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Technological Innovation Capacity: Impact Factors in National Agricultural Research Organisations in Nigeria

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Abstract

This paper looks at the factors that may impact for Technological Innovations in National Agricultural Research institutes in Nigeria. Factors which existing literature show as influencing agricultural technological innovations were identified and selected. These were presented to research personnel in 12 Research institutes who were requested to indicate their importance to technological innovations on a likert scale type instrument. Their responses were analysed using descriptive statistics. The following factors were rated very highly Autonomy on Authority, Technological development level, information sharing with external linkages, level of technological expertise by key research personnel, Incentives and reward system and an enhanced formal and informal linkage system. These findings are discussed and their implications for innovations in agricultural practice in Nigeria were examined. Deriving from these discussions, are actions and measures capable of further enhancing innovation consciousness while improving technological innovativeness in public Agricultural R&D systems in Nigeria and in most developing countries facing same challenges were suggested.

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Introduction

Innovation capabilities can be understood as a firm's technological learning process, translated into the technological and operational capabilities. This learning process can involve acquisition, imitation, adoption, modification and/or the development of a new set of knowledge and technical systems for internal as well as external use. In the agricultural research systems, such technologies are always in effect to combat hunger, and develop efficient farming methods and systems to grow more food. The integration of these capabilities effectively promotes innovation, which creates competitive advantages either for the organisation producing such technology or for the farmer adopting it to enrich his/her life.

The process of technological innovation involves interactions among a wide range of actors in society, who engage in a system of

mutually reinforcing learning activities. These interactions and the associated components constitute dynamic "innovation systems." Innovation systems can be understood by determining what within the institutional mixture is local and what is external. Open systems are needed, in which new actors and institutions are constantly being created, changed, and adapted to suit the dynamics of scientific and technological creation. The innovation systems concept embraces not only the science suppliers but the totality and interaction of actors involved in innovation. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways. Government, the private sector, universities, and research institutions are important parts of a larger system of knowledge and interactions that allow diverse actors with varied strengths to come together to pursue broad common goals in agricultural innovation. In many African countries, the

state still plays a key role in directing productive activities. But the private sector is an increasingly important player in adapting existing knowledge and applying it to new areas. Innovations are important. Innovations involve processes, interaction, integration, institutions and people. Innovations yield products and confer benefits. Some organisations are more innovation prone than others. The difference lies in innovative capabilities (Fagerberg, 2005; Sumberg, 2005; Hall *et al.*, 2006). Technological capability is what the firm does to change what it knows, in other words, internalize new knowledge. The firm's development is based on this process of technological change, which can be seen in terms of new products, efficient manufacturing, cost reduction and higher standards of quality among others. It is the ability to employ, at a given time, a given productive capacity by using a changed set of routines embedded in knowledge, skills and technical systems.

Data Collection and Methodology

According to literature on Innovative capacities, a variety of factors were identified from Internal to external workings of firm, Organisational, Individual level assessments that propel innovations. The following factors were highlighted for the purpose of the research: External Linkages and Interactions, Formal and informal communications with stakeholders in value chain, autonomy on authority, Conducive government policies or regulations, technological development level, Incentives and reward system, Internal Cross functional communication system, technological level of key personnel, information sharing with linkages, Investments in R&D over time, Understanding Organisational core values, Monitoring testing and adoption, organisational Strategy, co-ordination within firm. These factors summarise major indexes to scale impact factors on technological innovations in research organisations. Respondents were also asked to highlight top five research management issues identified in their various organisations. The questionnaire included questions on the organization's mission; research management issues and training needs; scientific and technical training needs; the availability of physical and human resources; research outputs; management

systems and procedures; partnerships and linkages; and funding options. Survey was done from June 2012- July 2012. 150 Questionnaires were distributed and 129 were received at the end of the survey. All completed accordingly. The effective rate was 90%.

Data Analysis

The survey requires that the respondents rank high given factors according to their influence degree, This method was adapted from Gao & Zhang (2011) in *determining the drivers of innovation and determinants of capability performance*; the one with the higher the scores the higher the scale. From practical observations, some individual in some organisation may rank multi options and equal several options. In order to reflect a more accurate results the total points on a factor (if Investments in R&D over time is selected for an example by all 129 respondents in various organisation, its total point are the sum of the points evaluated from the 12 organisations) it's then divided by the selected times, the average score is decided. The selected rate is then calculated by dividing the selected times by the sum of the organisations which is 12. Average scores are then divided by the selected rates to determine the ultimate scores, the smaller the ultimate score the higher the impact of a factor. Average score is used to reflect the occurrence of a selected factor selected rates reflects the acceptability of the factor by all respondents. Which implies only the factor which is continually acceptable can reflect the key factor that influences technological innovative capacity.

Results and Analysis

Table 1: Technological Innovation Impact Factors

Impact Factors	Total Score	Times Selected	Average Score	Selected Rates	Final Score	Ranking
External linkages and Interactions	300	80	3,75	6,66	0,56	8
Formal and informal external linkages	203	75	2,71	6,25	0,43	5
Autonomy on authority	199	87	2,28	7,25	0,31	1
Conducive government policies or regulations	220	60	3,66	5,00	0,73	12
Technological development level	165	78	2,11	6,50	0,32	2
Incentives and reward system	450	116	3,88	9,66	0,40	4
Internal Cross functional communication system	203	73	2,78	6,08	0,46	6
Technological level of key personnel	224	87	2,57	7,25	0,35	3
Information sharing with linkages	170	80	2,13	6,66	0,32	2
Investments in R&D over time	227	69	3,29	5,75	0,57	9
Understanding organisational core values	387	89	4,34	8,16	0,53	7
Monitoring testing and adoption	296	72	4,11	6,00	0,69	11
Organisational strategy co-ordination within firm.	320	79	4,05	6,58	0,62	10

N=12

The above illustration provides for a very clear understanding at the various factors that influence technological innovations in public research organisations in Nigeria. Autonomy on Authority, Technological development level, information sharing with linkages, the level of technological expertise by key research personnel, Incentives and reward system and an enhanced formal and informal linkage system, rank among the first five of all options presented to respondents. Options categorised under Incentives and reward system, External linkages, organisational culture, Technological level of personnel and sharing with linkages are also very important judging by the times they were selected. Due to the bureaucratic top down approach of many research institutes, respondents are beginning to understand that if a research team lead vested with a sole authority to plan and execute programs with various sub teams, adequate program planning on learning for key

research staff and a more efficient linkage with external actors would propel technological innovation.

In contrast above, other researchers feel that a well planned organisation culture that plans for the quality of its human and physical resources, peer effects, may spur technological innovations. In the light of the above observations it's important to know the role a well motivated staff morale, adequate provision of physical resources, an a constructive incentive system will do to boost innovation in all aspects of a research technological development and its sustainability in the whole. The resources for technological innovation are derived from institutions themselves while innovative activities are complemented by what core competence they build. In the process of innovation, research organisations have a problem of inadequate external links, either

they fail to harness this opportunity or they are not as organised as an entity to build on such ventures. There is a high linkage deficit between industry, universities and research institutes, which in itself is a combination of strength to propel innovative action. However, under the overall situation of weak capacity in these organisations, low funding and weak adoption of some produced technology in Nigeria, Research organisations may not be able to sustainably match the required productivity required to actualise sustainable agricultural productivity in the sector in the short run. Most research organizations have diversified beyond their core task of technology development and give considerable attention to non-research tasks such as training, dissemination and the provision of public services. At the same time the services provided by the research organizations are often seen as not relevant to the needs of stakeholders and may be the major cause for the dwindling fortunes of what partnerships can help achieve together. When there are considerable linkages and all parties share information, gaps are immediately taken into consideration and adequate solutions are made for.

Measures and Suggestions

Linkage

The most important potential linkage partners for agricultural research organizations include: farmers, farmer organizations and farmer cooperatives; government extension services; other research organizations in the public sector; international and regional research organizations; NGOs; private sector actors/users in research and technology transfer (agribusiness, processing companies, research and input suppliers); donor and development agencies (external investors and stakeholders); and government policy and decision making bodies. For each of the different partner types there are specific reasons to establish and maintain effective linkages. For example, linkages between research and extension organizations are needed for making research outputs and results available on a timely basis, for training of extension staff in new research methods, for preparation of information materials and methods, for conducting field days, demonstrations and on-farm research activities. The functions of linkages with

international research organizations include providing access to global technology, obtaining training, improving regional cooperation on shared research problems, and avoiding duplication of research efforts.

Capacity Deficit & Training Needs

There exists a high capacity and incentive deficit in most of the agricultural research organizations. The response presents an urgent situation requiring attention, inadequate and decaying infrastructure as these would hugely impact on innovation produced.. Support is urgently needed to strengthen the abilities for fundraising, diversifying fund sources, and the advocacy and negotiation for agricultural policy change and increased investment in agriculture and research. Training for scientific skills should be coupled with a better work environment and organizational culture, both of which have been proven to be important motivating factors for researchers and their organizations to perform better. Training and learning support for enhancing both technical knowledge and organizational and management skills are paramount for an organisation willing to innovate technologically. Modern techniques in breeding; genetics; biotechnology; disease control; plant, animal, and fish nutrition and health; aquaculture; processing, packaging, marketing, and storage techniques; biometrics and statistical analysis; GIS; analysis of climate change; and soil and water management appear to be the most widely cited technical training requirements. There needs to be a strong emphasis on improved ability for agriculture economics, policy analysis, impact assessment, and extension research, support is required for new approaches in research design and methods, performance monitoring and evaluation, strategic planning, data and knowledge management, IPR policy, patent procedures for technologies, stress management, effective communication, and quality management for research.

Overall Performance, Incentives and Physical Resources

Overall, performance measures differ with different perspectives of research institutes. Such differences can result from stronger organizational emphasis on programs and opportunity as an explicit organizational

arrangements, vision and mission. This could stem from greater emphasis on research collaboration and or how individual performance indicators are framed. Satisfaction with physical infrastructure and the work environment were significant in explaining variations in several performance measures analyzed. Among the indicators of work environment, those most often significant were the perception of participatory leadership and or a degree of freedom for supervisors to exercise authority in their domain absolving external influences on chains of command, and the presence of well-qualified staff, transparency, and open information. Research personnel are somewhat satisfied with the level of research facilities and physical infrastructure. Optimal salary levels are to be looked into in recommending priority investments for increasing their productivity and output.

Conclusions

Technological Innovation is seen to drive the development of Agricultural Research organisations in so many ways as it provides it with the tool to face the challenges of food sufficiency in Nigeria. The understanding of the fact that concept development should come first in all of these should be a pre-condition for agricultural technological innovation. In the real situation, agricultural systems in Nigeria are currently being transformed from the traditional methods to a more modern and sustainable future. It is pertinent that agricultural research institutes tries to improve upon the understanding of technological innovation in agricultural development and establish new concepts in agricultural technological innovation. There exists an urgent call to improve scientific and technological input from the study as majority of respondents' share the belief that a more sound input in technological development of key research personnel is needed to build upon this; guide the organisation to be the main precursor of technological innovation, pivoting external linkages in building the desired structures needed to build innovation, integrating the process of innovation through its various departments and sub units after concept development, assimilation and absorption.

Consequent upon this, Technological innovations in most public R&D organisations in Nigeria rely greatly on talent cultivation and incentive measures. So it's necessary to cultivate and retain high quality talents, especially inter-disciplinary that are good in Science & Technology, management and research operations-which has come to be a great source for most innovation occurring in high-tech organisations.(Gao & Zhang, 2011).Cultivation of innovation talents mainly needs improve the mechanism for measuring individual staff performance, an incentive to encourage and attract high level technological innovation talents to get engaged in research agendas of institutes in the country side, carrying out surveys to provide technological and intellectual support. Barriers hindering an effective incentive mechanism should be given prompt attention at all levels. Brilliant contributions to research agendas in area of technological innovations and commercialisation of research which create great economic benefits for the organisation should be rewarded accordingly. In strengthening these talent teams, efforts should be made to building a virile technological management back bone and high quality technological cadres at the basic levels. While, optimizing resource integration, improving service system for high technological innovation talents by making provisions for further training and effective technology information sharing system for these high level technological innovation talents.

The role of Government cannot be over looked; Most Public Agricultural R&D organisations in Nigeria receive majority of its funding from government sources and given its role as the prevalent policy maker. By this it makes it an important participant in Agricultural research activities in the country. it roles includes guiding innovation governance through Macro policies and working out related laws and regulations to provide for fair environment for agricultural research institutes technological innovation, protect new techniques, and patent rights. At the same time enhancing the scientific and technological information platform, improving service system for technological innovation, increase technological information dissemination by reviving the almost moribund Agricultural Development Programs in various

states for extension activities, Broaden Channels of technological innovation by creating the environment that could accommodate the private sectors and enhancing the quality of dialogue to foster technological innovation in agricultural Research and Development Systems.

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