertiliser to the users was the responsibility of the researchers. Extension agents as key actors played a significant role in extending the innovation

to farmers, and ensuring adherence to specifications for the use of the innovation. They were the major sources through which the results of the innovations were taken back to researchers, and they encouraged the farmers to modify the use of improved seeds mainly in relation to agronomic practices. Although considered as the last key actors, agro-dealers supplied the best quality seeds to the farmers and informed them about procedures for planting and preserving the seeds. They ensured the use of appropriate seeds, and the acceptable seeds were taken to processors for improvements

4.1.2 Representative innovation II : Storage systems

Table III: Actor identification for storage systems

Innovation system actor	Key actor	Role played/To be played		
		Development/Modification achieved	Development/Modification to be achieved	
Farmer	Yes	R F 1 16	Spreading innovation. Sustainability and continuity.	Use of innovation for other purposes.
Researcher	Yes	R F 2 13	Innovation development. Consideration of cultural, economic and ecological factors.	Various storage systems for different crops.
Innovation vendors	Yes	R F 3 10	Good quality storage bags. Protection of bags from imitation	Feedback to researchers and vendors.
Extension agents	Yes	R F 4 9	Spread of innovation. Information on how to use the bags.	

Source: Survey data, 2012.

Key: R = Ranking of the actors; 1 – considered first actor, 2 – considered second actor, 3 – considered third actor and 4 – considered fourth actor

F = Number of workshop participants mentioning the actors.

Farmers and researchers were considered 1st and 2nd key actors for the storage systems respectively. The farmers helped in spreading the innovation to other farmers and when found suitable, ensured the use of innovation consistently. The PICS bags introduced for cowpea storage were later used for storing maize and this was found to be effective. The researchers developed different storage systems and considered certain factors in such development. Lela agro produces good quality bags based on the specifications given by the researchers and

introduced a logo to avoid imitations by other vendors. Extension agents provided useful information on how the bags are used. In addition to the formal innovation identified (PICS) in relation to storage systems, the farmers discussed the use of jars and metal drums for storing cowpea in the area. The innovations (jars and metal drums) were considered informal and have some commonalities with triple bagging (PICS) technology. Both were based on the principle of storing cowpea in air-tight (hermetic) containers. Most farmers opined that the

use of jars and metal drums were equally effective (traditional) storage systems. This is consistent with findings of [18] that more than 60% of cowpea produced in Senegal is stored in metal drums. Metal drums according to them are widely used in Senegal and Benin.

4.2 Linkages among the innovation actors

Links between actors in relation to information exchange were assessed during the workshop. Such links varied between the participants, with each group ranking the intensity of links with other actors involved. The actor linkage matrix from RAAKS window B4/a is shown in the table IV below.

Table IV: Actor Linkage Matrix

Links with	Farmers	Extension Agents	ICRISAT/IITA	Ministry of Agric.	of Agro-dealers
Perception of ;					
Farmers	2	1	3	4	5
Extension agents	1	2	2	5	4
ICRISAT/IITA	1	2	1	3	3
Ministry of Agric.	3	4	4	1	4
Agro-dealers	1	2	4	5	2

Source: Survey data, 2012.

Scores: 1 – 5; 1 – Very frequent, formal and informal.

5 - Hardly any contact, either formal or informal.

The result shows that farmers' perception on their links with extension agents in relation to information exchange was at least as strong as those among themselves. In other words, farmers had very frequent contact with extension agents and thus received more information concerning agricultural activities from extension agents than fellow farmers. According to them, increased use of mobile phones and other means of communication results in more contacts. Similarly, extension agents perceived frequent contact with farmers more than with other extension agents. However, farmers' perceptions on their links with ICRISAT/IITA were weak as they emphasised that agricultural related information from these research institutes is received indirectly, through the extension agents. For their part, the two research institutes present (IITA and ICRISAT) expressed strong links with farmers and extension agents, mainly due to increase in the use of participatory research approach and training and demonstration. The two approaches facilitated contact with farmers and extension agents, thus improving capacity building and exposing the farmers to various agricultural innovations in the state. When asked about their perceptions on links with ministry of agriculture and agro-dealers, farmers considered them lowest in relation to information exchange, with scores of 4 and 5 respectively. But in contrast the agro-dealers perceived frequent contact with farmers and described them as major clients. They were found to be major sources of improved seeds and other agricultural inputs. Sometimes the extension agents played a role in improving level of awareness and ensuring the appropriate use of inputs procured. Staff from the state ministry of agriculture emphasised their weak relation with other actors in information exchange. They mainly provide administrative services to other organisations.

However, the result of the semi-structured interviewed shows that there are commonalities as well as differences in the innovations identified. The farmers identified the use of the following innovations; Spacing, Fertiliser application, Zero Tillage, Improved seeds, Improved

Storage, Urea/Dusa feed (exogenous), Mixed cropping, Storage systems, Poultry droppings and Seeds preservation (Superior) (endogenous). It is important to have a clear understanding of the slight variations in the innovations identified in the two workshops. Although the research was conducted in the same state, zero tillage, urea/dusa feed mixture (exogenous) and use of poultry droppings (endogenous) identified in the interview, were completely absent in the workshop. However, some innovations discussed in the workshop such as sole and strip cropping, compost making, herbicide application, double planting and striga control were not identified in the semi-structured interview. [4] when explaining the innovation process in the African context emphasizes the variation of innovation systems across localities within the same or different countries. He further explains that such variations at local levels in addition to institutional mix are significant innovation features of all countries. The changes brought about by the innovations in the area were strongly accepted and utilised. According to the farmers the changes increased their production potential, particularly through increase in yield and land use.

4.3 Sources of Innovation Ideas

The farmers discussed the sources through which they received innovation ideas during the workshop. According to them the major sources of formal innovation in the state are those outlined. The sources of innovation ideas were outlined in the workshop: Exogenous (formal) innovations mostly evolved from research institutes and extension-based organisations and the endogenous (informal) innovations were mainly discovered through grandparents, fellow farmers, lead farmers, self-initiation and trial and error. Although the research institutes were the sources of exogenous innovations, extension agents through ADPs are the major links to farmers. Collaboration among the research institutes in sourcing innovation is important in establishing integrated innovation platforms in the state. Both innovation systems focus on innovation developments that are inclined to improving agronomic

practices. Improved agronomic practices are relevant to resource-poor farmers especially in increasing crop production. The main sources of exogenous innovation according to farmers are; IITA, Gatsby Charitable Foundation project, Sassakawa Global 2000, Bill and Melinda Gates foundation, Seed processing company and Purdue University, Indiana.

V. CONCLUSION

Apart from the formal (Exogenous) innovations taken to the farmers they were capable of developing more innovations to satisfy their ecological and economic needs. Both exogenous and endogenous innovations were practiced by the farmers simultaneously. Farmers expressed their abilities to modify/change some of the exogenous innovations to suit their farming needs and improve their livelihoods.

Moreover, ranking farmers as the first actors for the two representative innovations (use of improved seeds and storage systems) emphasised their achievements in innovation enhancement and the roles they played in establishing a strong coalition in innovation processes. The strong links of farmers as perceived by other actors in relation to information exchange clearly indicates how central farmers are in various agricultural and rural development programmes. The reflections of the farmers in the process of improving linkages and mutual learning were the most interesting aspects of the workshop. Farmer-led participatory innovation processes has successfully been enhanced in the workshop and was increasingly important in recognising local innovation systematically in their agricultural activities.

Recommendations

- Scientists have been encouraged to assist farmers in their innovation developments, so that local innovations would be appreciated through creating a receptive environment at all levels.
- Engaging farmers in exchange of ideas would be instrumental in better understanding of their farming situations and ways of improving them.
- Promoting grass root innovation through encouraging farmers to innovate and modify the formal (exogenous) innovation would be useful in agricultural and rural development of the area.

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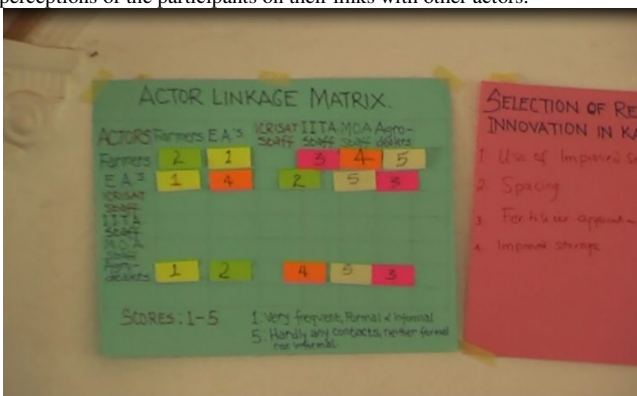
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- Agricultural Society of Nigeria (ASN).
- Farm Management Association of Nigeria (FAMAN).



Photograph I: Workshop for actor and innovation identifications at ADP headquarters

In the above photo a researcher and moderators are emphasising the perceptions of the participants on their links with other actors.



Photograph II: Workshop for actor linkages at ADP headquarters – Kano, Nigeria.

The above photo indicates how the actor linkage matrix was perceived by the participants during the workshop.