Introduction

WHY FOCUS ON INNOVATION SYSTEMS: IMPLICATIONS FOR RESEARCH AND POLICY

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This book provides knowledge gained from applying the innovation systems (IS) concept to agricultural and rural development (ARD). It attempts to respond to perplexing questions which continue to dominate the agricultural innovation agenda, particularly in the context of smallholder farming systems. These debates generally converge around the role of research and development (R&D) and science and technology (S&T) in the innovation process, the levels of public investment required and the innovation pathways to be pursued. And, more critically, what policies and institutional mechanisms are needed to sustain agricultural innovation and how governments can ensure that smallholder farmers are not marginalized in a competitive global trading environment. While several chapters provide the theoretical underpinning to support the discourse, others feature concrete experiences drawn primarily from sub-Saharan Africa (SSA) as well as other regions; Asia, the Caribbean, Latin America and the Pacific. This body of knowledge does not provide a blueprint for agricultural innovation in developing countries or emerging economies, however, the lessons learned can be useful in guiding the design, implementation and evaluation of future policies, programmes and research on agricultural IS.

In the 'golden age of agronomy', agricultural research, education and extension flourished and the diffusion of innovations, mainly technological, was the dominant paradigm; new technologies spread rapidly and effortlessly but with little impact on the ground in SSA (Röling, chapter 16). Agricultural production systems were modernized and developments in post-harvest, processing and transport systems, and growing demand in internal and external markets, provided new opportunities for farmers and other agri-investors. The scale of the expansion was also driven by enabling policies, regulations, banking and financial services and economic incentives. Rates of return on investments in agricultural R&D, were deemed to be highly profitable although doubts have since been raised as to the veracity of these claims (Alston et al., 2000). The downside to the 'Green Revolution' became apparent in the late 1990s. The 'agricultural treadmill' was derailed, and calls were made for a paradigm shift to address concerns about the sustainability of the agri-food system and reconsider the significant scientific and technological advances that had been achieved (McIntyre et al., 2009). Key elements that were identified for future success, given the multi-functional nature of agriculture, included "Revalorisation of traditional and local

knowledge and an inter-disciplinary, holistic and system based approach to knowledge production and sharing" (McIntyre et al., 2009).

Achieving sustainable intensification of agriculture is now one of the greatest intellectual, social and economic challenges to feeding a world population that is projected to reach 9 billion by 2050. While yields can be increased using available technologies (e.g. certified seeds, irrigation and small-scale machinery) – for example cereals in SSA under traditional low-input production systems yield less than 1 t/ha – the reality is that this will not be simple. Success will depend on the nature of the policy and institutional framework, the physical and human infrastructure, as well as the ease with which knowledge, financing and markets can be accessed and the assurance that remunerations for public and private investors, including smallholder farmers, will be attractive under internationally accepted trading norms. To achieve the goal of inclusive development, the various options (technological, social, environmental and economic) will have to be rigorously assessed through the active engagement of multiple stakeholders and by embracing different perspectives. We are of the view that networks of motivated and committed actors can shape the agricultural innovation process at multiple levels and scales and millions of smallholder farmers will benefit.

Contextualizing Innovation Systems and Agriculture and Rural Development

The relevance of the IS concept to ARD remains unclear, controversial and contested, despite growing acceptance of the notion of the agricultural IS (World Bank, 2006; World Bank, 2012). The IS concept is also contested in the S&T policy domain, where its validity as a tool for explaining the differences in economic growth and competitiveness between nations remains in doubt.

In the agricultural domain, thinking and approaches on agricultural innovation have evolved, from the 'diffusion of innovations' (technology transfer) paradigm in the 1960s, to farming systems research in the 1970s and 1980s, to agricultural knowledge and information systems in the 1990s and more recently to agricultural IS (World Bank, 2006; Klerkx et al., 2012). Linked to these transitions are the shifts from agricultural R&D, to agricultural research for development (AR4D), to integrated agricultural research for development (IAR4D) and more recently, agricultural research and innovation, all of which are discussed in the context of IS in this volume (Adekunle et al., chapter 12; Hall et al., chapter 15; Sanyang et al., chapter 13). At the same time, public extension and advisory services have been restructured, private extension has grown in importance and new tools and approaches have been piloted and mainstreamed (Francis, 2013). The value chain approach, as a tool for shaping ARD agendas, is also increasingly being used.

Within the S&T policy domain, the linear model of innovation (the science push), shifted to the interactive innovation model (the demand pull), to the IS concept in which networking, knowledge and learning became increasingly important for explaining economic growth and competitiveness. Although technological innovation is still necessary, organizational and institutional change began to be factored into the analysis of innovation and economic performance. Innovation is now more often described as a process involving networks of actors, although as Edquist (1997) noted the boundaries of the 'innovation system' are not clearly defined. Lundvall (2010) asserted that "innovation is a fundamental and inherent phenomenon … and firms must engage in activities

which aim at innovation just in order to hold their ground" as innovation underpins growth in a modern economy. Some experts, development and innovation practitioners, and policymakers may have a problem in designating smallholder farmers as 'firms', although they are essentially entrepreneurs, operating a 'business' in a competitive environment.

These shifts have collectively contributed to the contestation of the IS concept within the agriculture domain, especially as R&D and S&T are no longer considered as the main source of knowledge or drivers of technological change. The nature of agriculture, as opposed to other industries, has also made it even more challenging for the concept to be widely embraced and endorsed; yet a body of knowledge has been growing on applying the IS approach to ARD. As Röling (chapter 16) points out, several IS narratives, each with their own theory of change, can be distinguished and this is also gleaned from the work presented in this book.

In 2013, the Technical Centre for Agricultural and Rural Cooperation (CTA) and Wageningen University and Research (WUR) jointly organized an Expert Consultation to make explicit these and other theories on innovation, consolidate differences of opinion and identify areas for further experimentation. As can be expected from a field of endeavour that is relatively new and is exploring unchartered territory, this resulted in a dynamic inter-disciplinary learning environment. The contributions reflected different traditions and various schools of thought that are represented by the agricultural, science, technology and innovation (ASTI) research, capacity building and policy advocacy programme of CTA which was rolled out across 79 countries in Africa, the Caribbean and the Pacific, the WUR/Convergence of Sciences-Strengthening Innovation Systems (CoS-SIS) programme, Directorate-General for International Cooperation (DGIS)-funded research in three West African countries that compared institutional experiments on innovation platforms (IPs) in eight agricultural domains (see www.wageningenportals.nl/cossis), and the R&D work of many other lead organizations.

We propose that insights on the relevance of the IS concept to agriculture can be gained from the experiential lessons which are based on systematic empirical evidence, as presented in this publication. Many of the approaches have proven useful in bringing about change through the involvement and empowerment of local communities, farmers and other actors, taking into account their competencies, habits and practices, the linkages that exist between and among them, and the policy and institutional framework within which they operate. The chapters enunciate theories about innovation, systems, mechanisms, obstacles and drivers of change, and policy and institutional issues for designing effective IS strategies that benefit smallholder farmers.

Core Messages

The IS concept is relevant to ARD and, though still evolving, is a useful framework for designing, implementing and evaluating the complexities of the agricultural IS. Emphasis should be on understanding the knowledge flows, learning behaviour and the policy and institutional conditions that hinder or facilitate change as well as the change itself. IS thinking should be mainstreamed into teaching, research and development programmes. Capacities of actors should be developed so that they can anticipate and respond to changes in the environment; local and

global. These and other issues are articulated in the chapters by Biggs and Justice (chapter 8), Bolo (chapter 7), Clark (chapter 5), Farinelli (chapter 6), Francis (chapter 17), Jiggins et al. (chapter 9), and Mytelka (chapter 3).

The innovation platform (IP) is an effective mechanism for mobilizing key actors at local, district and/or national levels for negotiation about collective action and concerted decision-making to create conducive conditions for continuous innovation. The platforms can occur spontaneously or be organized, operate independently or be facilitated, and can evolve or dissolve over time. Type 1 IPs can bring together value chain actors to support the identification, evaluation and adoption of a given technology (e.g. a new or improved variety) or a 'good/best' practice, and are effective in bringing about change. They can eventually address wider policy and institutional issues such as financing. Type 1 IPs are reflected in the chapters by Adekunle et al. (chapter 12) and Sanyang et al. (chapter 13). Type 2 IPs can initially bring together key decision-makers who are able to change the institutional conditions to enable innovation. Once achieved, other issues such as technology adoption can also be addressed. Type 2 IPs are featured in the contributions by Adu-Acheampong et al. (chapter 11), Jiggins et al. (chapter 9), and Osei-Amponsah (chapter 10). However, the IP should not be used as a tool "without any appreciation of the wider institutional and change agenda" (Hall et al., chapter 15), and neither as a "cure-all for governance failures" (Jiggins et al., chapter 9). Ownership of the IP should eventually rest with the farmers and other agri-entrepreneurs to ensure sustainability.

Innovation clusters, comprising groups of enterprises in the same sector or region, are also an effective mechanism for mobilizing actors. Growth in the wine industry in Argentina and Chile was as the result of product, process and organizational innovations and was supported by a 'sound knowledge base', technological modernization, and commercial intelligence and understanding of the changing demands of the target consumers (Farinelli, chapter 6). A producer (small, medium or large), cannot achieve success and remain competitive without having access to 'new' knowledge not only of technologies, but of markets and changing consumer behaviour and other support services.

Building capacity for conducting research on IS must be done cost-effectively. Biggs and Justice (chapter 8), Clark (chapter 5), and Mytelka (chapter 3), advance the need for building IS research capacity so that policies and programmes can be better informed and have more development impact by benefitting smallholder farmers. Jiggins et al. (chapter 9) affirm that the research capacity development approach undertaken by CoS-SIS is cost-effective, supports innovation processes and joint-learning, and can achieve 'scale-effect' on smallholder agriculture. CTA's approach to building IS capacity – which included training and using a case study approach for analysing the ASTI system by applying a standardized methodological framework and focussing on one commodity as opposed to the wider agricultural IS – is also cost-effective (Francis, chapter 17).

IS strategies must ensure that smallholder farmers benefit. Smallholder farmers, like all other entrepreneurs, need to be at the centre of the IS and be empowered so that they can participate actively as well as benefit from the process. In this book, Bolo (chapter 7) examines the institutional factors that shape interactive learning and notes that universities and research organizations are not the preferred choice for farmers seeking new knowledge. This must change. Triomphe et al.

(chapter 14) cautions against ignoring the active innovation that smallholders are engaged in, the overabundance of projects aimed at creating innovation dynamics without a clear exit strategy, and promoting technologies that may not be sustainable. Mytelka (chapter 3) recommends that a multi-goal approach and longer-term perspective be adopted to avoid disappointment and despair when smallholder farmers face challenges, e.g. markets fail, prices drop, and improved technologies become costlier when going to scale and they lose the control that they had in earlier stages of development.

S&T remain relevant for agricultural innovation and endogenous R&D and engineering capacity are needed. Scientists and engineers should be encouraged to come out of their 'comfort zone', adopt a longer-term view, go beyond the science push, and broaden their partnerships so that R&D investments lead to greater impact; entrepreneurship and employment.

Implications for Policy and Research

'IS thinking' moves received wisdom about smallholder development away from yields per hectare and technology adoption, to a higher level of aggregation, at which farmers, other entrepreneurs and organizations (e.g. R&D, universities, extension) interact at multiple levels and scales, either temporarily, or over time and structurally to create and or improve institutional frameworks and contexts that enable innovation. The policy framework must be insightful and flexible enough to allow the actors to create coalitions of interest around concrete opportunities and/or constraints for smallholder development.

Indeed, IS thinking is closely linked to the movement away from a narrow focus on research or technology generation and adoption, to one that seeks to create enabling institutional contexts for agricultural innovation. Technological modernization, though important, is unthinkable without creating the supportive conditions. A sound but responsive scientific base (inclusive of science and engineering capacity) that is embedded in the wider national IS, is needed for sustainable agricultural innovation. Research on agricultural IS, the drivers and constraints, actors and historical evolution must continue. Comparisons between system dynamics in agriculture, as opposed to other industries, should also be made and new tools and ways of measuring system performance explored.

Sustainable intensification of agriculture requires a multi-goal approach to policymaking and an adaptive vision of long-term development that is inclusive. Based on the concrete experiences outlined in this volume, some key policy implications for using IS approaches are presented and the capacity building and research on agricultural IS must continue.

Conclusion

The word 'system' implies a whole that is more than the sum of its parts, i.e. the system emerges through synergy.

- Systems can be created or allowed to emerge. Actors do not behave like a 'system' unless they share a sense of what the system is about and agree broadly on the goals that are to be achieved;
- The boundaries can be actively defined by the actors making up the system;

- Making sure the system functions effectively requires investments by the actors themselves;
- The policy and institutional environment is critical;
- Applying the IS approach as a policy instrument is useful. It requires IS capacity and supportive research to: map policies and identify and analyze constraints and opportunities (including from the perspective of smallholders); identify stakeholders and their networks and analyze their habits, practices, behaviours; and experiment with and evaluate options (e.g. innovation triggers such as incentives);
- Inclusive development rests on the voluntary decisions of smallholders themselves to learn, innovate and influence change processes. They will only do so if they perceive that there are benefits to be gained. Building capacity for innovation and embedding IS thinking and approaches can create such incentives.

Jacob (chapter 1) and Ouma-Mugabe (chapter 2) reviewed various chapters presented in this book to determine what has been added to the field of knowledge on IS and identify the gaps. Jacob emphasizes the need to synchronize S&T and education policies to address the S&T competency gaps that are obstacles to innovation in developing countries, so that farmers and other agriculture stakeholders can benefit. Ouma-Mugabe, notes that the IS concept has evolved but should be used judiciously so as not to disenfranchise poor farmers.

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