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# SYSTEMS OF INNOVATION AND AGRICULTURAL PRODUCTIVITY IN AFRICAN ECONOMIES

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## Abstract

*The essay presents an overview of the prevailing theoretical literature on innovation and agriculture. It examines the adequacy of existing innovation to guide policy regarding agricultural productivity, and some directions for fruitful linkage in innovation systems. It argues that innovation in the agricultural sector in Africa has been dominated by the narrow approach of employing technology transfer and adoption theory. It also discusses the lack of any serious attention to the demand side and their socio-economic characteristics. Indeed African farmers, their innovative behaviour practices and 'the markets' are relevant in studying innovative practices that result in sustainable agricultural productivity. Thus, increasing and sustaining agricultural productivity not only relies on improved production efficiencies, such as through adoption of modern or improved technologies and practices, but also critically relies on many other factors that are institutional, environmental, socially, economic and technological. All these are encompassed in the dynamics of Innovation system. Hence a more multi-layered, innovative behaviour and socio-economic heterogeneity approach is needed in Africa agricultural economy.*


**Key words:** Agriculture, innovation system, Africa and linkage

## Introduction

High and sustained rates of agricultural growth, largely driven by productivity, will be necessary if African countries are to accelerate poverty reduction, reduce food insecurity, favour rural development, increase export earnings, which will have a positive spill over effect on the economic development. Productivity in the agricultural sector is thus a crucial issue in the overall economic growth and development in Africa. The agricultural sector is faced with declining productivity coupled with global change in climate, environment, technology, politics, economies and increasingly greater interdependency of nation states. At the production level, agricultural productivity measures the value of output for a given level of inputs.



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To increase agricultural productivity, the value of output must increase faster than the value of inputs. Gains in overall agricultural productivity can therefore come from changes in the physical productivity level through change in technology employed in the production process, which results in more output per unit of input such as land (yields) or labour, or from changes in production and market costs and hence the increased profitability of farmers. Thus, increasing agricultural productivity not only relies on improved production efficiencies, such as through adoption of modern or improved technologies and practices, but also critically relies on many other factors that are institutional, environmental, social, economic and technological. All these are encompassed in the dynamics of Innovation system.

Innovation is thought of as new inventions which will be further developed into new products (Bogenhold, 2010). Innovation can be generally defined as something new to the particular locality or event but not necessary new to the world or all events (Waters and Reij 2001). In addition, innovation can take the form of new production processes, new products, new forms of organization and new markets (Lundvall et al., 2003). An innovation system is a network of actors and organizations that linked by a common theme with the aim of developing new technologies, methods and new forms of organization for use by the end users to tackle identified problems (Mapila, et al., 2011). An innovation system can be further referred to as a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into social and economic use, together with the institutions and policies that affect their behaviour and performance (World Bank, 2007). The innovation systems concept embraces not only scientists but also the totality and interaction of actors involved in innovation. In addition, it extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways (World Bank 2007). This concept of innovation emerged in evolutionary economics in the 1980s (Lundvall, 1985, 1988; Freeman,

1987, 1988; Nelson, 1988; Edquist, 1997). This was introduced to the analysis of developing-countries agriculture mainly as a critique of the linear model of agricultural research (Clark, 2002).

Innovation system framework highlights the ways in which heterogeneous actors interact in the generation, exchange, and use of information and knowledge; how individuals and organizations learn and change; and how social and economic institutions condition affect these interactions and processes (IBRD/World Bank, 2008). These provide insight into ways of increasing effectiveness of innovation processes by indentifying and exploiting comparative advantages of different actors and organizations; reducing transaction costs in the exchange of knowledge and technology; and achieving economies of scale and scope, exploiting complementarities and realizing synergies in innovation (Davis et al., 2007). As aforementioned, innovation is particularly important given the changing nature of Africa agriculture, including the growth of demand-side market forces and consumer preferences, the increasing knowledge intensity of agricultural production, and expanding private investment in new information, communications and agricultural technology (World Bank, 2007). Broadly the concept of innovation system can be defined as comprising the organizations, enterprises and individuals that together demand and supply knowledge and technology, and the rules and mechanisms by which these different agents or actors interact (IBRD/ world Bank, 2008).

Most agricultural production is increasingly integrated in supply and demand linkages. Agricultural production is based on a wider range purchased or stored or free input that must be economically and efficiently combined to result into a suitable production systems. All agricultural production systems are link to producers (mainly the farmers) and consumers (mainly the markets). Each of the links in these productions to consumption systems provides new opportunities for innovation. Agriculture and innovation are vital to promote poverty reduction, economic growth and development. However agricultural productivity in Africa has experienced a declined rate in



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productivity. One approach to address this challenge in African agriculture can be through innovation systems approach. Innovation is becoming central to the ability of farmers, agro-enterprises and countries to cope and compete in rapidly evolving technical and economic conditions (Hall et. al., 2006). Overall performance of the agricultural sector is influenced by agricultural innovation system, measuring sectoral performance, is vital to assessing an innovation system.

## The need for innovation system in Africa agriculture

Africa agricultural productivity has been declining for decades. Although on some matters there is broad agreement that there is need of favourable environments for investment and African governments need to invest more in public goods such as rural roads, agricultural research and extension services, and rural schooling, clean water and health care, but often in African systems of agriculture there are market failures in that farmers cannot get access to credit, insurance and inputs. These market failures can be severe and leave small farmers in a poverty trap from which they struggle to escape; even when the technology that allows them to produce more exists. These market failures may be overcome by institutional innovation, but in some cases stronger state intervention may be needed including the use of input subsidies. But even the availability of credit may have limited benefit to millions of the poorest farmers. Incremental production from improved inputs will not necessarily result in surpluses since Africa agricultural problems are complex with such problems as weak institutions, inefficient markets, weak policies and governance and cannot be resolved by technological fixes only. The complexity of African agricultural systems coupled with poverty and food insecurity has led to a shift in global agricultural research systems towards an innovation research systems.

Although there has been a long tradition of development assistance investment in public research systems, yet there is growing recognition that while public agricultural research is necessary, it is not sufficient on its own to create a dynamic innovation capacity (Hall et al., 2006). Furthermore there has been a recognition that agriculture

research efforts in many developing countries, especially African countries, are failing to bring about the social and economic transformations to their potential would suggest (Hall et al., 2006). However, despite these critiques, agricultural research would have been able to bring about expected results if not for a ranged of challenges being faced and that needs institutional change and multidimensional approaches to address. This calls for innovation system approach in African agricultural system. This study presents an overview of the prevailing theoretical literature on innovation and agriculture; examines the adequacy of existing innovation in order to guide policy regarding agricultural productivity and sketches some directions for fruitful linkage in innovation and agricultural productivity.

The rapidly changing nature of global food and agriculture system suggests the need to rethink how innovation can contribute to developing-country agriculture. While scientific and technological changes in agriculture can help foster productivity growth and poverty reduction, their contributions are incomplete without commensurate changes in the wider innovation system of which they are a part. A more systems- oriented understand of how innovation can promote increase in productivity is critical in Africa agriculture and its productivity which can ultimately increase food security and reduces poverty.

The strong focus upon Africa many disasters should not hide that there are also strong signs of a positive development (Muchie, 2003a). One goal of AU/NEPAD is to stimulate African GDP growth so that it reaches 7 per cent per annual. While this objective is laudable, this ambition to create a new framework of interaction to alter radically Africa's current rate of growth is strongly linked to building African systems of innovation (Muchie et al., 2003), most especially in agriculture sector, a crucial economic activity in Africa.

This study assumes sizeable importance since knowledge grain from the study could enhance the formulation of sound macro and micro

policies and investments by policymakers, investors, donor and practitioners for the emergency of sustainable innovativeness in Africa agriculture. It could also indicate those key variables (areas) that could be managed to produce more effective agricultural innovation system in Africa that will creates opportunities for reducing food insecurity and poverty and accelerating agricultural and economic development in Africa.

## Generation of innovation

Fragmentation of empirical work certainly characterizes the state of knowledge regarding the genesis of innovation (Nelson &Winter, 2009). The genesis of innovation can be grouped into three transitions: *creativity*, *destruction drivers*, and *cost –driven*. The first transition is the foundation of innovation while the last two are influenced by allocation effort of demand and supply.

***Creativity*:** There is a general notion of purposive acts of investment as an important part of the foundation of process of innovation (Nelson and Winter 1982, 2009). Every innovative idea is an act of creativity. Schumpeter (1934, 1942) emphasizes the relevant of creativity as a source of new problem solution in any innovative economy as in case of entrepreneurial activity. This ideal is expanded by more authors in the literature, such as in the study of Acemoglu et al. (2006), Aghion et al. (2009) and Carreira and Teixeira, (2010), relating creativity to productivity and economy growth.

***Destruction drivers*:** The destruction driver notion has been put forward as far back as 1890 by Marshalls analog of a forest in which the old trees must fall to give way to the new ones. The destruction drivers are factors that influence the demand for or pay-off from innovation. Hayek (1978) interprets willingness-to-pay on the demand side as a process of selection superior innovative goods or idea in a market competition and Nelson and Winter (1982) show how profit may serve as the selecting force that leads to the persistence of some innovations and to the vanishing of most others (Sartorius 2005). A particular case of evolution leading to the solution of unprecedented

problems is a task that could never be fulfilled by individuals on the basis of their mere rationality (Hayek 1978; Sartorius 2002). The demand side is widely studied with strong empirical support for the proposition that relatively factors and prices influence the nature of innovation at least in agriculture (Schumpeter, 1934, 1942; Schmooker, 1966; Hayami and Ruttan, 1971; Anderson, 2009).

***Cost Driven*:** The cost or the supply side is in contrast with demand side factors in which weak empirical support is found however the fact that there is difficulty in achieving any innovation proved its existence and explains the pattern of innovation over time. This is the sacrifice or opportunity cost of any innovation. The trade-off of the innovation and its cost depend on the result of the innovation. (Nelson and Winter, 1982; Hopehayn, 1992; Aghion et al., 2009 and Cainelli et al., 2010)

## Transition in agricultural innovation system

There are been notable changes in the concept of agricultural innovation system overtime. These changes have been in era that can be divided into four transitions. The four transitions can be stated as thus: National Research System (NRS); Agricultural Knowledge and Information System (AKIS); Training and Visit (T&V); and Innovation System (IS).

***National research system (NRS)*:** National research system used the concept of development effort on strengthening research supply by providing infrastructure, capacity management, and policy support at the national level (IBRD/World Bank, 2006). In the 1980s era, NRS was majorly used in agricultural sector. The underlying concept is classical linear which is that agricultural research through technology transfer, leads to technology adoption and growth in productivity (World Bank, 2006). The effectiveness of this concept lies in the adoption of such technology transfer. However this concept is not explicitly linked to technology users and other actors thereby possess the tendency of not reflecting the key actors' needs and changing circumstances of the sector.



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***Agricultural knowledge and information systems (AKIS)*:** Agricultural knowledge and information systems link people and organizations to promote mutual learning and to generate, share and use agriculture related technology, knowledge and information (IBRD/World Bank, 2006). This concept integrates farmers, agricultural educators, researchers, and extension staff to harness knowledge and information from various sources for improved livelihoods (IBRD/World Bank, 2006). Farmer as a key-actor is at the heart of the knowledge triangle formed by education, research and extension (FAO and World Bank 2000). However the concept's focus is restricted to actors and processes in the rural environment with limited attention to other institutional actors and factors.

***Training and visiting (T&V)*:** In the mid 1980 to late 1990, training and visit concept was focused. This concept focused on greater participation of the farmers and extension agents (Benor and Baxter, 1984). It involves training the farmers, allow them to practice and visit the farmers' farms to ascertain the adoption of the technology. The objective of T &V system was based on reforming and improving upon the effectiveness of conventional agricultural extension for agricultural development (Adeola, 2005). The effectiveness of this concept also lies in technology adoption and in fact enhances technology transfer and adoption that allows farmers feedback (Feder, Lau and Slade, 1987. The limitation of T&V lies in the sole involvement and dependency of extension agents and lack of other network and actors interaction (Moore 1984, Purcell and Anderson, 1997, Gemo, Eicher and Teclemariam, 2005; Andersoon, Feder and Ganguly, 2006.

***Innovation system (IS)*:** Innovation in agricultural sector till this transition has been dominated by the narrow approach of technology transfer and adoption theory. The innovation systems concept values the capacities and processes emphasized in the NARS and AKIS frameworks, including channels that give farmers access to information, and well-resourced and up-to-date scientific research and training organizations. The innovation systems concept goes further in

recognizing a broader range of actors and disciplines/sectors involved in innovation, particularly the private sector in its many guises along the value chain. Innovation systems analysis recognizes that creating an enabling environment to support the use of knowledge is as important as making that knowledge available through research and dissemination mechanisms (IBRD/World Bank, 2006).

This concept offers a holistic way of strengthening the capacity to create, diffuse, and use knowledge in providing solution to existing problems.

**Dynamic-linkage processes of agricultural innovation system**

Innovation system is a complex process. Innovation system is neither narrow nor linear process but is a broader process. Distinction has been made between narrow (linear) and broad approaches of innovation (Lundvall, 1992; Freeman, 2002). Narrow approaches promote the acquisition and dissemination of knowledge and are main sources of innovation (Figure 1).

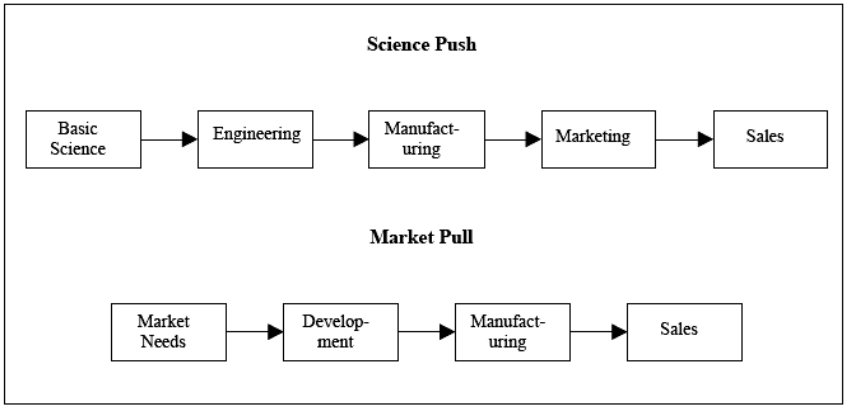


Figure 1: Linear model of Innovation

Innovation systems concept embraces not only the researchers and scientists who are traditionally involved in agricultural research but

also the end users of technologies and the interactions that take place between all the actors in the research process (IAC 2004). The broad approach recognizes that these "narrow" institutions are embedded in a much wide socio-economic systems in which political cultural and economic policy determine the scale, direction and relative success of all innovative.

Innovation System complexity stems from the fact that is not an isolated event. It is longer and bigger process involving: Knowledge and learning; research, science and technology; culture; attitude towards risk; actors' socio-economic characteristics; law; formal and informal institution such as market, regulations, incentives and governance mechanism. All these elements form the domains of innovation systems in agriculture. The domains are Demand domain; Research domain; Enterprise domain; Environment and Social Domain; Intermediary Domain; and support Domain. Figure 2 presents a framework that reveals the essential elements of innovation system in agricultural sector and the linkages between its components.

The making of an innovation system embodies both the desire and strategy to introduce well-functioning states, well-functioning universities and well-functioning industries, well-functioning and stable civil society, well-functioning markets – in the framework of a well-functioning Africa nation by a systemic perspective on co-development (Muchie, 2003b). It is necessary to develop a conceptual framework that captures the essential elements of integrated innovation systems.

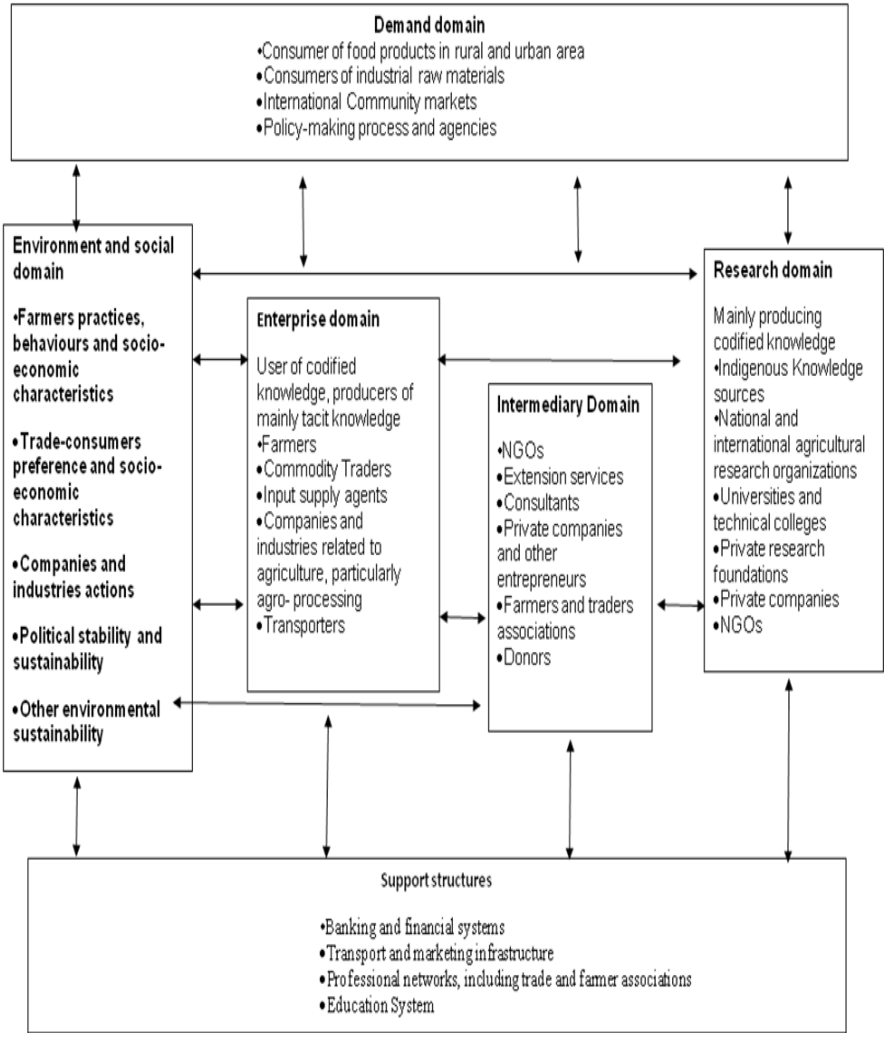


**Figure 2**: A Conceptual Diagram of Innovation System in Agricultural Sector

**Source**: adapted from Arnold and Bell 2001.

Implicit throughout the system presented above are farmers – both as consumers and producers of knowledge and information (in form of indigenous and existing practices), as producers and consumers of agricultural goods and services, as bridging institutions between various components and as value chain actors. The system represents an interface where different actors, including farmers, interdisciplinary teams of researchers, end users, extension agents, policy makers, private organizations, NGOs and agribusinesses, interact in order to identify problems for which innovations need to be developed.

## Conclusion

It can therefore be concluded from the review that agricultural productivity depends on collaboration for innovation. Research, science and technology is an important factor in agricultural Innovation system (AIS) but not the holistic component. Market is necessary but not sufficient condition to promote fruitful linkage in innovation systems and agricultural productivity. Intervention of social and environment sustainability is needed for effective agricultural innovation system. Behaviour and socio-economic characteristics of principal actors (farmers, processors, traders, among others) to innovation are essential component needed for fruitful linkage innovation system and agricultural productivity. Organization of stakeholders or actors is a central concept in successful Agricultural Innovation System. It is recommended that a multi-layered innovative behaviour and socio-economic heterogeneity approach is needed in Africa Agricultural Economy.



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