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Factors Influencing Scaling-up of Agricultural Innovations: Lessons from Ghana

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FARA serves as the technical arm of the African Union Commission (AUC) on matters concerning agricultural science, technology and innovation. FARA has provided a continental forum for stakeholders in AR4D to shape the vision and agenda for the sub-sector and to mobilise themselves to respond to key continent-wide development frameworks, notably the Comprehensive Africa Agriculture Development Programme (CAADP).
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Summary

Agriculture led development has become the buzzword in many development literature, given the impression that without Agriculture, development all over the world will be stalled. This assumption is premised on the fact that for the world to survive, food production to feed the ever growing population of the world would have to be doubled by 2050 (). Achieving such greater strides in the agricultural sector growth requires the innovative use of existing and new technologies and innovations that are directed towards increased land and labor productivity, efficient use of natural resources as well as adopting policies that ensures that producers in general are able to reach markets that generate greater value additions and sustainable incomes. Ensuring that such innovations contribute to the 'One World No Hunger' initiative of the German Government, the project dubbed "Programme of Accompanying Research for Agricultural Innovation" (PARI) is currently running in 12 different African Countries, each supported by the German Government through GIZ and implemented in Africa by the Forum for Agricultural Research in Africa (FARA). This project aims at facilitating efficient and functional innovation systems research and development in partner countries. In 2016 the PARI sponsored a study into exploring the factors determining scaling up of innovations and technologies in Ghana to inform policy about the factors needing critical focus in the area of scaling up of agricultural innovations. Agricultural innovation development are seen as important tools by which majority of the poor in developing countries, whose livelihoods depends on the agriculture sector can descent out of poverty. Yet in spite of this understanding most technologies and innovations developed in such agro based still find themselves on the shelves of the scientific communities. The rate of adoption of these technologies still remains low and limited, circulated among a few farmers in most of these countries. Generally, scaling up has been given little attention especially during the research design phase which is critical for any uptake activity. It has rather been considered as post-project activity. This study was aimed at exploring the literature on Agricultural Innovations in Ghana, as a way of highlighting the potential factors that influence widespread scaling up of agricultural innovations diffusion in Ghana and elsewhere. This work was mainly carried out by reviewing previous studies carried out in Ghana on scaling up of selected Agriculture innovations in Ghana. This review study indicates that capacity building, inherent attributes of the innovation, establishment of partnership strategies are among the key factors determining widespread scaling up of new innovations in the country. The study therefore recommend that future studies on scaling up of innovations in agriculture needs to broaden its scope to include all such factors. It is generally recommended that scaling up must be an integral part of any agricultural project that seeks to reach a large section of the farming population and this must start from the scratch to be able to have a wider impact on society.

Key Words:

Agriculture, Innovations, technologies, Scaling up, Ghana,

Introduction

Increasingly, there have been calls for research and development activities to go beyond pilot and one-off projects. These clarion calls have come about as a result of development partners' and funders' inability to adequately account for the impacts of their investments in terms of sustainability (Cooley and Linn, 2014). Many projects have been cited in several places with heavy investment from tax payers' money but in most cases these projects have either remained at the pilot stages or died when funding is exhausted. Thus, most projects have often failed to see the light of day as they could not reach be scaling up stage. In many cases, the supposed beneficiaries have remained worse off after the execution and completion of such projects. This and other reasons raise questions about the causes of such failures.

Reports by some agencies such as the International Fund for Agricultural Development (IFAD) suggest that about one billion poor rural people live in developing countries and that global food production will have to increase to 80 percent by 2050 to be able to meet the growing food demand (International Food Policy Research Institute [IFPRI, 2014]). The process of meeting this demand will require producers to increase production. The opportunity to do this seems to be offered through introduction of new technologies or technological innovations (Feder *et al.,* 1985). For more than 20 years, US$4 billion has been spent on agricultural research in Africa alone (Gundel, 2001), yet agricultural productivity in the same period has been stable or often has decreased (McCalla in Gura and Kreis, 2000). The question of why this state of affairs still remains unanswered.

Innovations in agriculture have been seen as the powerful means to address the problem of low agricultural productivity in sub-Saharan Africa (Larsen *et al.,* 2009). This assertion has been supported by many authors. Menter *et al*. (2004) reported that pressure was brought on research and development (R & D) institutions to ensure that funds being brought in must bring a lasting impact on the lives of people and communities, especially the rural poor. The institutions funded should also ensure that research is more effective in developing technologies that are adopted readily (Hounkonnou *et al*., 2011).

The government of Ghana seeks to modernise agriculture (FASDEP I & II) with a view to overcoming certain constraints in the agricultural sector. The constraints include inadequate technology development, dissemination, and adoption; and food insecurity. The aim is to improve productivity and production through science, technology, and innovation (MOFA, 2007).

For purposes of this study, agricultural modernisation or modernised agriculture is defined as state-supported initiatives to transform agriculture through mechanisation, synthetic inputs, new high-yielding varieties, and standardised recommended practices (Amanor and Pabi, 2006). Some agricultural technologies and innovations developed by the Council for Scientific and Industrial Research (CSIR) and other public institutions have been identified in Ghana. These have been characterised into domains such as crop variety improvement, crop pest and disease

management, improved agronomic and cultural practices, fisheries technologies, poultry-related technologies, weed control, soil fertility management, and livestock-related technologies (Ampadu-Ameyaw *et al*., 2016). However, these authors pointed out that a number of challenges affected the development, dissemination, adoption, and scaling up of technologies and innovations in Ghana.

Due to these challenges, not all the technologies identified could be regarded as innovations because they were at different stages of dissemination. Scaling up of such technologies was considered necessary for all identified technologies given that they may not be generating socio-economic benefits at any initial stage. Factors that have fostered innovations as postulated by Amanor (1994) include struggle with microclimate change by especially smallholder farmers, spread of exotic new weeds, and dramatic changes in relative prices. Evidence from some case studies in Africa according to Amanor (1994) suggests that high populations can result in agricultural innovation and sustained production (Mortimore, 1998; Tiffen *et al.,* 1994). Other factors tend to be either policy or market driven (World Bank, 2007). With the renewed focus on science, technology, and innovation-led development across the globe, understanding the factors that influence the spread of these technologies and innovations has become critical to policy makers, practitioners, donors, and the academia. Yet in spite of the numerous works done on the subject, there seems to be little focus on the determinants of innovation diffusion. While literature on scaling up of agricultural innovation abounds, most of it does not talk about the factors that influence the task of scaling up. This is the main objective of this paper.

Problem statement:

- Several technologies and innovations have been developed and given to farmers, yet the spread and impact of the technologies/innovations is not felt on the ground
- Access to funding is becoming problematic as citizens demand accountability of moneys spent on research
- Poor understanding on how new technologies and innovations are faring on the market and being adopted
- Understanding of the factors that determine diffusion of technologies/innovations is critical in understanding factors hindering uptake and therefore scaling up of new technologies and innovations.

1. Objectives

As pointed out above, this study aims at exploring scaling up factors that determine the successful up scaling or otherwise of agriculture innovations in Ghana. This is done through a case study approach by analysing selected agricultural innovations to determine the strategies used to scale up as well as factors that account for successes or failures of the scaling up. Findings from this study will provide useful inputs for researchers, governments, the private sector, donors, and other stakeholders to improve scaling up processes for innovations so as to maximise their socio-economic impacts on the wider population.

2. Conceptualisation

Agricultural Innovations

Innovation is the process of applying new or existing knowledge in new ways and contexts to do something better. It is a process that transforms ideas into outputs by replacing older established products, processes, and services with new ones (KARI, 2013). This transformation may be in products, processes, or services and can be incremental or radical and at various levels of the value chain. The Oslo manual for measuring innovation (OECD, 2005) defines four types of innovation namely, product innovation, process innovation, marketing innovation and organisational innovation.

Product innovation refers to a good or service that is new or significantly improved. This includes significant improvements in technical specifications, components and materials, software in the product, user friendliness, or other functional characteristics. Process innovation refers to a new or significantly improved production or delivery method. It includes significant changes in techniques, equipment, and/or software. Marketing innovation implies a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. Organisational innovation refers to a new organisational method in business practices, workplace organisation or external relations. Innovation consists of three basic elements: (i) technology innovation, including new varieties or breeds and soil or water management practices; (ii) organisational innovation, in terms of organising and delivering knowledge in new ways; and (iii) institutional innovation, in terms of rules, cultures, values, norms, behaviour, policies and laws (KARI, 2013).

Scaling- Up defined

There have been several contexts and definitions to which scaling-up has evolved but themes that run through the definitions are scale of impact, quality of impact, impact for whom, and sustained time frames (Binswanger and Aiyar, 2003).

The popular view of scaling up persists that it applies to only tangible objects (Fatunbi *et al*., 2015). Others feel that scaling up is not only about projects but for programmes and policies (World Bank, 2005) and therefore pre-defined scaling up as “the efficiency increase of socioeconomic impact from a small to a large scale of coverage”. After decades of neglect, volatile food prices, and persistence of hunger and malnutrition, the World Bank found a need to frame it in the context where governments, non-governmental and development partners including various actors could or should focus on how development interventions that have been successful could be up scaled to get the best and leverage on the gains in agriculture, rural development, and nutrition (World Bank, 2012).

In Agriculture, production may involve the scaling of agricultural innovations such as disease-resistant and drought-tolerant maize varieties, zero-tillage techniques, permaculture cultivation practices based on perennial crops, and automated milking systems (Wigboldus, 2016).

According to the International Institute of Rural Reconstruction (IRR, 2000) scaling up implies bringing more quality benefits to more people over a wider geographical area, more quickly, more equitably, and more lastingly stressing on more. From the agricultural innovation system concept or model (IAR4D) introduced by FARA, which aims to have a "good impact" (Fatunbi *et al*., 2015), scaling-up is defined as "efforts to increase the impact of innovations successfully tested in pilot or experimental projects so as to benefit more people and to foster policy and programme development on a lasting basis" (Simmons, Fajans and Ghiron, 2007). In this paper, this definition of scaling up will be adopted although the definition of IRR (2000) is more widely used. The adopted definition for this paper is echoed by Uvin (1995), who viewed scaling up as a successful transitional process from a pilot project to a large-scale, multi-dimentional operation.

Due to the complexity of the scaling up concept (Franzel *et al.*, 2010), there is currently very little knowledge about its precise meaning (Uvin, 1995). Scaling up has been considered in much broader terms, that is, as a process of adaptation, innovation, feedback, and expanded human capability (Krishna *et al.,* 1998). Also, depending upon the object of scaling up, the concept could mean transition, institutionalisation, transformation, integration, incorporation, evolution, and development (Wigboldus and Leeuwis, 2013). It should however be noted that 'scaling up' is often said to have come from a research and development model that forecasts research being done to identify possible improvements to agricultural practice, testing and refining such interventions in pilot locations and then widely disseminating the refined interventions (linn, 2012).

Scaling up is typically a long-term, non-linear process that combines generalised and context-specific approaches, focusing on the order of activities, integrating local and 'external' knowledge and mainstreaming new processes and principles (World Bank, 2003). Armed with the knowledge of the research gap, development agencies have sought to identify certain factors that prevent the increase in productivity and "hindering the realisation of meaningful transformations of people's lives despite decades of government and donor expenditures on poverty alleviation" (Wabungu, 2011).

Theories for scaling up centering on projects include but are not limited to that of UNDP (2013), which sees scaling up as processes that can take many forms. Scaling up can range from the national level, covering the whole population and then be upgraded to a policy reform having come about through a successful pilot, thereby reaching the wider geographic area and covering a greater number of rural and urban poor (Fatunbi *et al*., 2015). In covering a wider geographic area and number of people, Gundel *et al*. (2001) view scaling up to be of two dimensions, that is, horizontal and vertical. According to Uvin (1995), four different dimensions of scaling up exist: (i) quantitative (ii) functional (iii) political and (iv) organisational, which include 17 different kinds of focusing on structure, strategy, and resource base (Uvin and Miller, 1999) that will not be dealt with in this paper.

Extensive literature has often proposed a technology-transfer paradigm that has often implied that the main issue in scaling up "is to replicate the use of improved practices" (Franzel *et al.,* 2010). In this replication, there will have to be the exchange of information noted by Passioura (2010), that one of the most potent impediments in the facilitation of the scale up of agricultural research and development is method of "technology transfer". This implies a one-way flow of information and gives no indication of a mutually stimulating dialogue. It continues to argue that such a dialogue expedites scaling up. One important criticism of the conventional approach to technology dissemination (transfer-of-technology) from a livelihood perspective is its failure to reach the poor (Gundel, 2001). Here success has often been restricted to 'Green Revolution technologies' that best fit the needs of better-off and resource-privileged farmers (Conway 1997). Due to this situation, Cooper and Denning (2000) and Denning (2001) identified ten essential and generic elements of a successful scaling-up strategy.

Following these discussions, the analytical framework shown in Figure 1 will guide this study. The Framework is based on an existing framework developed by Hartmann and Linn. The framework details the roles in which drivers and pathways contribute to successful scaling of innovations.

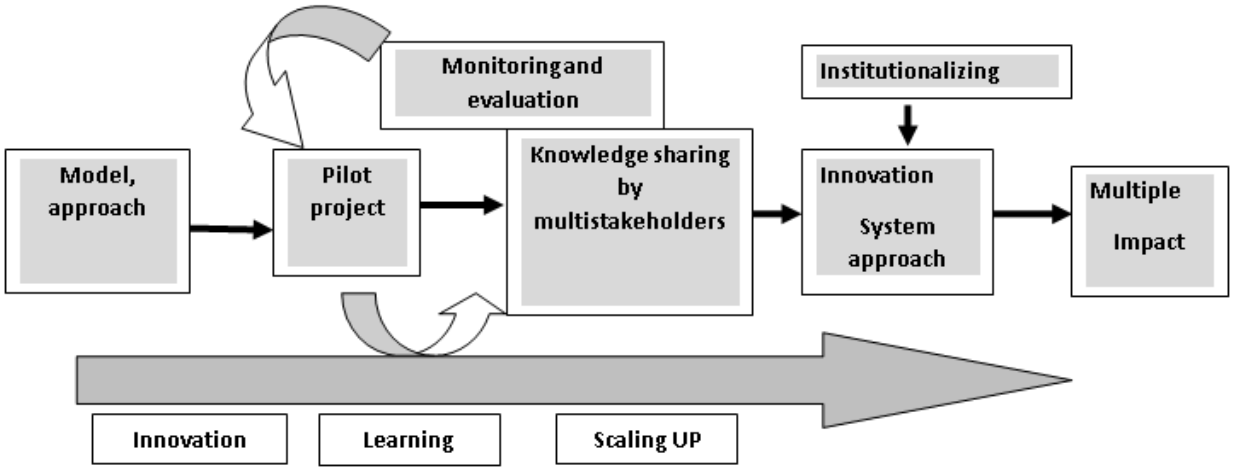

Figure. 1 : Analytical framework for scaling up
Source: Adopted and modified from Linn *et al*. (2011)

Methodology

The study aims not to provide a generalised method for scaling up but to prescriptively look for patterns that could provide explanatory analysis (Flyvbjerg, 2006; Yin, 2003). Thus, a case study approach involving analysis of "successful" and "unsuccessful" scale ups was adopted. This approach will not only enable an understanding of the scaling up processes but will also ensure

reliability and validity through the recognition of relevant indicators. The cases under consideration were selected from a report on the inventory of agricultural technologies produced by Ampadu-Ameyaw *et al.* (2016).

The definitions of innovation presented earlier presupposed that not all the 270 technologies presented by Ampadu-Ameyaw *et al.* (2016) could be classified as innovations because they were at different stages of development, transfer, and application. On that basis, six technologies were selected as innovations because they had been extensively disseminated and beneficiaries were applying them to generate socio-economic outputs. These innovations were further classified into successful and unsuccessful innovations based on the level of scale up. Successful scale-up innovations in this case were those that had been disseminated to other beneficiaries apart from those in pilot projects. In these cases, the beneficiaries both within and outside pilot projects were applying the innovations to generate socio-economic outputs. Unsuccessful scale ups were those innovations that could not be extended to beneficiaries beyond the pilot projects or those that were being applied only by the pilot project beneficiaries even though the innovations might have been disseminated to other beneficiaries. Both the successful and unsuccessful innovations were analysed to understand the scaling up strategies and to determine the factors that contributed to the successes and failures of the scaling up.

Findings and discussions of overview cases

This section gives an overview of the six selected innovations serving as case studies to draw out key elements required for an innovation to be adopted at scale or successfully scaled up.

1. **Simple Water Control Strategies for Rice Cultivation**

Statistics indicate that rice is fast replacing some of the popular traditional foods in many households; this makes the government spend millions on foreign exchange for its importation. Concurrently, rice is produced by both large- and small-scale farmers. At both scales, it is characterised by high costs of inputs and low yields, factors that reduce farmers' income margins.

The simple water control innovation that includes cheap and easy-to-construct terraces can be replicated in many places. This innovation began in the 1990s as an integral part of a multidisciplinary research project into producing rice and reducing poverty while cutting down on the cost of fertilisation. The aim was to ensure sustainability, help create employment, and reduce food insecurity for both locals and the country as a whole.

It is a collaborative effort with WARDA; the Agricultural Services Sub-Sector Investment Programme (AgSSIP); the Adapted Social Security Strategy and Action Plan (ASSAP); and the Soil Research Institute (SRI), with the Crop Research Institute (CRI) as the main body in charge of the project. Funding was provided by JICA.

This initiative succeeded partly because the government acquired about 5000 hectares of land in about 5 selected regions. The land was acquired for use in a programme to train prospective

farmers in agronomic practices related to the use of the innovation. Moreover, the innovation enabled reduction of production costs and improvement of farm management practices. For example, it aimed to minimise use of fertilisers and chemicals and hence increase profits. Though scaling up has been successful, efforts to widen the success have been hampered by scarcity of land. The rice crop is being treated as both a subsistence and commercial crop. It is grown on about 1.4 million hectares throughout the country, mostly on rented land. Farmers are looking up to the government to improve farming and related conditions. Moreover, the cost of fertiliser is prohibitively high; the situation is exacerbated by the shallowness of Ghana's soils. Rice is now cultivated in almost all parts of the country including the forest ecological regions for home consumption; the surplus is sold. Average production for 2007 was about 185.3 mt. Inconsistency in rainfall duration and amounts is another factor that frustrates farmers as most of them rely on rainfall.

2. Improved Nile Tilapia (Akosombo Strain of *Oreochromis niloticus*)

The Akosombo strain of the *Oreochromis niloticus* (Nile Tilapia) was developed by the CSIR-Water Research Iinstitute in 1997; it was improved between 2001 and 2006. The advantage of the improved strain includes its fingerling growth rate that is at least 25% faster than that of those collected from the wild.

The aquaculture industry was to be made viable and profitable so that it would contribute its quota to help solve the problem of protein imbalance and alleviate poverty among the population through the breeding of the improved Nile tilapia strain.

The project is a collaborative effort involving the farmers, the Water Research Institute, and the WorldFish Centre. It spans over 10 years and is funded by Ghana Government through the World Bank-sponsored projects--NARP and AgSSIP, as well as UNDP and EU through the WorldFish Centre. Successful scale up strategies have been: dissemination of information through workshops, local and international conferences, seminars, on-farm trials in farmers ponds, and farmer-to-farmer contacts. These dissemination efforts proved to farmers that they could increase their yields by rearing the strain.

The governments and authorities of various countries in the western Africa sub-region have supported dissemination and adoption of the innovation through projects funded by development partners such as the FAO-sponsored project, "Aquaculture investments for fish farmers through improved management of Tilapia genetic resources", which was inaugurated in 2009 at Abidjan, Cote d'Ivoire. The project promoted the use of the Akosombo strain among six countries within the Volta Basin (Benin, Burkina Faso, Ghana Cote D'Ivoire, Mali and Togo). It subsequently led to a sixfold increase in Nile Tilapia production in Ghana and the other countries in the sub-region within three years.

3. Technology for the production of high quality cassava flour (HDCF)

Cassava is an important food source and a famine preserve with low cost/input and flexible production. The country has lately been promoting cassava use and the improvement in its

value chain due to its popular use in traditional foods such as *gari, fufu,* and *agbelima.* But cassava has a short shelf-life and should either be consumed immediately after harvesting or processed into shelf-stable products. The technology described here was intended to improve the traditional method of processing cassava and also produce a flour for rural-based bakeries. Cassava itself is used as a means of improving incomes of the rural poor where the locals derive their income from its production.

The innovation was a collaborative effort between six organisations: the CSIR-Food research institute; CSIR-Forest Research Institute; National Board of Small-scale Industries; Department of Nutrition and Food Science at the University of Ghana; Ministry of Food and Agriculture; and the Natural Resources Institute of the United Kingdom. It was funded by the Department of International Development (DFID). The technology has been transferred to small-scale processors who enjoy horizontal linkages with fellow processors and vertical integration with end-users. Cassava farmer groups are also linked to SMEs who are then also linked to larger firms. This is one key success in the scaling up of the innovation and has been replicated in other regions. It has brought about entrepreneurship development and relationship building due to linkages and training in the business of cassava farming. Cassava farmers were given other training in good agronomic practices; the training has seen many farmers who initially struggled to produce enough yields to feed their families now enjoying high yields. Though the innovation initially lacked policy support for the uptake of HQCF in the flour industries, the Ministry of Science and Technology and Innovation, in Ghana is assisting to develop a national policy on composite flour production and usage in Ghana, which will be a stepping stone to further scale up the innovation.

4. Maako-Ntoose

The Maako Ntoose, which is a new variety of pepper with the characteristics of tomatoes, was developed by CSIR-Crop Research Institute. The yield of this variety was estimated to be about 35 metric tonnes per hectare over the cropping season of about 5 months and it was expected to increase yield and lower cost in the processing of pepper. The advantage this innovation was its nutritional qualities, particularly Vitamin C. This advantage was the main reason why the researchers collaborated with the Asian Vegetable Research and Development Centre, the Ministry of Food and Agriculture, A. Panford Ltd--a private commercial agro-processing company, and the Vegetable Producers and Exporters Association of Ghana to conduct this work. Results had not been fully disseminated to end-users, but awareness had been created about the Maako Ntoose through print media and on the Internet.

The project initially faced challenges including late release of funds and lack of transportation to move the research from one ecological zone to another. Seed production equipment needed to enable production of the seed on a commercial basis was not available and there was no strong seed production system. Institutional structures for promoting the innovation were weak, and there was no seed law, neither were there forums in Ghana to create wider awareness of the innovation.

5. **Utilisation of Azolla as manure in lowland rice cultivation on the vertisols of the Accra Plains**

The innovation involved the development of techniques by which Azolla, a fern mainly found growing on the surfaces of ponds and also along the lower Volta Lake at Kpong and Asutuare, fixes nitrogen through a symbiotic association with an alga, *Anabaena azollae*. The product of this association can be utilised as green manure in rice fields, and has been reported to lead to a saving of 21 percent in the use of organic fertilitiser. Nitrogen has been found to be a major constraint in the production of rice grown under irrigation on vertisols of the Accra Plains. The constraint is attributed to low fertility because of low levels of organic matter in the soils. Consequently, the symbiotic association helps farmers to reduce the cost of rice production since they need not buy much fertiliser for their crops.

The innovation was the result of a collaboration between the Agricultural Research Centre at Kpong, the Ecological Laboratory, and the Soil Science Department of the University of Ghana. The project was funded by AgSSIP with some support from the Kpong Irrigation Project. The only means of disseminating the results was through a farmers' forum, which has been limited to participants of the forum only. This is due to scarcity of funds and has limited its coverage. Due to intense heat, Azolla is not available all year round. Replication can only be done in some parts of the country provided the temperature is high enough to support the growth of the fern. Azolla is recommended for areas that are waterlogged most of the time. Extension workers in the Ministry of Food and Agriculture have not been involved sufficiently in disseminating this innovation. There should be a policy on practices such as burning of bush and rice straw, to increase the benefits of the innovation.

6. **The market for provision of agricultural mechanisation service provision market**

Due to the decision by the government of Ghana (GoG) to embark on transformation of agriculture under its Medium Term Agricultural Investment Plan and Accelerated Agricultural Modernization Policy, private enterprises known as Agricultural Mechanization Services Enterprise Centers (AMSEC) were established. Moreover, agricultural machines are provided to farmers at subsidised rates to scale up tractor-hire services to smallholder farmers. The government perceived this as a viable business model that could be attractive to private investors based on the firm investment theory and field-based assumptions on the various costs and revenue. The AMSEC concept was initiated in 2003 to provide timely and affordable mechanised services to farmers who cannot afford agricultural machinery on their own (Agricultural Engineering Services Directorate, 2003). Initially, the proposed AMSEC package included a range of agricultural machinery such as tractors, harvesters, boom sprayers, planters, power tillers, seed drillers, slashers, ridgers, and rice mills. However, during AMSEC implementation, this package changed. On average, each AMSEC was allocated a package of five tractors with basic implements such as plows, harrows, and a trailer. According to the Agricultural Engineering Services Directorate of the Ministry of Food and Agriculture, the decision to allocate five tractors to each AMSEC was based on the expectation that each AMSEC could serve in a season about 500 small-scale farmers with an average land holding of 2.0 hectares. This was to be implemented in both the northern and southern parts of the country.

Challenges faced included the need for individual tractor owners to migrate across the two rainfall zones between the north and south. The demarcation between seasons makes it possible for tractor service providers to migrate from the north to the south and vice versa to offer plowing services (for a maximum of 45 days) in either region. However, in practice, migratory service providers are rare. According to various studies, it was hampered by a number of factors, including service providers' lack of knowledge and limited networks outside their own regions, additional costs imposed by operators' oversight, and lack of support in making the necessary logistic arrangements.
Moreover, it turned out that the service charge in the northern part of the country was lower than that in the southern part. Also, the gross margin in the north was lower than that in the south due to the fewer effective plowing days that made it unattractive for owners, considering the high initial cost of investment.

Discussion

This section presents factors that influence scale up of innovations based on the above six case studies. The analyses of the cases showed that three innovations (high quality cassava flour (HQCF) innovation; Improved Nile Tilapia; and Simple Water Control Strategies for Rice Cultivation) were successfully scaled up. The unsuccessfully scaled innovations were Maako-Ntoose; Utilisation of Azolla as Manure in lowland rice cultivation on the vertisols of the Accra Plains; and the market for provision of an agricultural mechanisation service.

Factors Contributing to successful scaling-up

Some elements of strategies for scaling up can be seen in, for example, the high quality cassava flour (HQCF) innovation where there was the fostering of linkages within HQCF processors and among HQCF processors and end-users under the project C:AVA (Cassava: Adding value to Africa). Gundel (2001) stated that 'identification of appropriate research objectives and outputs within the development process to ensure widespread uptake, networks, and partnerships were some of the strategies for scaling-up." This statement has been reiterated as very important in natural resource management and for scaling up (see Uphoff, 1998; Borrini-Feyerabend *et al*., 2000, Gundel, 2001). Networks and partnerships do not only cover farmers and processors but a wider range of stakeholders. Studies that have included a wide range of stakeholders are able to generate change across many levels and sectors of the society (Wambugu *et al*., 2011). An example is the SCALE methodology in central Kenya, which proved effective in making civil society stakeholders plan and implement campaigns to promote fodder shrubs (AED, 2006).

The establishment of formal partnerships and informal networks can strengthen institutions to scale out technologies (Carter and Currie-Alder, 2006). Partnerships between the non-governmental organisations (NGOs) and the government could also extend impacts to a wider stakeholder coverage and to the poor while building the capacity of researchers (Millar and Connell, 2009). Collective action and farmer-to-farmer dissemination through the use of lead

farmers' ponds in order to convince other farmers of the yield increase and positive performance of the Akosombo strain led to the success of the uptake of the innovation. In a study by Wambugu and Franzel (2004), it was found that fodder shrub adopters had on average passed on information to six other farmers producing a huge multiplier effect (Wabungu *et al*., 2011).

Capacity-building facilitated scaling up as in the case where the Food Research Institute and the Root and Tuber Development Programme (RTIP) made certain initiatives to promote the use of the innovation through the development of recipe books. The Women in Agricultural Development (WIAD) Directorate of MOFA trained several bakers, caterers in vocational institutes in all the regions of Ghana, and cassava farmers in the business of cassava farming and entrepreneurship development. The training incorporated capacity-building objectives through the development of appropriate dissemination mechanisms and not just showcasing products at an early stage (Gundel, 2001).

Inherent attributes of the innovation have been identified as another key factor for adoption and scaling up as they can be very important in decision-making and other considerations (Wambugu *et al*., 2011). An example of the simple water control strategies for rice cultivation is its intrinsic property such as its ability to reduce the cost of production through minimisation of fertiliser use, which increased the adoption by farmers. Farmers consider such benefits of the technology before deciding to adopt a new agricultural practice (Wambugu and Booth, 2010).

Funding is a critical factor for successful scaling up. This was evident in the HQCF technology, which has received funding from the C:AVA Phase II project that was funded by Bill & Melinda Gates Foundation; Root and Tuber Development Programme (RTIP) that promoted the use of HQCF for the bakery industry; and the Ministry of Environment, Science, Technology and Innovation. The West Africa Agricultural Productivity Programme (WAAPP) facilitated and funded the development of the composite flour policy. *Enabling policy environment* also plays a major role in ensuring successful scale up, hence this was considered as critical for the promotion and utilisation of HQCF in composite flour for bakery products.

Factors that contributed to unsuccessful scale up

Seed or unavailability of planting materials in the case of the Maako ntose led to the inability of the farmers to take up the innovation. In a study conducted by Wambugu *et al.* (2011) it was found that seed availability was a key constraint in milk-producing areas in Kenya; the only solution was through ICRAF and partners, who helped small-scale private seed entrepreuneurs meet seed demand and thus launch a thriving private seed market that is key to sustainable growth in the adoption of fodder shrubs.

Lack of extension services was found to be one of the pitfalls of innovations that could not be scaled up. An example is the case of the Utilization of Azolla as Manure in lowland rice cultivation on the vertisols and the maako ntose. A study on how to counter an increasing demand for information and planting materials for fodder shrub by Wambugu and Booth

(2010) showed that mechanisms for involving a wide range of extension service providers including NGOs, private companies , CBOs, and farmers was the best way of addressing this problem (Wambugu *et al.*, 2011).

Lack of funds and declining budgetary allocation to the extension service (Republic of Kenya, 2001) led to the lack of involvement and shortage of extension service providers as indicated in the study by Wambugu *et al.* (2011).

Conclusion and Recommendations

From literature, it can be inferred that scaling up must be an integral part of the project from the onset and strategies must be put in place to enable successful scaling up of an innovation. Some of the strategies were: enabling policy environment; intrinsic property or inherent nature of the innovation itself such as being simple and able to reduce costs, partnerships and networking including farmer-to-farmer dissemination of information; collective action; and involvement of extension providers. Funding must be adequate. Furthermore, partnerships between governmental and non-governmental organisations that provide support to projects by fostering capacity-building and training of farmers and stakeholders must be encouraged. Finally, according to Gundel (2001), from the perspective of researchers, scaling up has been neglected or given very little attention during the research design phase; it has often been considered a post-project activity and therefore recommended to for inclusion in the pre-project design.

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