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Entrepreneurship as driver of a 'self-organizing system of innovation': the case of NERICA in Benin

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Abstract

Understanding how an innovation system emerges and develops is critical to its promotion and to ensuring successful innovation processes. Unfortunately, research on innovation system approaches has neglected the interplay between innovation and entrepreneurship and overlooked focus on how innovation systems occur. Based on a unique framework integrating the innovation systems concept and entrepreneurship theory, this study uncovers a process of innovation system formation: a 'self-organizing system of innovation' based on a promising technology: the New Rice for Africa (NERICA). This finding highlights the pre-eminent role of entrepreneurship in innovation processes, thereby posing new challenges for development actors and opening up a new avenue for research into innovations.

Keywords

innovation
innovation system
self-organizing system
agriculture
NERICA

Introduction

The current global food and financial crises seem to be promoting an all-embracing economic recession that heightens threats already overhanging the lives of vulnerable populations. To help its disproportionate share of these threatened populations to survive, Africa has to innovate, particularly in agriculture. This revives the debate on effectiveness of methods so far used for agricultural technology dissemination in sub-Saharan Africa (SSA). This study tackles the issue from perspectives of innovation systems concept and entrepreneurship theory based on the dissemination process in Benin for the New Rice for Africa (NERICA®) varieties. NERICA, a family of new improved rice varieties developed by the Africa Rice Center (AfricaRice, ex-WARDA), has specific advantages which make production of these varieties an exciting business opportunity. However, for such a technology to make the journey from research station to the consumer's plate is very time-consuming and complex. The route is not straightforward and completing the journey requires many interactions

and joint efforts. We call this journey the NERICA-based innovation process. It includes all actions through which the new technology transforms from its state of seed to the state of edible rice.

This study highlights the experiences of Benin during this journey. By describing the formation process of an innovation system based on NERICA, it leads to the discovery of a self-organizing system of innovation in developing country agriculture. The first section discusses how the combination of the innovation system approach and entrepreneurship theory better enlightens agricultural innovation processes. It forms the theoretical background for the case study developed in the second section. The findings pose new challenges for development actors and propose a new agenda for research in the field of innovations.

Theoretical background

From the linear through to participatory approaches to the innovation system concept, great strides have been made in understanding innovation processes. However, there is still a tendency to move away from the fundamental: the interplay between innovation and entrepreneurship. Entrepreneurship rests on innovations (Drucker 1985) which, reciprocally, rely on entrepreneurial activities to thrive throughout the economy (Schumpeter 1934). When technologies are generated as 'artefacts', it is through market mechanism they transform into innovations (Vespagen 2001). This implies that, on its own, a technology is not worth a great deal; one starts to create things of great value only when the technology meets the market through the catalyst of entrepreneurial management (Drucker 1985). Combining the concepts of innovation system and entrepreneurship, our approach focuses on how they are inextricably linked one with the other and should be distilled to a framework (Drucker 1985) that addresses innovation processes in agriculture. Emphasis is put on how their interplay gives rise to an innovation system.

Innovations and entrepreneurship

Generally, innovations denote new goods and services that business produces and introduces into the market (Vespagen 2001) with the purpose of creating a new value for users and financial returns for itself (Walters 2007). To be an innovation, new technologies or R&D results need to be profitable (Kostic 2008) and society must discover through business that they are worthwhile. In developing countries where agriculture is characterized by large numbers of heterogeneous production entities (farmers), technologies need to address multiple application perspectives (Hall, Clark and Naik 2007). Andersen (1992) noticed that adoption of agricultural technologies often requires simultaneous use of other inputs denoted as complementary technologies. They include:

- Integrated crop management knowledge (capacity) at research, extension and farmers' levels and also for agricultural training schools and local NGOs.

- Inputs such as fertilizers, herbicides and pesticides
- Credit systems appropriate to farming
- Agricultural equipment necessary to perform on-farm and post-harvest tasks
- Marketing capacities

Schumpeter (1934) had argued along the same lines and highlighted that innovations do not appear independently of one another but in swarms or clusters. This clustering of innovations occurs, he added, because the initial appearance of one or a few entrepreneurs facilitates the appearance of others, and thus the appearance of yet more, in ever-increasing numbers (Kiessling 2004). Therefore, understanding the dynamic mechanism ensuring and sustaining the simultaneous supply of the main and complementary technologies expands focus to a wider set of economic agents and activities and, logically, calls for a holistic approach for analysis and actions.

Understanding the innovation systems approach

The innovation systems approach is foremost a new way of thinking and a more holistic tool for tackling socio-economic and development issues. It can be understood as the permanent or temporary but continuous mechanism through which socio-economic and development actors find their ways woven and converging towards an innovation event on which depends their success. To exploit it, they engage in relationships through which they generate, adapt and exchange knowledge and other resources while supported by new institutions and policies (Dalohoun 2005; Röling 2004). It describes the interplays between multiple and interconnected actors seeking opportunities and exchanging resources for greater achievements (Lundvall 1995). The systems approach also underscores the links between the actors' activities. It is the quest for additional resources that leads actors into interaction (Foray 1997) through which they form a system and become its components by developing linkages. They engage in relationships depending on perceived benefits and mutual interests; they only take part in innovation events that match with their objectives. An entity belongs to the system based on what it can provide to or can receive from other components (Clark 2002). Becoming a system component is a challenge and a process; there is an art to discovering, engaging and dealing with new people or previously known people but with focus on new things. Consequently, an innovation system may not have well-defined boundaries (Röling 2004; Van Mele, Salahuddin and Magor 2005) and the relationships may be merely temporary. In the framework of this study, the innovation system approach presents the following insights for analysis:

- The process through which an agricultural technology transforms successfully into innovations involves not only multiple actors and the interactions among them but also the use or the combination of multiple other technologies.

1 <http://web.extension.uiuc.edu/ii/dea/PDF/entrepreneurship.pdf>.

- Identification of the actors regarding their activities and the roles they play in the innovation process can start from any of them.
- Innovation process sustainability in terms of actors' capacities to innovate framework for learning to develop competences required to operate in changing socio-economic environments
- The formation of an innovation-enabling environment: suitable and adaptable institutions and policies that support, guide and provide incentives for actions.
- Finally, the innovation systems are open systems and as such, they create space for the unexpected to happen through entrepreneurial processes.

Innovation system and entrepreneurship

Entrepreneurial venture has the potential to prompt innovations and to sustain an innovation system. In engaging in new economic activities, entrepreneurs re-organize them in an innovative and valuable way (Schumpeter 1934). Entrepreneurs search for changes and respond to them by exploiting them as opportunities (Drucker 1985).¹ From the system perspective, Radosevic (2007: 20) argues that 'entrepreneurship is the outcome of the simultaneous emergence of three types of opportunities: market, technology and institution [. . .]'. But this study contends that opportunities do not just arise for the entrepreneur. Instead, it is the entrepreneur who eagerly hunts events, methodically who conceptualizes and creates opportunities and marshals resources, through linkages to exploit them. Entrepreneurial endeavours awake other actors, offer them opportunities and propel them into the innovation process. The combined insight is that entrepreneurship can spur innovations, steer innovation processes and compel the creation of an innovation-enabling environment while giving rise to and sustaining the innovation system. Entrepreneurial venture is viewed as an embedded power that steers institutions, stimulates learning and creates or strengthens linkages which constitute the pillars of innovation systems.

Methodology

This article builds on empirical research using the case study method to examine current patterns of NERICA dissemination in Benin. Through the unique approach combining the innovation systems approach and entrepreneurship theory, the study describes the process by which a class of entrepreneurs has taken the lead in the innovation processes while creating the basis for a NERICA-based system of innovation to emerge. Fieldwork was conducted in April 2007 and August 2008 in four important rice production zones. Given the range of respondents, their diversity and the multifaceted data sought, unstructured and flexible questionnaires were used for individual interviews and group discussions. Apart from farmers and farmer organizations, respondents included researchers and extension officers, government officials and managers of business enterprise and NGOs.

NERICA dissemination process in Benin

Basic country context

Benin is located in West Africa and covers an area of 112,622 km² with 8.2 million (estimate, July 2007) inhabitants. Its landscape is mostly flat to undulating plains but also comprises some hills and low mountains. The climate is tropical, typically hot and humid in the south and semi-arid in the north. Watercourses comprise some important rivers and several lakes. Natural resources include small offshore oil deposits and some mineral resources such as gold, limestone, marble, precious stones, iron and phosphates, none of which are fully exploited. With an active population of 53.7 per cent and an adult literacy rate of 34.7 per cent, Benin has a weak economic standing which rests predominantly on agriculture. Service and industrial sectors provide (estimate, 2006), respectively, 53.5 per cent and 13.7 per cent of gross domestic product (GDP). Textiles, food processing, construction materials and cement account for the major industries. With just 32.8 per cent contribution to GDP, the agricultural sector employs about 65 per cent of the active population. Cotton alone accounts for approximately 80 per cent of total export earnings. Other export crops include palm oil products, cashews, coffee and pineapple. Maize, cassava, yams, groundnuts, beans, livestock and so forth represent the most important staple crops. Rice is gaining in importance as both a cash and staple crop.

Despite the relatively high natural production potentials (land and water), domestic production is weak and covers only about 10–15 per cent of demand for rice (CCRB 2004). Some specialists blame inappropriate policies and institutions not suited to supporting domestic production against importations. Others think that the basic problem lies rather in the quality of the product which does not meet consumers' preferences and demands (Adegbola and Singbo 2005) due to production conditions. Production takes place essentially using only rainfall, with irrigation possibilities underexploited. There is no mechanism supplying proper seed. Inputs such as fertilizers, pesticides and herbicides are also barely obtainable. At post-harvest system level, the economic agents lack skills to satisfactorily handle the activities (CCRB 2004). Overall, extension services have become limited. Credit schemes to farming still need better adaptability. Can a technological breakthrough like NERICA induce institutional changes that would both break the status quo and challenge the existing framework?

What is NERICA?

NERICA is the brand name of a family of improved rice varieties specially adapted to the agro-ecological conditions of Africa. These hybrid varieties from the Africa Rice Center (AfricaRice, ex-WARDA) combine the best traits of two rice species: the African *Oryza glaberrima* (OG) and the Asian *Oryza sativa* (OS). As such, NERICA presents specific characteristics and advantages depending on the variety (WARDA 2007, 2008):

- High yield (up to six tonnes per hectare – at least three times more than OG)
- Quick maturity (80–100 days – i.e. 50–70 days earlier than OG)
- Resistance to local biotic and abiotic stresses, such as drought and iron toxicity
- Higher protein content (by 25 per cent) than international standard varieties
- More responsive (than OG) to fertilizer

Obviously, these characteristics granted NERICA the capacity to sell itself. It has attracted those economic agents already on daily alert for potential events they can turn into opportunities. In the pursuit of their economic or developmental goals, a number of self-motivated actors happened to meet at a crossroad: the NERICA. They dared to exploit the new technology from diverse perspectives. The most important included Songhaï, the Banque Régionale de Solidarité (BRS), Groupe TUNDE, BSS-SIPRI, PADRO and VECO.

Songhaï: taking the leadership in seed production

The non-governmental organization (NGO) called Songhaï is a socio-economic and rural development actor specializing in agricultural production, training and research. It supports an integrated production system based on minimal inputs and the use of local resources. Wastes from one production unit become inputs for others, and production activities become more profitable because they belong to the system in which the different components strengthen each other through what they provide to or receive from others. To promote general-purpose and versatile agricultural entrepreneurs and technically outstanding professionals, the Songhaï pedagogical content rests on the range of interconnected activities carried out in various production units composed of crop production and animal husbandry, fish farming and renewable energy, processing and mechanics (agricultural machinery), farm and business management.

Songhaï ranks first among the pioneers of NERICA production in Benin and has a particular motivation for its interest and commitment to NERICA dissemination: it was challenged to endorse a framework conducive for rice production as a profitable agricultural commodity. At the heart of this self-conferred responsibility stands a will to supply seeds to farmers and purchase the resulting paddy. Indeed, for years, Songhaï has been conducting experiments with more than 300 rice varieties brought from all over the world. Songhaï eagerly entered into partnership with WARDA to test some of the NERICA varieties so as to determine their performance under actual farming environments in Benin. It tested four varieties (NERICAs 1, 2, 4 and 8) and reported the results to WARDA from which it expects feedback for comparison and harmonization with those obtained elsewhere by actors in similar agro-ecological zones willing to share experiences on complementary technologies.

Meanwhile, Songhai revitalized interaction within the Réseau National des Fermiers Songhai (RENAFERS) – National Network of Songhai Farmers – by focusing during an ordinary annual meeting on NERICA and its opportunities for business. These range from the farm level (seed and paddy production) to post-harvest system activities (trading in seed and paddy, processing and marketing of edible rice). Songhai promised to provide NERICA seed within the RENAFERS and committed to buy resulting paddy for processing.² Songhai's ambition to increase the current capacity of its processing unit constitutes a key incentive for the farmers to engage in NERICA production. Together, they initiated new deals with the Benin National Institute for Agricultural Research (INRAB) to formalize the seed production process with certification; and with the regional extension services and other actors to enable the supply of further complementary technologies. Songhai inspired its alumni to specialize, notably in seed production, paddy parboiling and processing. Conscious of the limits of the capacities of its credit schemes³ (Dalohoun 2005) and in pursuit of its objectives, Songhai marketed the alumni by projecting their technical skills and entrepreneurial competences before credit establishments. This appeal received a positive echo.

- 2 Songhai has limited processing capacities and problems occur when those whom it has not supplied also come to offer their paddy.
- 3 In its attempt to help its alumni and other prosperous farmers, Songhai has set up a Rural Micro Credit Scheme (for more details, see Dalohoun: 2005).
- 4 For confidentiality we can mention, with their consent, only those already publicly known.

La BRS: investors' reference

Interviewed on the Bank's involvement in NERICA-related activities, two management staff said:

We heard about the NERICA and we initiated contact with WARDA and INRAB. We wanted to get insights into rice production economy. It came out that NERICA production appears profitable given its characteristic traits and there's a growing market for the end product. The research institutes displayed a long list of business opportunities arising from NERICA seed and paddy production, harvesting, processing and commercialisation; all of which require substantial investment. Seed and paddy production requires financing of fertilizers, seeds, labour and small tools. Processing may require heavier investment depending on the production capacities envisaged. Storage and marketing are investment activities that also need strong financial supports. By connecting to WARDA and INRAB, the Bank got connected to networks of diverse actors. They are those whom the NERICA has also fascinated and who are either already in the business or willing to start. While BRS was initiating links towards these potential economic agents, they were also seeking financing possibilities with the Bank. To name just a few,⁴ we have links with TUNDE, BSS-SIPRI, farmers' associations in the central region and Songhai.

- TUNDE is specializing in processing and counts on BRS to finance a large capacity milling industry. It also expects the Bank to finance farmers with whom it is willing to enter contract farming relationships.

- BSS-SIPRI is involved in NERICA production, processing and commercialization. It expects the Bank to finance its activities as well as those of the network of its farmers.
- Farmer organizations – through collaboration involving INRAB, the Bank has been financing NERICA seed and paddy production in the central region. Besides other conditions, beneficiaries need to use seeds certified by INRAB.
- With Songhai, BRS has an exciting partnership agreement as described in Box 1 below.

Songhai was looking for appropriate credit schemes on the behalf of the RENAFERS. BRS was seeking skilled, competent and innovative economic agents with sound business plans. The Bank believes that possessing technical knowledge and good practices are not in themselves sufficient but comprise a necessary and significant success factor. Hence they concluded the following agreement:

- BRS finances NERICA-related business investments that Songhai alumni propose, given that:
 - o Songhai processes, selects and recommends the business plans
 - o Songhai provides seeds to the farmers or verifies seed sources
 - o Songhai buys paddy resulting from seeds it has supplied or verified
- Any economic agent willing to buy any agricultural equipment that Songhai produces can apply for credit at BRS to acquire it.

Interviewed BRS Staff

Box 1: An increase in linkages

The Groupe TUNDE (TUNDE): NERICA production hub

The group is a prosperous enterprise specializing primarily in printing and publishing. Recently, TUNDE has also become the exclusive concessionaire in Benin of the European automobile giant Volkswagen. Currently, it is becoming a key actor in

NERICA production. The Chief Executive Director revealed his ambitions when interviewed:

I heard about WARDA and its NERICA. I approached INRAB to establish the strength of the benefits claimed for the technology and how it could become an opportunity for business investment. I carried out profitability studies from seed through to edible rice covering paddy production, processing and commercialisation, which showed NERICA production to be lucratively attractive. My company is interested in processing, which is actually the bottleneck within the system. Many farmers are ready to enter contract farming with the company to produce seed and paddy. I am targeting Nigeria which constitutes a huge market. Starting from 250,000 tonnes I want to reach 600,000 tonnes of edible rice per year by 2010. Consequently, I am negotiating with diverse actors to experiment with irrigation potential on a 10-hectare site to demonstrate its profitability to competent entrepreneurs; and

also collaborating with INRAB to define a road map leading to seed multiplication on 4,000 hectares. So many farmers are enthusiastic to start producing NERICA.

BSS-SIPRI: providing hope for small producers

BSS-SIPRI is the official business name of an enterprise specializing in NERICA seed and paddy production, paddy processing and marketing. It has been experimenting with NERICA varieties (1, 2 and 4) on 20 hectares since March 2005. BSS-SIPRI is concerned exclusively with biochemical-free production using organic matter. According to its director, leaders of farmer organizations often abuse small producers, a situation he seeks to reverse by inducing behaviours with concrete and positive results that impact on the lives of small farmers. Eight hundred hectares of land in Benin are already enlisted by BSS-SIPRI (see Box 2 below).

I was seeking opportunities for self-employment [. . .]. I heard about NERICA, studied its profitability and decided to build my business on its production. Because I had so little knowledge about rice production, I needed to connect to whoever could help me: researchers, extension officers, farmers, government officials, banks, and traders. In some instances I deal with them individually, but in others I have to bring some of them together before we find appropriate solutions to certain issues.

Executive Director, BSS-SIPRI

Box 2: Entrepreneurial processes induce linkages

Involvement of PADRO

PADRO is a French NGO working with the extension agency, farmer organizations and micro-finance establishments, and indirectly with the Ministry of Agriculture. It aims to promote and support farmer organizations by providing technical services and adult training with particular attention to women. It also facilitates access to credits and helps farmers develop business plans. PADRO has credit schemes for farmers with a number of micro-credit organizations. An interviewed manager said:

PADRO focuses on rice in general, not on NERICA alone. However, the NGO is registering a great enthusiasm among farmers towards NERICA, with increasing demand for assistance. To respond to their needs, PADRO has to pioneer new sources of information and provide new technical services and more resources. Farmers appear more innovative and entrepreneurial minded towards taking advantage of NERICA. While some farmers want to make new use of impoverished land, others are concerned with covering rent through escape from the production of traditional crops. In addition to usual farm management knowledge, the farmers request support to design business plans enabling them to access various credit schemes. We seem to be observing the start-up of a promising and self-building commodity sector.

Yet, the route is still long and arrangements underway need profound adaptation, more commitment and policy changes.

VECO compelled to shift focus to NERICA

VECO is a Belgian NGO working through a project initiated in 2002 with focus on culture, communication, sustainable agriculture and food security. In practice, it contracts local NGOs to conduct specific activities with farmers on its behalf. In relation to NERICA, farmers have compelled VECO to shift focus to rice production by allocating more resources to enhance adoption of NERICA varieties. It has entered a realm of new challenges: new actors, rules, relations and resources. This led the project coordinator to declare:

[. . .] Pertinently, farmers are pushing as they themselves are pushed by their innovativeness. Fortunately, they are getting to know where to go and which doors to knock on. But when knocking on a door, they knock so hard that unexpected doors also open to them [. . .]

The government of Benin

Besides the will to improve agricultural production and reduce the pressure induced by the current food crisis, it is foremost the entrepreneurial dynamism stemming from the NERICA phenomenon that is encouraging and compelling the Benin government towards policies for agricultural business development. In February 2008, the government issued a new agricultural development strategy plan aiming to establish an institutional, legal, regulatory and administrative environment conducive for agricultural activities. The ultimate objective is to stimulate and improve investment in agriculture through the entrepreneurial process. Concrete and salient policy measures include (MAEP 2008):

- Land tenure improvement
- Ensuring the availability and accessibility of reliable and useful information on the agricultural sector
- The promotion of a new generation of agricultural entrepreneurs through the support and endorsement of agricultural training establishments to inspire the emergence of large-scale and entrepreneurial farming.
- Improving levels of funding (public and private) in the agricultural sector through the establishment of a national fund and proper credit schemes for agricultural development.
- Land development strategies to stimulate specific commodities in the valleys of the Ouémé, Mono and Niger rivers.
- Promote irrigation to enhance an increase from irrigated agriculture, from 1 per cent of hydro-agricultural development in 2004 to 5 per cent by 2011.
- Promote mechanization of agricultural operations from one tractor per 100,000 hectares in 2004 to one tractor per 2000 hectares by 2011

- Promote agro-industry to allow the processing of agricultural products, from 1 per cent in 2004 to 10 per cent by 2011
 - Increase and strengthen R&D capacities of INRAB to enhance adequate technological innovations for productivity improvements
 - Increase, strengthen and improve potentials and management capabilities of extension services
- 5 The average size of family farms is estimated at 1.7 hectares for seven people. However, 34 per cent of farms cover less than one hectare. Only five per cent of farm lands reach more than five hectares in the south against 20 per cent in the north of Benin (MAEP 2008).

Discussion and conclusion

The concept of a self-organizing system of innovations

In Benin, NERICA dissemination has not followed the conventional process. Instead of the usual intervention methods of new technology promotion through assistance programmes, entrepreneurial venture has activated the process leading to what is called a self-organizing system of innovations. This illustrates the process of how a system of innovation emerges, develops and becomes sustainable. Initially, the local Benin media reported informally about WARDA among its general reporting since the organization was new to Benin in 2005. Its central focus was portrayed as the breeding of a family of New Rice for Africa (NERICA), and there was additionally some briefing on the economic potential of these new rice varieties which caught the attention of several economic agents. Self-motivated economic entrepreneurs then deliberately engaged in interactions with the national agricultural research institute (INRAB) and WARDA to determine the strength of the claims made for NERICA varieties. They also performed profitability studies with the objective of transforming the new technology into opportunities for business. Hence, diverse agents (entrepreneurs) found their ways converging on this same NERICA when they were pursuing individual (initially) growth and development interests. In their attempts to methodically marshal resources necessary to exploit the potentials of the NERICA, they consequently entered relationships with one another and also with yet other secondary organizations and partnerships:

- Trying to develop non-traditional investment opportunities, the BRS has been financing NERICA-related activities at both farm and post-harvest system levels.
- The Groupe TUNDE SA, specializing primarily, in printing and publishing is becoming a NERICA production hub. Targeting the neighbouring Nigeria as a big market, it is setting-up a milling industry to process 600,000 tonnes of edible NERICA per year. To achieve these objectives, it is working with WARDA and INRAB researchers, extension officers, diverse experts, farmers and other economic agents.
- BSS-SIPRI is the official business name of another enterprise specializing in NERICA seed and paddy production, paddy processing and marketing. It started experiments with NERICA varieties (1, 2 and 4) on 20 hectares in March 2005. BSS-SIPRI is concerned exclusively with biochemical-free production and has already mobilized about 800 hectares of land (a very big production area in the context of Benin).⁵

- Some farmers are exploring possibilities of how to make new use of impoverishing lands while others were concerned with rent seeking through escape from the production of traditional crops, get into NERICA-based innovation processes.
NGOs (PADRO, VECO etc.) are compelled to shift focus to the promotion of NERICA based on the needs of farmers they support.
- The research and extension system is being propelled to be more proactive towards the farming community involved in NERICA.
- The Government of Benin is prompted to create or adapt new policies and institutions to support the NERICA-based innovation processes. It has recruited about 2000 new extension agents to support the process.

Some ways forward

The concept of a self-organizing system of innovations as enhanced by the example of NERICA dissemination in Benin seems ideal and challenging. It conveys the idea that when entrepreneurs take the lead in sourcing innovations, an innovation system emerges independently of any particular intervention method. Yet, the route towards its maturity is still long and requires to be sustained by an agricultural innovation policy that enhances necessary adaptation, commitment and policy changes. Benin lacks a formal innovation policy. In practice, it is the innovation policy that provides incentives for economic agents and guides their actions. However, innovation is an ubiquitous phenomenon (Lundvall 1995) and 'innovation activities are performed within a framework shaped and organized by public policies of tangible and intangible infrastructures, legislations, fiscal and education systems and other regulations' (Hauknes and Wicken 2003: 14). In addition to the measures included in the Benin Government strategic plan to revitalize the agricultural sector, one could recommend the expansion and intensification of overall innovation capacity building, development and strengthening; but without an innovation policy, such efforts might all appear to be like putting a vessel to sea without a compass.

Our findings suggest that investing in entrepreneurial development can hasten the emergence of a system to mobilize resources for successful agricultural innovation processes. Entrepreneurial process stimulates dynamic interactions among self-motivated actors in their quest for diverse resources under new, improved or adapted institutional arrangements (see Box 3 below). This implies that efforts to promote innovation need to expand beyond the conventional focus on research and extension. Support to agricultural technology dissemination processes must go beyond assistance to poor or small farmers. Much more emphasis needs to be given to financing, to policies or institutions and to other activities that can enable entrepreneurship. Indeed, for all the efforts and focus on enabling innovation through research, participation, poor farmer empowerment and partnership, it seems that the international community has forgotten that enabling innovation is as much to do with enabling entrepreneurship, since most technologies transform into innovations through business mechanisms.

In 1997, the extension agency campaigned and mobilized farmers to produce rice. It provided training on farm and post-harvest system activities. In the absence of a proper seed mechanism, paddy served for seed and yields began to decrease from year to year. Credit was inappropriate, rare and virtually unobtainable. Later we discovered that Songhai provided credit in the form of seed and also committed to buy the paddy. But its processing capacity is limited and we could scarcely expand our production. Now, NERICA (with its advantages) couples with the TUNDE milling industry project to revitalize hope in rice production.

As an experiment, TUNDE has financed seeds, fertilizer and technical assistance for 40 farmers who may become seed and paddy producers. Every farmer received two NERICA varieties and one local variety, each of which is to be tested on a plot of 200mL under the same conditions. NERICA has proven superiority but its production requires a new dimension of actions. First, its production requires proper seed. Secondly, to appear credible, one needs to have a business plan and demonstrate competences for its implementation. A producer needs to be dynamic enough to become involved in relations through which he can tap into available funds for agriculture, credit schemes at BRS and other inputs (fertilizers, pesticides and herbicide, transport etc.) with traders. He also needs to negotiate the supervision of INRAB for the seed certification process and technical advice, and a follow-up by the extension agency. You see, our training on agricultural entrepreneurship has a payoff: it is allowing us to take advantage of NERICA.

Rice Farmers' Association, Ouémé

Box 3: Agricultural entrepreneurial training spurs innovation

This revives the debate over the interplay between innovation systems and entrepreneurship. An analysis of an innovation system that does not take account of entrepreneurship renders this concept irrelevant (Radosevic 2007). Literature on innovation systems highlights the important role the private sector plays in innovation processes (World Bank 2008); but it fails to capture and explain the essence of the dynamic mechanisms through which it does so. The emerging approach highlighted in this paper shifts focus from the private sector to entrepreneurship. Indeed, at either corporate or public sector levels, it is the entrepreneurial mind that causes changes and developments. The French economist Jean-Baptist Say regarded economic development as the result of venture creation and hoped the English Industrial Revolution would spread to France and help serve as means of developing farming through entrepreneurship (Filion 1997). Explicitly, he was expecting the dissemination of new technologies in French agriculture through entrepreneurial processes. Drucker (1985) also notes that, on its own, technology is not worth a great deal. One starts to create things of great value only when the technology meets the market through the catalyst of entrepreneurial management (Butler-Bowdon 2008). Research on innovation systems in developing countries' agriculture should consider expanding and deepening the theoretical development of the framework merging the concept of innovation system and entrepreneurship theory. Empirical studies will be associated and emphasis will be put on how to create, develop and sustain a class of agricultural entrepreneurs in developing countries.

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