



Innovation Systems: Towards Effective Strategies in support of Smallholder Farmers



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Innovation Systems: Towards Effective Strategies in support of Smallholder Farmers

J. Francis, L. Mytelka, A. van Huis and N. Röling (eds.)



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Acronyms

| | | | |
|------------------|------------------------------------------------------------------------------|-----------|-------------------------------------------------------------------------------|
| 2WT | Two-wheel tractors | CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| 4D | For development | CT | Cultural theory |
| 4WT | Four-wheel tractors | CTA | Technical Centre for Agricultural and Rural Cooperation |
| ACP | African, Caribbean and Pacific | DADU-MOFA | District Agriculture Development Unit of the Ministry of Food and Agriculture |
| AFSI | Africa Food Security Initiative | DFAT | Australian Department of Foreign Affairs and Trade |
| AGRA | Alliance for a Green Revolution in Africa | DFID | Department for International Development |
| AIS | Agricultural innovation system | DONATA | Dissemination of New Agricultural Technologies in Africa |
| AR4D | Agricultural research for development | FAAP | Framework for African Agricultural Productivity |
| ARD | Agricultural research and development | FAO | Food and Agricultural Organization of the United Nations |
| ASTI | Agricultural science technology and innovation | FARA | Forum for Agricultural Research in Africa |
| ATCB | Association Provinciale des commerçants de céréales | FFA | Free fatty acids |
| AVRDC | World Vegetable Center | FNZ | Fédération Nian Zwè |
| BecA | Biosciences eastern and central Africa | FOB | Free-on-board |
| BMA | Business model of agronomy | GDP | Gross domestic product |
| CAADP | Comprehensive Africa Agriculture Development Programme | GHG | Greenhouse gas |
| CCA | Collaborative case assessment | GIFT | Genetically Improved Farmed Tilapia |
| CCS | Carbon capture and sequestration | HP | Horsepower |
| CIG | Concertation and Innovation Group | HYV | High yielding varieties |
| COCOBOD | Ghana Cocoa Board | IAR4D | Integrated Agricultural Research for Development |
| CODAPEC | Cocoa Disease and Pest Control programme | ICT | Information and communication technology |
| CoP | Community of Practice | IER | Institut d'Economie Rural |
| COP | Cost of production | ILRI | International Livestock Research Institute |
| CORAF/ WECARD | Council for Agricultural Research and Development in West and Central Africa | INERA | Institut de l'Environnement et de Recherches Agricoles |
| CORFO | Corporación de Fomento de la Producción | INTA | Instituto Nacional de Tecnología Agropecuaria |
| CoS-SIS | Convergence of Sciences-Strengthening Innovation Systems | | |
| CPO | Crude palm oil | | |

| | | | |
|------------------|-----------------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------|
| <u>INV</u> | Instituto Nacional para la Vitivinicultura | <u>SLIM</u> | Social Learning for the Integrated Management and Sustainable Use of Water |
| <u>IP</u> | Innovation platform | <u>SME</u> | Small and medium sized enterprises |
| <u>IPM</u> | Integrated pest management | <u>SNVCA</u> | Nouveau Système d'Appui-Conseil et de Vulgarisation Agricole |
| <u>IPR</u> | Intellectual property rights | <u>SSA</u> | Sub-Saharan Africa |
| <u>IRR</u> | Internal rate of return | <u>SSA-CP</u> | Sub-Saharan Africa Challenge Program |
| <u>IS</u> | Innovation systems | <u>S&T</u> | Science and technology |
| <u>JOLISAA</u> | Joint Learning in Innovation Systems in African Agriculture | <u>STI</u> | Science, technology and innovation |
| <u>KTI</u> | Knowledge, Technology & Innovation | <u>STiP</u> | Systems thinking in practice |
| <u>LBA</u> | Licensed Buying Agents | <u>T&V</u> | Training and Visit Scheme of Extension |
| <u>LBC</u> | Licensed buying companies | <u>TGPI</u> | Theory-Guided Process Inquiry |
| <u>LIC</u> | Low income countries | <u>ToT</u> | Transfer of technology |
| <u>LP</u> | Learning Project | <u>TOT</u> | Training of trainers |
| <u>M&E</u> | Monitoring and evaluation | <u>UVA</u> | Union Vitivinicola Argentina |
| <u>MRSI</u> | Ministry of Scientific Research and Innovation | <u>UWI</u> | University of the West Indies |
| <u>NARO</u> | National agricultural research organization | <u>WAAPP</u> | West Africa Agriculture Productivity Program |
| <u>NARS</u> | National agricultural research system | <u>WIAD</u> | Women In Agriculture Development |
| <u>NGO</u> | Non-governmental organization | <u>WUR</u> | Wageningen University and Research |
| <u>NRM</u> | Natural resource management | <u>WW2</u> | Second World War |
| <u>OPRI-CSIR</u> | Oil Palm Research Institute of the Council for Scientific and Industrial Research | | |
| <u>OPV</u> | Open-pollinated varieties | | |
| <u>OU</u> | The Open University | | |
| <u>PPRC</u> | Producer Price Review Committee | | |
| <u>ProChile</u> | Dirección de Promoción de Exportaciones | | |
| <u>R&D</u> | Research and development | | |
| <u>R4D</u> | Research for development | | |
| <u>RIU</u> | Research Into Use | | |
| <u>RNRRS</u> | Renewable Natural Resources Research Strategy | | |
| <u>S&T</u> | Science and technology | | |
| <u>SAG</u> | Servicio Agrícola Ganadero | | |
| <u>SAM</u> | Strategic adaptive management | | |
| <u>SANParks</u> | South African National Parks | | |
| <u>SAP</u> | Structural Adjustment Programme | | |
| <u>SI</u> | Systems of innovation | | |

Foreword

Ever since scholars studying the factors underpinning industrial development and the rise of the ‘Asian Tigers’ proposed effective ‘innovation systems’ as a likely explanation, the notion has taken off. Due to the efforts of several organizations including CTA, UNU-MERIT, WUR and the World Bank, the concept has been incorporated into strategies for agricultural and rural development. The innovation systems approach has been mooted as a way out of the impasse created by the singular emphasis on technology transfer as the pathway of sustainable intensification and transformational change of smallholder farming. Focus has shifted to the role of interaction and learning among individuals and organizations in the agricultural innovation process. Farmers and entrepreneurs are at the centre and the institutional framework is considered the enabler in enhancing the generation, exchange and uptake of information, knowledge and technologies.

Several organizations have since adopted the innovation systems concept in their research, education and development programmes. Examples include ‘rolling out’: IAR4D by CORAF/WECARD; innovation platforms in the CGIAR/FARA SSA-CP; the WUR CoS-SIS post-graduate training programme in West Africa; the CTA ASTI system capacity building programme throughout the African, Caribbean and Pacific Group of States and; DFID’s RIU programme. In 2016, the G20 Tropical Agricultural Platform released the Common Framework for Capacity Development on Agricultural Innovation Systems which has been endorsed by several international development partners. What has become clear is that while the concept has found great relevance for explaining economic development in OECD countries and more so in manufacturing, applying it to agricultural and rural development is more challenging, especially in the context of smallholder farming systems in developing countries.

This publication provides a collection of papers, commentaries, expert opinions and reflections on state-of-the-art innovation systems thinking and approaches in agriculture. It is the direct output of a CTA and WUR/CoS-SIS collaboration which had its genesis in an expert consultation on ‘*Innovation Systems: Towards Effective Strategies in support of Smallholder Farmers*’. Practitioners and scholars involved in academic, research, training and development programmes came together to map the diversities and commonalities in applying the concept in agriculture and chart the way forward for informing policy and practice.

CTA and WUR/CoS-SIS are fortunate in having been able to bring together leading scholars and experts on innovation systems theory and practice to share their knowledge through this publication. We hope that it will lead to transformative change in agricultural policies, research, extension and development programmes, for the benefit of millions of smallholder farmers, thereby increasing their contribution to agricultural innovation and socio-economic development.

Judith Francis, Lynn Mytelka, Arnold van Huis and Niels Röling

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 uncharted 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/cosis), 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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Chapter 1

INNOVATION SYSTEMS AND AGRICULTURE: GOING BEYOND RESEARCH FOR INCREASING YIELDS

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Introduction

Arjun Appadurai, one of India's most celebrated anthropologists once put forward the claim that research should be treated as a right. It may seem counterintuitive to introduce the collection of articles in this volume with such a claim but if any piece of work proves this claim, it would be this. I shall first explicate Appadurai's argument and then address how these papers illustrate it. Appadurai argued that rather than treat research as "a high-end, technical activity, available by dint of training and class background," to specialists in education, the sciences and related professional fields, we should treat it as "a capacity" with democratic potential (Appadurai, 2006). Seen from this perspective, research would belong to a family of rights to which citizens in democratic societies are entitled. While this might sound like just another great ideal, my view is that the papers in this volume provide us with accounts of how this ideal is being realized in practice.

This collection of papers engages with a variety of issues arising from organizing and improving innovation in agriculture. At the risk of doing violence to its richness and diversity I would like to impose three themes as a framework around which this body of work may be analysed: conceptual and theoretical issues associated with innovation systems (IS); challenges and opportunities in innovation platforms; and cases of innovation platforms for smallholder agriculture. The second two themes are by far the richer and more interesting but the first is necessary and instructive. Broadly speaking one may argue that the IS concept has functioned as inspiration for the idea of innovation platforms (IPs) and that IPs may be seen as a rare operationalization of systems of innovation (SI). Many proponents of the perspective may find this to be a somewhat provocative point of departure. However, despite its fecundity and popularity with policymakers, SI analysis with the level of detail that is available in the accounts of IPs featured in this publication are the exception rather than the rule. Further, what IPs owe IS is their ability to operationalize the fundamental insight from SI, i.e. that innovation occurs in networks of actors representing different interests and having varying and in some cases complementary competences.

Innovation Systems: Conceptual and Theoretical Issues

Without going into further detail I would like to address the IS pieces in this volume since they provide a necessary context and backdrop for the rest of the volume. I am unable to give voice to every piece but Clark's, Ison's and Mytelka's are good exemplars of the offering available in the volume. Starting with Ison's chapter which poses the question 'what is systemic about innovation system?' Ison makes a plea for shifting focus to systemic innovation which would allow for the insights from systems scholarship – a feature long neglected from IS scholarship – to be introduced to the IS approach. One of Ison's main insights relates to the relation between knowledge and praxis.

Clark's contribution provides us with both a historical context for IS as well as a concrete instance of its application in the context of development. Clark takes his point of departure in the UK's Department for International Development's Research Into Use (RIU) programme. Clark alludes to the problems that Ison attempts to address, i.e. the failure of IS thinkers to take the extant research on systems on board. RIU was in many respects an early effort to bridge the gap between IS research and practice. The programme made two moves which were critical and may be regarded as lessons for the future. The first was that it placed 'innovation rather than research in the centre' according to Clark, and secondly it treated SI as a heuristic to be explored in a given empirical context.

Mytelka's chapter is paradigmatic in the sense that unlike the other two mentioned above, she follows the standard line in IS which is to ignore the meta issues that bedevil the IS concept. Mytelka focuses instead on 3 years of work on Global Energy Assessment. This is an interesting empirical reference point, not the least because research on innovation in energy is increasingly being dominated by the sociotechnical transitions perspective outlined by Geels (2002), among others. Within IS, the majority of work on energy is done from the perspective of technological innovation systems. Mytelka's piece is an effort to link energy transition to innovation.

Innovation Platforms: Conceptual Issues

The notion of IPs takes as its point of departure the SI insight that innovation takes place in networks of actors. The bulk of the book's chapters are devoted to providing studies of different attempts at implementing this idea in agricultural innovation. Rather than revisit each case separately, I will provide a rather schematic account of some of the issues raised in these chapters which may require either further attention from the research and/or the policy community, or to which there are already research findings in another area that can be applied.

One of the most important take home lessons from these cases is that universities (as well as research organizations) are not the 'go to' actors for smallholder farmers. Several of the authors reflect on the implications of this for the role of research and development (R&D) in innovation but unfortunately they are on the wrong track. Several decades of European Union research on small and medium sized enterprises (SME) show exactly the same pattern as is reported here for smallholder farming (Freel, 2003; Davenport, 2005). The moral of the story however is not to look for ways to make universities better serve such actors but to accept that in some respects

knowledge transfer is best done in farmer-farmer or firm-firm networks. The emphasis should not be on who provides the knowledge needed by the farmer or the firm but that knowledge is provided. That being said, there may still be a need to find a way to bridge the gap between the academic and research community, and smallholder farmers, given that in these contexts problems may arise that concern farmers, and those to whom they may normally turn may not necessarily have knowledge that the universities have.

While there are many reasons why SMEs do not see universities as a first source of knowledge, two reasons are relevant for drawing lessons for smallholder agriculture. One is the cultural gap between SMEs and universities, a gap that is likely to be held even more strongly for farmers and universities in developing countries. A second reason, and possibly more difficult to overcome, is the fact that knowledge exchange with universities does not only require a certain level of competence but it also takes a great deal of time. It may be that like SMEs, farmers just do not have the time to engage in this fashion. What then can be done, assuming there is something to be gained from promoting direct interaction between smallholder farmers and universities? One potential route could be through students and internships. This would have to be supervised and paid for by the university since it is unlikely that farmers can or would provide funding for this. This is also a good point in the narrative to return to IPs because these provide a context for such internships.

A key point of departure for SI is that the totality of the system is important. For many developing countries, the problem is not simply one of getting university research to address issues of relevance, it is also one of providing the necessary linkages with users which would stimulate relevant research. Student internships are an excellent starting point since they ensure that scarce resources are not wasted on teaching new tricks to faculty who may have already decided against them. The other is that faculty are always keen to put their students out there since it is 'reflected merit'. Students may be ideal participants in IPs as they can be used both to transfer knowledge from the university and for problem-solving. Governments may subsidize internships and in so doing invest in building capacity for the next generation of researchers, who will, because of this experience, see it as natural to engage. The moral of the story is that engagement does not happen overnight.

Case Studies: Testing Theories

The third group of chapters are accounts of specific cases in the application of IS approaches and IPs to promote agricultural innovation in specific contexts. Each of these is a rich account with insights that go way beyond the ability of this rather impressionistic overview to capture. I have chosen to emphasize three of the key lessons that may be gleaned from these cases. The first is that taken together the chapters provide proof of the fact that while policy interventions may create a facilitating context for innovation, it is important to bear in mind that innovation remains serendipitous. Not only is it difficult to predict what will happen but many of the more positive outcomes are often unintended. While planned, innovation is difficult to achieve. These cases confirm that managing the processes intended to facilitate innovation enhances one's chances of success. Chapters by Adekunle et al. and Sanyang et al. address some of the organizational and managerial issues associated with IPs.

Reflections for the Future

The papers in this volume share a commitment to improving agricultural innovation. They all share a firm belief in the view that R&D is the route to achieving this end, providing that the extant problems in connecting universities and research organizations with other stakeholders in agriculture can be resolved successfully. While I share this belief, I wonder if by focusing too much on universities and R&D, we may be missing an opportunity to use agriculture as a platform for making a more significant intervention. A key but surprisingly little mentioned obstacle to innovation in all sectors in Africa, Caribbean and Pacific countries is the low levels of scientific and technological competence in all but a few countries (e.g. South Africa). Programmes such as those featured in this volume need to be institutionalized in the farmer population and transferred from generation to generation. Ultimately, the chances of this happening will increase if these programmes can be sustained on their own terms. Consideration must be given to going beyond research for improving yields, and this requires changes to education and research systems and rural development agendas. Science and technology policy must be supported by education policies at the primary, secondary and tertiary levels, such that farmers as well as other agriculture stakeholders can access as well as benefit from the wider education system.

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Chapter 2

INNOVATION SYSTEMS APPROACHES AND AGRICULTURE AND RURAL DEVELOPMENT

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Introduction

There is now a proliferation of academic and non-academic literature on the application of the ‘innovation systems’ (IS) (or ‘systems of innovation’, SI) concept to agriculture and rural development and in particular agricultural research and development (R&D). A quick search of Google Scholar turns out at least 150 scholarly articles on ‘IS and agricultural R&D’ and ‘IS and rural agriculture’ in Africa that have been published in the past decade or so. The concept has its origins in a study on Japan’s industrialization and economic change by Freeman (1987) and works published in the early 1990s by scholars such as Lundvall (1992), focusing on comparative analysis of institutional aspects of techno-economic performance of Organisation for Economic Co-operation and Development countries. Its application to the study of agricultural R&D in Africa and in the developing world in general is relatively recent (Clark, 2002).

This overview synthesizes 13 of the chapters in this volume on the application of the concept of IS and related approaches to agriculture and rural development, which in several cases focus on Africa. The chapter maps out the different conceptual approaches adopted and/or used by the authors as well as the case studies highlighted, and outlines key strengths and weakness in the application of SI. The review starts with a short background on how SI and related new or emerging concepts of innovation platforms (IPs), inclusive innovation, and social innovation are defined. It concludes that while the concept has evolved and provides a good framework for designing, implementing and evaluating development projects, it can also be subject to misuse and/or used to justify projects that exclude and disenfranchise poor farmers to the advantage of powerful agencies.

Conceptual Background

There is an overwhelming consensus that orthodox well-entrenched approaches for studying, planning and evaluating agricultural R&D in the developing world, and in Africa particularly, have huge conceptual and relevance deficits (Clark, 2002; Hall and Sulaiman, 2002 and Knickel et al., 2009). For example, Knickel et al. (2009) show that many of the approaches for planning, funding and organizing agriculture and rural development are based on or guided by linear models of

agricultural R&D and rural development. The models have been used to design, implement and evaluate R&D programmes that often separate farms and farmers from research and researchers, research from extension services, and farms from markets. Innovation is treated as the outcome of a linear process, from knowledge production to knowledge adoption and application.

The chapters in this volume which have been reviewed, eschew linear models of innovation. They are all underpinned by the understanding that innovation is a complex non-linear process. The chapter by Lynn Mytelka (chapter 3) titled *Innovation Systems Approaches in a Time of Transition* treats innovation as a socially-embedded process that is influenced by policies, habits and practices of various actors including local communities, non-governmental organizations (NGOs), R&D institutes, universities, professional associations, private companies, governments and donors. The ‘system’ can refer to a particular economic sector such as agriculture, a geographical region or a nation. Mytelka argues that the innovation process is characterized by uncertainty and that not all innovation supports or contributes to sustainable development.

Mytelka sees IS approaches as a set of “conceptual tools and frameworks” for focusing on the behaviour of and interactions among various actors in the system. She emphasizes their potential application to inclusive and sustainable development and the role of policy and policy processes in shaping innovation activities within IS. Her emphasis, that “IS approaches are particularly useful since they do not regard ‘research to the market’ as a linear track, nor do they limit innovations to those at the frontier of knowledge”, is noteworthy.

The chapter by Ray Ison (chapter 4) titled *What is Systemic about Innovation Systems? The Implications for Policies, Governance and Institutionalization* introduces the concept of ‘systemic innovation’ and proposes a shift from IS approaches. It defines systemic innovation as an “inter-connected set of innovations” (Ison, 2016). Ison discusses epistemological aspects of the word ‘system’ but does not really make a good case for the proposed conceptual shift from IS to systemic innovation. In their chapter, Jiggins et al. (chapter 9) use the concept and though they do not explicitly define ‘system innovation’ as Ison does, they generally use SI to refer to the behaviour of actors and institutional changes that influence the generation of novelty (Jiggins et al., 2016).

Norman Clark’s chapter (chapter 5), *The Use of Innovation Systems in a Technology Development Aid Programme: The Case of Research Into Use (RIU)*, traces the origins of the concept of IS to efforts of leading scholars – particularly Freeman (1987), Lundvall (1992) and Nelson (1993) – to explain the sources of post Second World War economic growth and change in newly industrializing countries of Asia and industrialized countries of Europe and the USA. Clark argues that the IS approach is a useful heuristic that places “the analytical centre of gravity with innovation rather than science and therefore it could be used to throw light on how formal science might engage more effectively (and institutionally) with practical development issues as they affect the very poor farmer in poor countries” (Clark, 2016).

Adekunle et al. in chapter 12 – *The Theory of Change Underlying the Efficacy of the Agricultural Innovation Platforms (IPs): The Case of Thyolo Vegetable IP, Malawi* – emphasize the role of

organizations and policies in stimulating technological innovation in agriculture and promote the use of IPs. They critique the linear model of innovation that “assumes that the problems of agricultural development are largely technological in nature” and note that it is no longer relevant to agricultural research, development and innovation in Africa (Adekunle et al., 2016).

Application of Innovation Systems Concept

With the exception of Ison, the other chapters feature case studies on the various approaches of applying the IS concept to agriculture and rural development more generally and to agricultural R&D, more specifically. According to Clark, by adopting the IS approach the Research Into Use programme shifted attention from the mere production of scientific and technical knowledge to ways of ensuring that knowledge was used in agricultural R&D. “The IS heuristic allowed programme managers to build up local networks of stakeholders which contributed to building capacity and this approach can best be used to inform prospects for rural technology development in low income countries” (Clark, 2016).

In his chapter – *Innovation Systems and Capability Building Among Smallholder Farmers: Lessons and Insights from Kenya’s Flower Farmers* – Maurice Bolo (chapter 7) uses the IS approach to study processes of knowledge sharing between farmers, researchers and NGO practitioners. Bolo focuses on the institutional factors that influence interactive learning. The argument is made that farmers preferred and interacted more with non-academic NGO practitioners, and less with universities and public research agencies. This is mainly because “[r]esearch organizations and universities exhibited a hierarchical culture which restricted their interactions. NGOs demonstrated a ‘clan culture’ where teamwork is important. Input suppliers were characterized by a ‘market culture’ and were more results-oriented on winning market share and penetrating new markets” (Bolo, 2016).

In the chapter titled *Innovation Platform and Pricing Policies: The Case of Cocoa in Ghana*, Adu-Acheampong et al. (chapter 11) demonstrate how the Concertation and Innovation Group, an IP, can be an effective institutional mechanism for mobilizing cocoa farmers and getting them to engage with national level state agencies to reform pricing policy to improve the welfare of farmers. The IP, which contains key actors in cocoa production, marketing and export, operates at both national and local levels connecting various institutions to enhance production and secure better cocoa prices. The IP has been an effective mechanism for addressing institutional and technological barriers to improved cocoa production in Ghana (Adu-Acheampong et al., 2016).

The chapter by Stephen Biggs and Scott Justice (chapter 8) – *Political Power in Innovation Systems: Smallholder Sustainable Intensification and Rural Mechanization* – is about the political economy of applying the IS approach to mechanization in rural Bangladesh and Nepal. They show how powerful agencies and individuals invoked the IS framework to promote large-scale mechanization. This led to policies and practices that undermined mechanization and innovation in smallholder farming. As Biggs and Justice (2016) assert: “People and organizations in powerful positions use IS frameworks and techniques selectively to promote particular economic and cultural agendas... However, they do highlight that a narrow apolitical preoccupation with

the development of IS theory and practice might detract attention from strengthening the analytical capability of IS that looks at the nature of innovation in science and technology.”

Mytelka also documents cases of the political economy of innovation and technology choice. In one case, a local community in Mali chose to produce biofuels as part of a multi-purpose project to generate electricity for lighting, refrigeration, welding, food processing and other uses, and reduce reliance on imported fuel. The choice to plant jatropha for biofuel was made by local farmers themselves in the village of Garalo in Mali. It was not influenced by external actors such as donors or central government and some of the success could be attributed to the close links that were developed and sustained with research institutes. Scaling up such a local initiative could be problematic for smallholder farmers. In another case study, Mytelka demonstrates how the decision to build coal powered plants as part of the Tata Mundra project in India was influenced by the investor – the International Finance Cooperation – without due regard to environmental consequences of the investment. The decision was largely based on a path dependent approach of making technology choices based on earlier investments and earlier thinking that narrowed the scope for learning and innovation. In this latter case, as Mytelka elucidates, there is a weaknesses of the IS approaches and that is the “unwritten assumption that innovation is by nature progressive and represents a social ‘good’ for humanity” (Mytelka, 2016).

The chapter – *Building Innovation Capacity of Local Actors: The Case of Chilean and Argentine Wine Industries* – by Fulvia Farinelli (chapter 6) provides case studies of how national governments of the two countries designed and implemented deliberate or explicit policies that stimulated knowledge-intensive focused R&D in winery, directed the location and institutional configuration of knowledge producers (e.g. universities), leveraged different sources of finance (mainly foreign direct investment and domestic banks), created incentives for suppliers of raw materials (e.g. farmers), and promoted the procurement and use of new machinery and equipment in wine manufacturing firms. Farinelli demonstrates that the ability of both Argentina and Chile to penetrate the international wine market is to a large measure accounted for by “quality upgrading, R&D investments and the incorporation of sophisticated new machinery and equipment within an enabling policy and institutional framework” (Farinelli, 2016). This particular chapter underscores the importance of having the right policies and institutional arrangements to grow and nurture IS.

Conclusions

The ensuing chapters reviewed and synthesized in this chapter all demonstrate that the concept of IS has evolved and is increasingly being applied in studies on, and planning of, agriculture and rural development and agricultural R&D activities in developing countries. The concept provides a good framework for designing, implementing and evaluating development projects. However, it is also subject to misuse or even abuse. It can be invoked or used to justify projects that exclude and disfranchise poor farmers to the advantage of powerful agencies and individuals.

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Chapter 3

INNOVATION SYSTEMS APPROACHES IN A TIME OF TRANSITION

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Abstract

The most important features of innovation systems (IS) approaches are their ability to conceptualize change as a long-term, socially-embedded processes in which the habits, practices and norms of the actors involved are a critical component. Policy also plays an important role in shaping the parameters within which decisions are made. However, there are also some inherent weaknesses, specifically the unwritten assumption that all innovation is inherently good and progressive. The case studies presented in this chapter illustrate that this is not always the case, particularly the impact that innovation has had on patterns of global competition and on inclusive development, and the lack of attention paid to contemporary issues such as energy transitions. It is argued that IS approaches would need to be further adapted to deal with new and emerging issues such as sustainable and inclusive development and the process of change itself. New linkages, multi-goal approaches and longer-term perspectives in evaluating goals and objectives need to be given greater prominence. New tools and new metrics need to be developed for evaluating alternatives over the long-term and for making choices about change. Interactive, participatory practices, including dialogues with smallholder farmers are necessary so that their expressed interests, needs and preferences are considered.

Keywords: Socially embedded process, Multi-goal, Global competition, Inclusive development

Introduction

My intention in this chapter is not to arbitrate among the various schools of thought on whether there is value in the IS approach or whether the wave of new analytical tools – including the focus on soft systems methodology, value chains and clusters that have emerged – could be considered as replacements for, or complements to, IS approaches. However, reflections on work carried out over 3 years on the Global Energy Assessment (GEA, 2012), brought into focus the lack of attention paid to environmental issues and inclusive development in all of these approaches. In light of the growing concern about climate change and the slow pace of ‘catching up’ in most developing countries, the focus will be on IS approaches and their potential link to inclusive development in a time of transition.

Learning, Innovation and Linkages

Until quite recently, developing countries were regarded as ‘technology users’, reliant on imports of technology, as opposed to being technology producers and ‘innovators’ in their own right. Such views supported the conceptualization of technology as embodied in machinery and equipment, and its transfer and assimilation as automatic and context-free. From this perspective, ‘catching up’ was understood primarily as a process of technology transfer from leaders to laggards and ‘reinventing the wheel’ was regarded as unnecessary. Moving out of agriculture and into industry was promoted as a development paradigm.

By the 1970s and 1980s, researchers in developing countries, and those working with them, began to question the linearity and passive nature of the technology transfer process and its ability to contribute to development (Bell, 1984; Katz, 1985; Mytelka, 1985; Rosenberg and Frischtak, 1985; Westphal et al., 1985; Lall, 1992; Kim, 1997). The emergence of the Asian tigers accelerated this process, as newer research pointed to the role that learning through reverse engineering and adaptive research played in their advance. It was found that effective absorption and diffusion of new technologies mainly took place when accompanied by two broad sets of purposive actions:

- Innovative practices, such as adapting imported technologies to suit local conditions, adjusting to new sources of inputs, altering the product mix, and resolving bottlenecks in production (Stewart, 1984; Katz, 1985; Mytelka, 1985; Westphal et al., 1985; Lall, 1992) and;
- Technological learning, by engaging in a process of intensive technological searching and protracted negotiations with prospective sellers or licensors of technology, by adopting a strategy focused on adaptation and upgrading of the original design and by developing in-house research capabilities (Rosenberg and Frischtak, 1985; Ernst et al., 1998; Katz, 2004; Bell, 2009).

Purposive actions such as these, however, required a supportive policy environment (Bell, 1984; Kim, 1997; Nelson, 2004). However, in the absence of such a supportive environment, licensing of product and process technology, a potentially important vehicle for achieving technology spillovers often became a substitute for learning and innovation (Mytelka, 1978). This, in turn, tended to reduce the need for linkages to the local knowledge system and become a disincentive for local enterprises to engage in a process of innovation¹.

During the 1980s and 1990s, as industry became increasingly more knowledge intensive, changes in production and competition in industrialized countries drew attention to the role of knowledge and innovation in the competitiveness of firms and, by extension, of nations (OECD, 1992). Over time, the knowledge intensity of production extended beyond high technology sectors to reshape a broad spectrum of traditional (including agriculture) and new industries in both developed and developing countries (Mytelka, 2000). Agriculture was particularly important among them.

¹ See the case of the Andean Group in the 1970s (Mytelka, 1978) and Iran in the early 2000s (UNCTAD, 2005).

These competitive challenges placed a premium on learning, knowledge flows and innovation that overtime led to growing interest in IS thinking, first in industrialized countries (OECD, 1992) and then in what came to be known as emerging economies. The latter is well illustrated by the development of local competences that contributed to the emergence of domestic innovation and the export success of a range of new industries such as the Korean auto and electronics industries, the Indian software and pharmaceuticals sectors, the Cuban pharmaceutical industry, the aeronautical industry in Brazil, as well as a number of natural resource based industries such as biofuels in Brazil, wine in Argentina, Chile and South Africa, and flower exports from Colombia. These changes can best be understood from the perspective of an IS approach.

The Strengths of Innovation Systems Approaches

As a set of conceptual tools and frameworks, the IS approach is still evolving, but from its earliest beginnings it has provided a comprehensive and integrated analysis of the processes whereby societies and economies learn to innovate². In this context, an IS has been conceptualized as a network of firms and other economic agents that, together with the institutions and policies that influence their innovative behaviour and performance, bring new products, new processes and new forms of organization into economic (and social) use. From this perspective, IS approaches are particularly useful since they do not regard ‘research to the market’ as a linear track, nor do they limit innovations to those at the frontier of knowledge. Instead innovation is understood to include processes by which firms master, modify and implement the design and production of goods and services that are new to them and their countries, if not to the world. This has proven useful in the analysis of IS in developing countries.

Among the strengths of the IS approach is its focus on interactions among actors/agents in the system and their embeddedness in organizational and institutional contexts that influence their behaviour and performance (Figure 1). The actors in an innovation process can include enterprises, government ministries, non-governmental organizations, professional associations, research and development institutes, hospitals, innovation and productivity centres, extension services, standard setting bodies, universities and vocational training centres, information gathering and analysis services, and banking and other financing mechanisms to name only a few.

Organizational and institutional contexts are understood as the “sets of common habits, routines, norms, rules and established practices that regulate the relations and interactions between individuals and groups” (Edquist, 1997), prescribe behavioural roles, constrain activities, and shape expectations, the nature and extensiveness of their interactions, their risk taking, learning behaviour and hence their propensity to innovate (Mytelka, 2000). Habits and practices of actors are learned behaviour patterns marked by the historical specificities of a particular place and moment in time. As such, their relevance may diminish as conditions change. This is particularly likely in periods of transition to new technologies, competences, modes of operation, habits and competitive practices that actors require (GEA, 2012: Chapter 25).

² See the papers by Freeman (1988), Freeman and Perez (1988) and Lundvall (1988) in the pioneering study by Dosi et al. (1988).

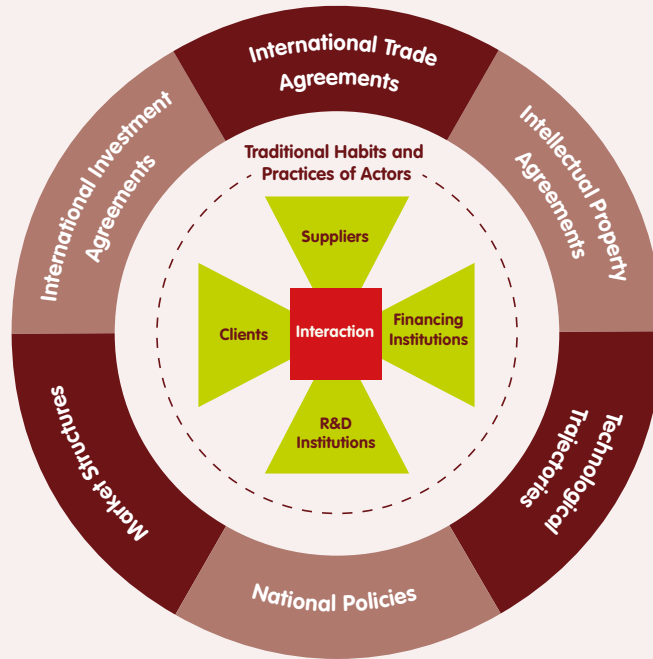


Figure 1. An innovation system

Source: Adapted from Mytelka (2000)

IS approaches also acknowledge the importance of policies and policymaking processes in learning and innovation. Whether tacit or explicit, policies play a role in setting the parameters within which actors make decisions about learning, innovation, investment and collaboration. From a policy perspective, IS approaches draw attention to policy dynamics and the way these emerge from the interaction between policies and the habits and practices of the actors whose behaviour is targeted by policy. The impact of policies can thus be expected to vary across different organizational and institutional contexts, as well as over time.

In periods of transition, policies can be designed to reinforce older desirable habits and practices or to induce change, provided that there is some understanding of the habits and practices of the actors in the system and a continuous process of feedback provides the inputs for adaptive policymaking. Learning and unlearning on the part of policymakers, practitioners, users and producers of all sizes in an emerging or established IS are thus at the heart of the system's ability to respond to new challenges, such as those resulting from the growing knowledge intensity of production, and the energy and environmental challenges that we are currently facing.

In the past, the process of transition was extensively discussed in innovation literature with regard to mobility – the advent of trains and cars – and the changes brought about by information and

communication technologies (Geels, 2005). More recently the focus has turned towards energy transitions (Geels and Kemp, 2012).

In the Global Energy Assessment (GEA, 2012), the team, of which I was a member, began the process of analysing the many different pathways that could lead towards an energy transition and explored how developing countries could link the transition process to innovation and sustainable and inclusive development. Although some of our commentators and critics believed that these were alternative objectives and could not be realised simultaneously, our research has shown otherwise. Adopting a long-term, multi-goal perspective is both feasible and essential in meeting today's challenges. The following two sections provide brief case studies to illustrate both the importance of linking energy transitions and innovation processes to sustainable and inclusive development, and the utility of an IS approach in doing so with implications for smallholder farmers, fisher folk and the wider agricultural IS.

Adopting a Multi-goal Approach: Case of Biofuels and Fisheries

Biofuels have been praised as a means to provide energy and reduce greenhouse gas emissions, and criticized for contributing to the destruction of tropical forests and competing with food crops for the use of agricultural lands. *Jatropha* is an important feedstock for biofuels because it can grow on marginal land and in arid environments unsuitable for food crops (UNDP, 2009). It is also a good candidate for smallholder production. The case of *jatropha* in Garalo, Mali, illustrates how a multi-goal perspective and a process of continuous dialogue have contributed to the successful development of the Garalo project.

Rethinking Biofuels

In 2007, rather than rely on imported diesel fuel for a future off-grid generator, the villagers of Garalo chose to plant *jatropha* on 440 ha of their land as part of a multi-goal project to stimulate rural development by providing electricity for lighting, refrigeration, welding and agricultural processing machinery for use by businesses, workshops, health services and schools. It would also be used to supply electricity to reduce the costs of the village water pumping system by replacing the diesel generator, then using electricity from a local mini-grid they planned to build. That grid now has over 230 clients, of which 198 are households (Goertz, 2006; Burrell, 2008; ACCESS SARL, 2010). However, due to the length of time *jatropha* seeds take to mature, in 2011 *jatropha* oil accounted for only 5-10% of the fuel used in the mini-grid, the remainder coming from diesel.

Much of the success of this project lies with the farmers who played an important role in designing the project and in the decision to plant *jatropha*. Of the 440 ha planted with *jatropha*, 2 ha were prepared as a nursery and 95% of the fields were planted by individual farmers³. A survey of the *jatropha* fields 2 years after the project started, showed that a large percentage of farmers⁴ had chosen to intercrop *jatropha* with local food crops such as maize, sorghum, millet, peanut, sesame and beans – thus dealing with the assumed need to choose between food and fuel as some ardent

³ The remaining 5% were collective fields.

⁴ 70.2% of the 118 ha sampled in the field study (Burrell, 2008).

supporters of green technology had earlier argued. They also developed and sustained close links to research institutes relatively nearby and this led to considerable follow-up experimentation and local learning, as well as improved methods of inter-cropping (GEA, 2012).

The problem in using jatropha oil for fuel in a multi-goal approach arises when it is reconceptualized as an export commodity. Scaling up the smallholder model for large-scale production of biodiesel, whether for the domestic market or for export, can have an unexpected, often negative impact on inclusive development.

First, the assumption that jatropha is a low cost, low-input crop that grows virtually by itself is problematic in the context of scaling up. Research in India shows that the price of jatropha depends on increasing yields, which in turn requires improved seeds, water and fertilizer (Altenburg et al., 2008). This puts jatropha into direct competition with food crops. It also increases upfront investment costs, which are beyond the capacity of most smallholders. Large projects such as these are thus frequently undertaken by foreign investors and many involve the purchase of land owned by local farmers, or long-term leasing arrangements. Failure to reach anticipated yield levels in a reasonable time frame, and changes in global pricing have led to the abandonment of many such ventures in India (Cotula et al., 2008), Ghana (Dogbevi, 2009) and Tanzania (Carrington and Valentino, 2011).

Second, movement towards mass market and export activities often requires a different management and ownership model that increases uncertainties associated with global pricing trends and limits the role that jatropha can play as a driver of local development, especially for smallholders. These problems are not unique to jatropha but span a wide range of agricultural activities. Curiously, they are often driven initially by the need to deal with a problem affecting smallholders. In the next case study, for example, a lack of attention to longer-term issues, and the absence of dialogues with smallholder farmers over time, contributed to their ultimate exclusion from the sector.

The Gift Fish Project: From Inclusion to Exclusion of Smallholder Farmers

The decline in wild fish stocks, the negotiation of fishing quotas to regenerate stocks in the wild, and the development of farmed salmon and their export from developed countries and Chile, were the stimulus to create the Genetically Improved Farmed Tilapia (GIFT) fish project, funded by the United Nations Development Programme and the Asian Development Bank, and implemented by the WorldFish Center⁵ in partnership with the Philippine Bureau of Fisheries and Aquatic Resources. Its objective was to develop new strains of 'improved farmed tilapia' for export (Acosta et al., 2006).

The project, initially based on Nile tilapia, used a traditional breeding process that selected for growth and sexual maturation (Acosta et al., 2006). The main actors in the process of breeding

⁵ The WorldFish Center, a non-profit organization founded in 1977 with funding from private foundations and governments, became one of the CGIAR's network of 15 international agricultural research centres in 1992.

and distributing improved tilapia were: the primary multipliers (breeding nucleus) who were the main source of the latest generation of improved fish, and those responsible for maintaining the genetic integrity of these stocks; the secondary multipliers consisting of private or government-owned hatcheries who multiply the stock; and the grow-out farmers who receive and rear the fingerlings.

When donor support ended in 1997, the project had met its initial goal of producing a hardy, fast growing and high yielding (bigger) tilapia (Ponzoni et al., 2010). Continued breeding research, however, would require a new source of funding. A non-profit private foundation, GIFT Foundation International (GFII), was created and the GIFT breeding materials were provided to institutional partners of the GIFT project and to GFII (Acosta et al., 2006). Subsequently the Foundation through “licensing arrangements, formed alliances with the private sector hatcheries in seed production, distribution and technology transfer to farmers” (Acosta et al., 2006). This arrangement, however, did not provide sufficient funds for GFII to expand its markets and gain access to more selective breeding research. In 1999, GFII established a formal alliance with GenoMar, a private sector Norwegian bio-technology company.

Between 2002 and 2004, a study was undertaken, with funding from the Canadian International Development Research Centre, WorldFish and Philippine institutes (Acosta et al., 2006). The study showed that the new alliance with GenoMar had opened the path to private appropriation of knowledge in successive improvement of the GIFT fish strain. It also resulted in a reordering of the goals and priorities of further research. The initial public sector phase of the GIFT project had focused primarily on small, subsistence and resource-poor farmers to whom fingerlings were distributed by both public and private hatcheries. In the short run this made it possible to include smallholders. In the longer run, however, their purchase of fingerlings would not have provided the revenue to sustain research into further improvement of GIFT fish. Other, more innovative, approaches would have had to be designed.

The decision to sign an exclusive use agreement with GenoMar, however, shifted the focus to an emphasis on examining strains that were more relevant to medium and large-scale farmers (e.g. selection of strains for high input and optimal environments) (Acosta et al., 2006). Moreover, dissemination mechanisms that specifically targeted small and poor tilapia farmers were largely absent. In the initial GIFT approach, the distribution pathway went from breeding to licensed private hatcheries, to the grow-out farmers, as opposed to either direct distribution to farmers from the breeding nucleus, or distribution through public hatcheries or accredited hatcheries, whether public or private.

There were also discernible differences between the public and GenoMar phases of the project with regard to access to information and opportunity to innovate for small fish farmers. An overwhelming majority (83%) of the accredited hatchery farmers interviewed in 2004 claimed that, over time, more focus was given to the monitoring of production and sales of fingerlings and less to providing services to address farmers’ technical needs (Acosta and Gupta, 2004). Larger farmers, who were reportedly better educated and had a wider set of linkages to information

sources than smaller farmers, were less affected by this shift (Acosta et al., 2006). Similarly, the same study reported that although “the profile of users based on land ownership shows that genetics-based technologies for tilapia are scale-neutral ... the capital requirement for tilapia farming is relatively high. As a result, users of genetically improved tilapia are farmers who have access to capital from their own personal sources indicating that well-off farmers are reaping the benefits of tilapia genetics technology” (Acosta et al., 2006)⁶.

The Challenges of Path Dependency and Lock-in

Path dependence is the tendency for past practices and decisions to shape present choices. Continuous flows of knowledge and information provide critical inputs into the choice process, but they do not deal with issues of path dependence or lock-in. Understanding the habits, practices and norms of the actors in a transition process is essential in developing ways to deal with the challenges of path dependence and lock-in.

For governments, businesses and users of new technologies – whether engineers, architects, farmers or urban planners – path dependence is reflected in a range of beliefs and boundaries that shape choices about new technologies. These can include creating “beliefs about what is feasible or at least worth attempting,” and boundaries that shape processes of choice such as lines of research to pursue, kinds of products to produce, and organizational routines and development trajectories to adopt (Teece, 1988). Path dependence also emerges in contexts where earlier investments result in high sunk costs (costs that cannot be recovered), habits and practices are entrenched, and ‘expert views’ are shaped by earlier thinking that narrows the range of choices to established technologies and evaluation techniques.

Once a technology is adopted, a number of related technologies, derived products, and business models become established and lock-in occurs. Improvements in products and knowledge about new possibilities and applications accumulate, generating further learning economies. Combined, these processes create powerful self-reinforcing mechanisms that make change very difficult, since even when economically feasible, new technologies face higher short-term adoption costs compared to established technologies (Cowan and Hulten, 1996; Unruh, 2000).

The Tata Mundra Project

In the energy field, the Tata Mundra project provides a good example of path dependent decision-making. In 2008, the World Bank’s International Finance Corporation (IFC) approved a US\$450 million (€400 million) loan for the Tata Mundra project, designed to build five coal-fired power plants in the Indian state of Gujarat. The first of the Tata Mundra power plants was commissioned in mid-2011. Although it is expected to emit 40% less CO₂ than existing coal-fired power plants in India, given the lifespan of this plant it will nonetheless contribute 23.4 million t of CO₂ per year to the environment for the next 25-30 years (IFC, 2009).

⁶ The development of the export flower industry based on roses in Colombia generated a similar process of exclusion with regard to smallholder farmers (Mytelka and Bortagaray, 2007). See also chapter 7 by Bolo (2016) on the choice of R&D partners of Kenya’s flower farmers in this volume.

Rashad Kaldany, IFC vice-president at the time, justified the decision to build coal-fired plants in India on the grounds that, in comparison with other alternatives, “[t]his is by far the least expensive and to try to do something like either wind or solar would cost huge amounts in terms of subsidies” (Wroughton, 2008). Taking traditional norms opposed to subsidies as the point of departure in making this choice had the effect of eliminating many new or renewable energies from serious consideration, although India had already successfully developed wind and solar industries.

Traditional economic practices – such as short-term static cost comparisons of old, established industries with industries based on new technologies, and focusing mainly on the bottom line – then precluded decision-makers from taking into account longer-term considerations, such as the future costs of retrofitting a plant with carbon capture and sequestration (CCS) technology, or the imposition of a carbon tax on coal-fired power plants.

From a development perspective, locating the new coal-fired plant on the coast and importing coal, when India has considerable reserves of coal, reduced incentives to improve the efficiency of domestic coal production and distribution. The Tata Mundra project therefore reduced the country’s efforts to develop cleaner natural gas resources or increase efforts to move towards a clean energy system based on local wind and solar industries. Combined, these disincentives contributed to electricity shortages and blackouts that resulted from the rising costs of imported coal.

A Repeat Performance

In 2010, the World Bank approved yet another loan for the construction of a coal-fired power plant without CCS – this time in South Africa. When fully operational in 2015, the Medupi power station was expected to emit 25 million t of CO₂ per year (Duffy, 2010). South Africa’s energy and chemical company, Sasol, is one of the world’s major developers of Fischer-Tropsch based Syngas and Coal-to-Liquids processes. As in India, path dependent decision-making in South Africa reduced opportunities for local innovation and the stimulus to move towards an energy transition.

In November 2012, the World Bank’s new president, Jim Yong Kim, reporting on the ‘devastating’ risks of climate change contained in a World Bank Study, noted that without a global agreement to cut carbon emissions, so many emissions would be ‘locked-in’ by 2017 that global temperatures would likely exceed the 2°C threshold (Clark, 2012). Nonetheless, World Bank support for the Tata Mundra project continues.

Conclusions

Among the most important features of IS approaches are their ability to conceptualize change as a long-term, socially embedded process in which the habits, practices and norms of the actors involved is a critical component. The IS approach also identified, early in its development, the important role that policy plays in shaping the parameters within which decisions are made. Together these two elements have contributed to the analytical strength and durability of IS approaches.

They also have some inherent weaknesses. One is the unwritten assumption that innovation is by nature progressive and represents a social 'good' for humanity. As the studies in this chapter illustrated, this is not always the case, particularly regarding the impact that innovation has had on patterns of global competition and on inclusive development. Another is the lack of attention paid to contemporary issues of global importance such as energy transitions and the environment. Just as IS approaches were eventually adapted to the analysis of innovation processes in developing countries, some changes in the way we currently think about sustainable and inclusive development and the process of change itself will be required to deal with new and emerging issues. Three of these were highlighted in this short paper.

New linkages, multi-goal approaches and a longer-term perspective in evaluating goals and objectives, already a feature of the IS approach, need to be given greater prominence. For example, one of the most important links between clean and sustainable energy, transport systems and inclusive development is their link to agriculture. From this perspective, agriculture becomes less a part of the problem, as earlier development literature would have us believe, and more a part of the solution. Rethinking commercialization within the context of smallholder farming from a multi-goal perspective, as in the Garalo case on biofuels, provides one example of how this might be done to benefit local communities. But the need for multi-goal approaches and a longer-term perspective is particularly critical in a world where farming for export has become a major source of income for many developing countries. The lack of attention to longer-term issues and the absence of dialogue with small farmers are particularly problematic for inclusive development, as the GIFT fish project illustrated. The over use of water resources, pressure on land use, as well as the social and economic problems encountered in scaling up for export of both food and fuel crops, need to become more central in IS analysis. One way in which this can be done is to develop new tools and new metrics to aid in evaluating alternatives over the longer-term.

In addition to the development of a longer-term perspective, these new tools and metrics can aid in making choices about change, as illustrated by the Tata Mundra and Medupi case studies which failed to begin a process of transition to renewable energy. Path dependence and lock-in are deterrents to change. These not only emerge among local actors, but as the Tata Mundra and Medupi cases illustrated, they also affect decisions involving members of the donor community. Far more effort will be needed to understand the habits, practices and norms of all actors and to take them into consideration in a change process.

Lastly, new capacities for carrying out change processes effectively will have to be developed. Until recently, dialogues with users, for example, have not featured centrally in policymaking or project planning in most developing countries. Although they relate to the broader set of habits, practices and norms that affect innovation and transition processes, they were not well-established practices. Instead, the common approach consisted of either a top-down process of communication – that involved the distribution of materials, awareness-raising campaigns and formal training programmes – or a process of consultation through focus groups and stakeholder meetings. The latter gives the impression of being a dialogue but in fact has pre-established boundaries that provide little opportunity for those consulted to express interests,

needs or preferences not already on the agenda, and follow-up, in the form of further discussions, rarely occurs. In the Garalo case, interactive, participatory practices such as dialogues were important from the earliest phases in project design and they continued to support knowledge and information flows of utility to the farming community thereafter. From an IS perspective, this approach embeds change processes within the community itself and while it does not solve problems, it can open channels for innovative ways to deal with them.

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Chapter 4

WHAT IS SYSTEMIC ABOUT INNOVATION SYSTEMS? THE IMPLICATIONS FOR POLICIES, GOVERNANCE AND INSTITUTIONALIZATION

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Abstract

In research for development (R4D) discourse, and innovation studies more generally, the ‘S’ word – ‘system’ – has gone feral with significant implications for understanding, practice and policy development. This conceptual confusion is unpacked and a case made for shifting the focus on the use of ‘system’ to that of ‘systemic innovation’. Four praxis (contexts) ground the theoretical and methodological ideas: (i) the Learning Project (LP) for the Africa Food Security Initiative (AFSI); (ii) the Social Learning for the Integrated Management and Sustainable Use of Water project (2001-2004); (iii) the development of strategic adaptive management within South African National Parks; and (iv) experiences of developing undergraduate and postgraduate systems courses at The Open University (OU), UK over the last 40 years. Systemic innovation is posited as a particular form of systems thinking in practice (STiP), a mode of praxis (theory-informed practical action) that draws on a rich tradition of systems scholarship and as both process and outcome. It is particularly constrained or enhanced by institutional, especially governance, arrangements.

Keywords: Social learning, Praxis, Systems thinking, Systems scholarship

Introduction

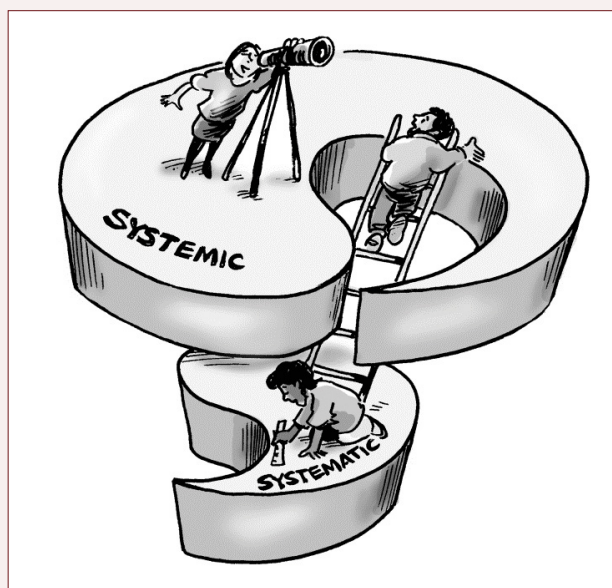
In research for development (R4D) discourse, and innovation studies more generally, the ‘S’ word – ‘system’ – has gone feral. Mainly, it is used as a noun but sometimes as an adjective as in ‘system innovation’ or ‘innovation system thinking’ in which, if my memory of grammar is correct, there really should be a hyphen between ‘innovation’ and ‘system’ when referring to thinking! In my experience there is limited, or unsophisticated, differentiation between the two adjectives derived from system, namely systemic and systematic (Figure 1). As systems’ educators at the OU, we have undertaken ‘conceptual battle’ with these words over the last 40 years. So, what can be made of the ways in which terms like ‘innovation system’, ‘system innovation’ and ‘systemic innovation’ are used?

This chapter is intended for systemic innovation practitioners. It makes a case for shifting the focus of use of the ‘S’ word to that of ‘systemic innovation’, a mode of praxis (theory-informed practical action) that draws on a rich tradition of systems scholarship (Ramage and Shipp, 2009; Ison, 2010). The paper is framed as an inquiry into what systemic innovation practitioners do when they do what they do. The purpose is to improve systemic innovation praxis, particularly in R4D, through a discussion of systems’ concepts and the history of systems scholarship. Four praxis contexts are used to ground the theoretical and methodological ideas: (i) the LP for the AFSI (Ison et al., 2012c; Ison et al., 2014a); (ii) the Social Learning for the Integrated Management and Sustainable Use of Water (SLIM) (SLIM, 2004) project (2001-2004); (iii) the development of strategic adaptive management (SAM) within San African National Parks (SANParks) (Kingsford and Biggs, 2012); and (iv) the experience of developing undergraduate and postgraduate systems courses at the OU in the UK over the last 40 years (Blackmore and Ison, 2012).

At the OU, the explanations we offer regarding the ‘S’ word and its variations have changed over time, often in response to our own learning as academics about our students’ learning. I say explanations because an explanation is something that is more fluid and open to social negotiation and renegotiation than a definition. As Ison et al. (2013a) explain: “The common understanding of definitions can be constraining because, as abstractions or declarations, they become limited to a one dimensional snapshot of a complex dynamic including loss of focus on the boundary conditions that a definition creates.” Instead, we invite user responsibility in making it clear how they choose to use a term or concept. Following this imperative, Figure 1 shows how we see systemic and systematic praxis combining to form a whole, a duality (e.g. like the predator and prey concept), rather than a self-negating pair (a dualism, such as objective and subjective) (Ison, 2010).

Figure 1. My understanding of the relationship between systemic and systematic, the two adjectives arriving from the word ‘system’ – the systematic is nested within the systemic or, in other words, the systematic is a special case of the systemic; together systemic and systematic form a whole, a unity, known as a duality.

Source: Ison (2010)



In recent years, whenever I have been asked to give a talk or run a workshop I usually pose, early-on, the following question to audiences or participants: ‘How does walking arise as a practice?’¹ Almost invariably the answers that are given are grounded in systematic, linear or causal thinking. Only rarely do I receive the answer that walking arises in the relational dynamics between a person, or organism, and a medium such as a floor. If the relational dynamics between the two are broken, then walking as a practice does not arise. The thinking that underpins these two answers is radically different and has major implications for what we do when we do what we do, such as how we might understand the governance of a water catchment or a systemic innovation.

These different modes of thinking are also relevant to the ‘S’ word. Within the systematic tradition, systems are seen as things in the world (as ontologies) that can be discovered, described, modelled or engineered. Historically, this can be understood as the mainstream understanding and is what Checkland (1981) labelled the hard-systems tradition. In contrast, the systemic tradition understands a system to be an epistemological device for knowing about a situation of concern, so as to learn means for improvement and change i.e. for innovation. Thus, a system in this tradition is a product of a distinction, formulation, or invention by someone, or a group, concerned with improving situations using systems thinking. In this tradition, practitioners realize that when a system is generated, it is not a thing but a system-environment (or context) relationship mediated by a boundary judgment made for a purpose. In other words, they understand the relational dynamics at play as in the example of walking. It is this latter tradition that Checkland (1981) elucidated, but perhaps unfortunately labelled, the soft-systems approach. It is also important that people working with systems’ concepts appreciate the history and diversity of the different systems’ intellectual lineages (Ison, 2010; Ison, 2012a; Ison, 2012b). Table 1 outlines how we currently explain the ‘S’ words to OU students.

Table 1. Explanations associated with the use of the word ‘system’ and related terms

| | |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| System | An integrated whole distinguished by an observer whose essential properties arise from the relationships between its parts; from the Greek <i>synhistanai</i> meaning ‘to place together’ |
| System of interest | The product of distinguishing a system in a situation, in relation to an articulated purpose, in which an individual or a group has an interest (a stake); a constructed or formulated system, of interest to one or more people, used in a process of inquiry; a term suggested to avoid confusion with the everyday use of the word ‘system’ |
| Systemic thinking | The systemic action of our own cognitive system that is not limited to language and logic (background systemic thinking). Within language (i.e. in the foreground) it can be understood as the understanding of a phenomenon within the context of a larger whole; to understand things systemically literally means to put them into a context, to establish the nature of their relationships |
| Systematic thinking | Thinking, which is connected with parts of a whole but in a linear, step-by-step manner |
| STiP | A term to convey the understanding that systems (systemic + systematic) thinking and practice operate as a duality |

Source: Ison (2010)

¹ In doing this I follow the example of Humberto Maturana, as for example his foot-shoe example, cited in Maturana and Poerksen (2004:83-85).

Other systems' concepts are central to the concerns of this paper – these include *connectivity* and its relationship to *networks* (my own view is that systems theory and network theories are compatible if one accepts the need for some form of boundary judgment when attempting to act purposefully to transform a situation) as well as *feedback* – because of the role it plays in monitoring, controlling, learning and adapting. The animating questions of this chapter are: *What types of STiP is relevant for systemic innovation praxis? What exactly is a systemic innovation and what could a systemic innovation approach become? How would systems concepts be systematically applied to improve systemic innovation approaches?*

Why Systemic Innovation?

The confusion around the 'S' word is not restricted to R4D as a recent major report called *Systems Innovation* makes clear (Mulgan and Leadbeater, 2013). These authors describe their concerns as:

“[part of a] growing interest in systemic innovation². We are defining this as an interconnected set of innovations, where each influences the other, with innovation both in the parts of the system and in the ways in which they interconnect. Yet rather than simply theorizing, we want to make this practical. We want to explore the potential of systemic innovation to help tackle some of the key challenges the UK currently faces, from supporting an ageing population to tackling unemployment.”

My own contention is that the distinctions between systematic and systemic are not trivial as how the terms are understood affect what we do – our praxis – and the institutions (norms, rules of the game) we invent which, knowingly or not, impinge on what we try to do in the name of innovation. Mulgan and Leadbeater's (2013) espoused concerns above are probably shared by most R4D practitioners – to get R4D innovations working together, or joined-up, in ways that deliver ongoing benefits, such as in an effective 'innovation platform' (IP) (e.g. Hounkonnou et al., 2012). In other words, the 'what' of their concerns is held in common, but to be genuinely systemic, 'how' and 'why' have to be addressed in relation to each other and to 'what! Praxis, as I will use it, is about addressing 'what', 'how' and 'why' systemically in a given context, to create what I will call a STiP performance. Framed in this way, innovation can come about in multiple ways (see below).

Armed with the distinctions I am making, I would rewrite the quote above because unfortunately the language confuses systemic innovation, a form of praxis, and a 'system' that is assumed and, unwittingly through language, given an ontological status. Too often means and ends are confused in the use of the 'S' word. The essences of Mulgan and Leadbeater's (2013) narrative are (N.B. I start and finish with *'the situation'* – not *'the system'*):

- (i) there is a situation of concern in which some form of systemic innovation (interconnected set of innovations) is desired;

² The shift to the term systemic innovation away from system innovation came at the suggestion of Martin Reynolds, an OU colleague and myself.

- (ii) engaging with the *situation* through a praxis of systemic innovation if done well can realize improvements (innovations) that are systemically desirable and culturally feasible;
- (iii) formulating systems of interest, as epistemological devices to learn about and transform a situation of concern, is central to systemic innovation praxis;
- (iv) the driving purpose is to transform a situation of concern to a new situation in which stakeholders appreciate the systemic dynamics, possibly claiming that a system now exists and is functioning, because questions of boundary, purpose and connectivity of elements have been understood and resolved, and possibly institutionalized;
- (v) a systemic innovation can be claimed.

Central to my distinctions around ‘S’ are the epistemological commitments that are knowingly or not brought into the practice space. Community of Practice (CoP) theory (Wenger, 1998; Blackmore, 2010) can be used to explore the implications. Figure 2 is central to CoP theory as it describes the duality that exists between participation and reification (made into a thing) that unfolds through the life of a CoP, e.g. a concern for ethics might arise through conversations and other forms of R4D practice and these abstract concerns may then be reified by the generation of an ethics clearance process and/or a consent form (or the process could operate the other way). There is thus a link that can be made in STiP to the processes of generating a system of interest in the participation domain. This would constitute starting out systemically and an outcome could be the reification of a system design that makes sense in the context of its generation. But problems arise when such a ‘system’ is taken out of context without another round of participation! Thus a system, as an epistemological device, is only ever relevant to the context of its generation. It cannot be ‘rolled-out’ or ‘scaled-up’, although the processes associated with the generation of a praxis like systemic innovation can.

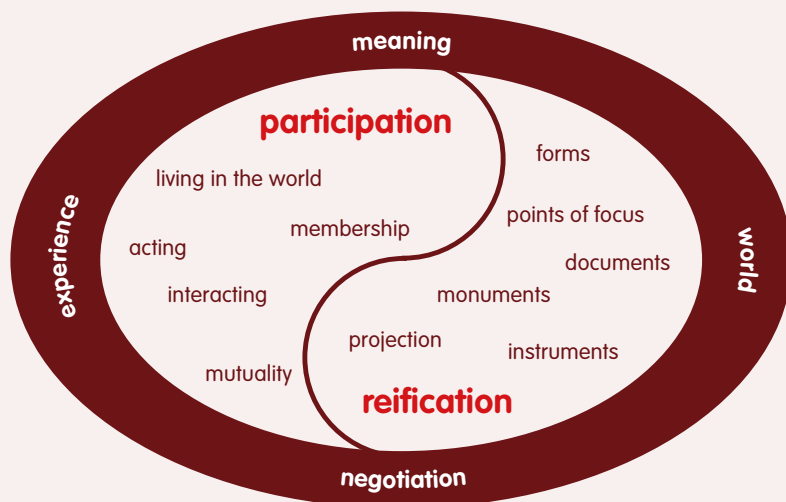


Figure 2. The participation-reification duality in CoP theory
 Source: Wenger (1998)

Alternatively, it would be possible to start out in the systematic tradition – seeing systems as things, as reifications – but it would be a trap in the medium to long-term to not open-up boundary judgments and patterns of connectivity and causality to wider scrutiny through a form of participation or social learning. Failure to do this may lead research, for example, down the wrong pathway from the start. The reification-participation duality can also be understood as a key element in processes of institutionalization, i.e. an institution is a reification or codification of some abstract set of concepts which may, or may not, be generated through appropriate participation.

Evidence

Reflexive R4D Praxis

From late 2011-2013, my colleagues and I in the Systemic Governance Research Program designed and ran an LP as part of an Australian Agency for International Development (AusAID)-Commonwealth Scientific and Industrial Research Organisation (CSIRO) funded and led AUD\$30 million (€20 million) AFSI, which partners with the Council for Agricultural Research and Development in West and Central Africa in West Africa and Biosciences Eastern and Central Africa (BecA) Hub in Eastern Africa³. The LP was funded by CSIRO (for background see Ison et al., 2012c) and its aim was to design a learning system in the AFSI situation such that reflexive and responsible R4D practice was an emergent outcome. We drew on Schön (1983) who sought to establish “*an epistemology of practice implicit in the artistic, intuitive processes which [design and other] practitioners bring to situations of uncertainty, instability, uniqueness and value conflict.*” Within this tradition, ‘learning systems’ cannot be designed deterministically (i.e. as a blueprint). Rather, theory-informed contextual design is pursued to create favourable conditions for emergence (in our case, emergent co-research inquiries between Monash University and CSIRO LP participants and, subsequently, with BecA-connected African-based counterparts – see Ison et al. (2013b) where material from one of the emergent inquiries is published). Thus, a ‘learning system’ can only be said to exist after its enactment, i.e. upon reflection. ‘Design’ of learning systems is also a form of systemic action research. It is too early to elaborate fully what we have learned from this project but we do know that (i) initial framing and starting conditions and (ii) institutional arrangements were not conducive to realizing our design ambitions (Ison et al., 2014a; RCEP, 2010).

One of our first tasks was to produce a document we called ‘Notes for the Field’ (Ison et al., 2013c) designed to introduce, to the mainly CSIRO biophysical scientists, ideas about reflexive praxis, action research, and some possible theoretical frameworks which could be used to interpret their R4D experiences. To do this, we argued, there is a need to appreciate systemically what we (as researchers) do when we do research as a form of practice, rather than what we might claim we do. Figure 3 is a heuristic model developed for this purpose depicting an engagement of two researchers, although there are usually many more researchers involved. For clarity, the researcher/practitioner (P) with his/her unique traditions of understanding is abstracted out of the research situation (S). Practice, as performance, arises through the systemic interaction of P;

³ The former AusAID is now part of the Department for Foreign Affairs and Trade.

F (a chosen framework of ideas); M (methodological choices aided by T, tools or techniques); S (situation of concern, which may be framed in many ways); and C (capturing or reifying some outputs of the process). The theoretical framings and methodological choices shown here reflect preferences and appreciation of context, i.e. others could be chosen.

What becomes apparent from understanding research in terms of Figure 3 is that there are multiple sites for learning, and thus innovation, i.e. changes in understanding or practices of the situation (S) such that it might be *transformed* to a new situation; in a framework of ideas or theory, in method or methodology, in practitioner embodiment and the overall performance of the practitioner in context (with others). I would argue that all of these dynamic processes are central to the functioning of an IP.

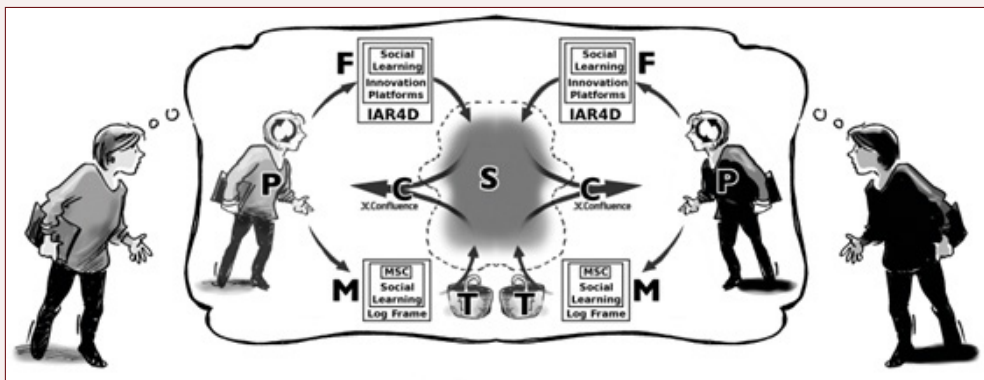


Figure 3. A heuristic designed to facilitate systemic reflection on what is done in the practice of collaborative research. P, practitioner; F, framework of ideas; S, situation; M, method or methodology; T, tools or techniques used as part of method; C, confluence, an on-line data repository used to aid assimilation of data; MSC – most significant change; IAR4D – integrated agricultural research for development.

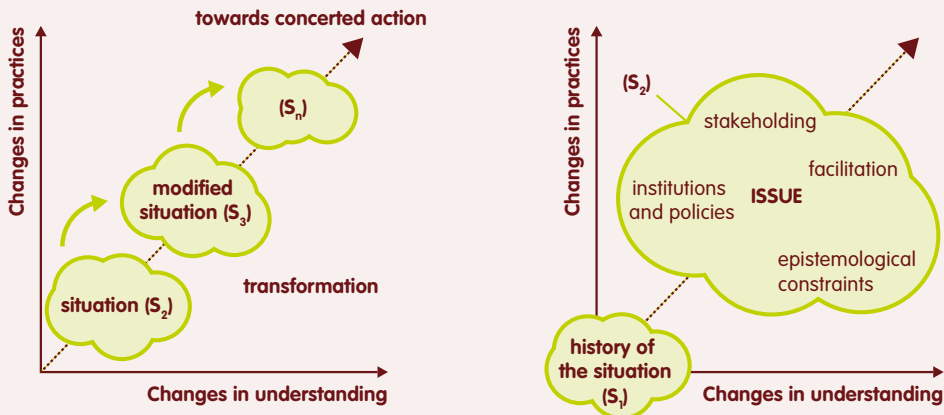
A number of factors get in the way of the praxis dynamics revealed in Figure 3 which leads to poor performances as in, for example, the functioning of an IP. Thus the factors, or ‘variables’ that constrain effective performance, the transformation of one situation to another (which is what an IP essentially tries to do), need to be understood, and if necessary changed so that they do not constrain but enhance innovation. This is a role for governance of innovation based on social learning (Ison et al., 2013a).

Social Learning

We conceptualize social learning as we have come to understand it through 14 years of research as a duality – a social process of situational transformation (or innovation), and a governance mechanism which can be invested in by governments (think of an orchestra as both entity and

social process engaged in creating performances). Social learning is theoretically and methodologically central to our design and interpretation of LP activities and systemic governance research. Figure 4 shows the adapted SLIM heuristics, which can be used to design, mediate, facilitate, theorize or interpret research practice in situations characterized by interdependencies, complexity, uncertainty and multiple stakeholders, such as natural resource dilemmas and ‘wicked’ situations (Blackmore et al., 2007; Ison et al., 2007). I would argue systemic innovation could be understood in these terms. The same approach could be used to determine what is needed in a given context to create and sustain an IP.

How do we design for transformative research (or practice) using systems approaches?



Social learning: process of socially constructing an issue by actors in which their understandings and practices change, leading to transformation of the situation through collective/concerted action.

Figure 4. Adapted SLIM heuristics for innovating in situations of uncertainty (for more detail see Steyaert and Jiggins, 2007; Collins and Ison, 2009)

I reprise our current version of the SLIM heuristics (SLIM, 2004; Ison et al., 2007; Steyaert and Jiggins, 2007; Collins and Ison, 2009) because it is in this framing that I wish to elaborate on policies and institutions in the next section. The detail and theoretical ideas, which these heuristics integrate, are given in Table 2. In terms of this chapter’s ambition, a question to ask is: is it possible to conceptualize, develop and thus institutionalize (e.g. systemic innovation) when reflexive, epistemologically aware praxis is missing?

Table 2. The main elements of the SLIM heuristics

| | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Start with situations not systems and utilize agency (freedom to reframe) to make framing choices relevant to the circumstances – this includes the choice to frame aspects of a situation as a system, or to frame a situation as a complex adaptive system. | 6. Facilitation can be carried out by a person or ‘mediating object’ (which may be a new technology such as new breed, etc.), not necessarily someone in a leadership position, and is an enabling role in social learning. |
| 2. Reject the problem metaphor and belief in a knowable, fixed problem at the start in favour of constructing the issue (or system of interest as an epistemological device). | 7. Epistemology refers to the different ways of knowing that each person (or groups, including organizations) carries with them in engaging with the situation; of particular concern is the implications of differences that arise from ecological, technical and constructivist rationalities. |
| 3. The history of the situation can influence the possibilities of the current situation, by enabling learning from past experiences, or by constraining opportunities for action from past decisions. History also applies to people in the situation. | 8. Learning processes underpin the arrow in the heuristics based on social theories of learning, including single, double and triple loop learning. |
| 4. Institutions refer to the set of formal and informal rules, norms, regulations and policies that are created to shape what we do. | 9. Transformation of situations driven by changes in understanding and practices of those involved, as well as 10 below. |
| 5. Stakeholders who actively engage in stakeholding are influenced by and influencers of the situation, and have different perspectives on what is at stake. | 10. Changes in social relations , including trust that emerges from being involved in a ‘joint enterprise’ and which produces ‘ relational capital ’. |

Just as the research my colleagues and I undertook on social learning was driven from the realization that participation was necessary but not sufficient in complex, uncertain dilemmas, or ‘wicked’ situations. As a result, we have also come to understand that the governance aspects of social learning requires more attention, including innovative means to institutionalize social learning approaches. The experiences of Hounkonnou et al. (2012) are similar.

Systemic Governance and Social Learning

The cyber-systemic lineage of framing governance, which we adopt in the Systemic Governance Research Program based at Monash University, is not new (see Blunden and Dando, 1994) but it is possibly neglected in recent governance discourse or confused (Rhodes, 1996). Within this framing (Cook and Yanow, 1993; Ison, 2010), the central organizing metaphor, as shown in Figure 5, is that

of two helmsmen (sailors) charting an ongoing, viable course in response to feedback (such as currents or wind, for example) and in relation to a purpose that is negotiated and renegotiated within an unfolding context (i.e. in response to uncertainty). Within this organizing metaphor, it is important not to assume that the sailors are navigating to some pre-set map or course but, as in historical times, ‘wayfinding’ (Ingold, 2000:231) or ‘sensemaking’ (Weick, 2009).

Thus governing encompasses the totality of mechanisms and instruments available for influencing social change in certain directions including a practitioner’s own history (i.e. traditions of understanding and identity). Whether purposeful or not, the collective activities of governance produces effects comprising varying degrees of coordination/lack of coordination, control/loss of control and certainty/uncertainty. The point is to arrive where a loss of control does not lead to fear but to social learning and innovation.

What we have learned from the SAM research, undertaken primarily within SANParks (and which is currently being studied further in collaborative research), is that systemic governance is the context in which adaptive planning, designing, regulating and then managing sits. Governance, that is genuinely ‘adaptive’, is also systemic and incorporates learning and change in response to uncertainty but, despite the growing need, is usually poorly done (e.g. Allan and Curtis, 2005). Often this is because of a lack of clear rationalization (and critique) of the interacting effects of private and public forms of action (Osberghaus et al., 2010).

Systemic governance?

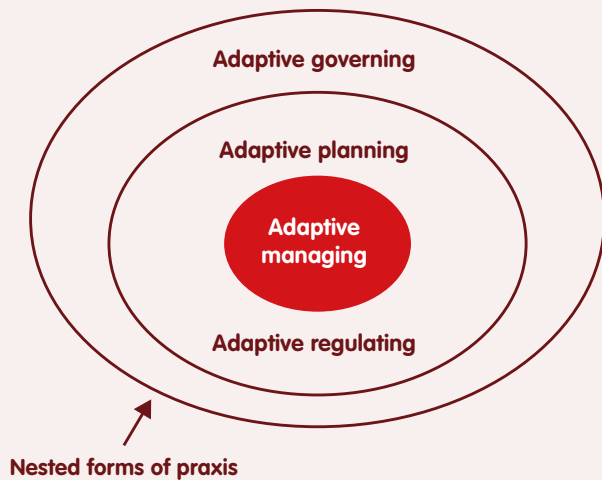


Figure 5. Helmsmen responding to feedback (e.g. currents, winds, purpose)

Source: http://upload.wikimedia.org/wikipedia/commons/3/3c/Girls_sailing.jpg

Within a systemic governance framing, and following SLIM (2004) and Leeuwis and Pyburn (2003), we have come to see social learning as a key element comprising governance mechanism and an unfolding social dynamic (Steyaert and Jiggins, 2007; Ison et al., 2013a). Governance can operate at the level of a meeting, a project, a programme, an organization, a set of policies, an IP or a government, and in relation to the biophysical world and other species (e.g. biodiversity). As outlined in the next section, institutions (or social technologies) and institutionalization are critical to the transformations that are sought within such a framework.

Praxis and Praxeology

The term praxis, rather than practice, is used in our work to make the point that all practice is theory-informed. The dominant paradigm or the ‘mainstream framing’ of how knowledge relates to practice is practice as applied knowledge, what Cook and Wagenaar (2011) call the ‘received view’. They posit that “*knowledge and context can be explained in terms of – and are evoked within – practice, and not the other way round – and that this transpires within real worlds, each of which has its own unique constraints and affordances, histories and futures.*” From this perspective, the practice of developing IPs, or ‘systemic innovations’, generates both context and new ways of knowing; the choices Cook and Wagenaar (2011) offered exemplify why theoretical framing of choices matter in relation to processes of acting out our conceptual understandings.

Through practice that engages with situations, a range of reframing and framing choices become apparent. But, a lack of awareness in policy and professional practice, as to how much an agency exists in relation to framing choices, has subsequent, or ‘downstream’, implications (RCEP, 2010). Unfortunately, the current mainstream approach stems from adoption of a narrow understanding of how science informs policy (e.g. Leach, 2008) and practice, which does not admit multiple partial perspectives from the start. We adopt a stance consistent with praxeology; that branch of knowledge that deals with practical activity and human conduct (Ison, 2010). We note that all praxis is contextual and dynamic. Thus, history matters, as do circumstances, stakeholders, small ‘p’ politics, skills of those involved, and the institutional arrangements (‘rules of the game’, in the institutional economics sense – North, 1990), which characterize the praxis domain⁴.

From 40 years of practice as systems educators we learnt that it was not enough to equip our students with their own systems thinking and practice skills – too often we set students up to fail in inhospitable institutional and praxis contexts. In our most recent programmes (Blackmore and Ison, 2012), we have seen it as an ethical responsibility to enable students to take what we call ‘a design turn’, i.e. to develop ways to improve practice at the same time as striving to transform their contexts of practice through systemic design. Another way to understand or frame this concern is under the rubric of systemic governance of a systems practice-context co-evolutionary dynamic. This framing and praxis, I would argue, is much needed in sustaining any innovation in an R4D context and relates to findings of Woolley and Douthwaite (2011) that R4D “projects need to intervene at three or more system levels, with their corresponding actors, to bring maximum benefit to small rural households.”

⁴ This section draws on Ison et al. (2014b).

Conclusions, Recommendations and Implications

Like Convergence of Science-Strengthening Systems of Innovation (CoS-SIS) (Hounkonnou et al., 2012; Jiggins, 2012; Jiggins et al., 2016), our research, post SLIM, has focused on institutions because of the critical role they play in enabling, or constraining, social learning as a process, and because of the need for recognition of social learning as an institutional form (governance mechanism) worthy of investment (Ison et al., 2013a). That said, we have not lost sight of the systemic interplay of all ‘variables’ in the SLIM heuristics (Figure 4; Table 2). We have learnt some things about institutions, but perhaps not in such a major and coherent way as CoS-SIS (Hounkonnou et al., 2012; Röling, 2008). The main lessons of this chapter are:

- The importance of conceptual and methodological clarity around the ‘S’ word as well as all other framing choices (e.g. Hall and Clark, 2010; Woolley and Douthwaite, 2011).
- The role institutions play in shaping landscapes and creating initial starting conditions is not well appreciated – a capability to cultivate is that of ‘reading’ an institutional landscape and appreciating the historicity of particular institutions (Wallis and Ison, 2011b).
- Institutional complexity needs to be appreciated (made apparent) (Wallis and Ison, 2011a) and the systemic implications understood for ongoing governance of a situation – institutions may need to be avoided, accommodated, subverted (e.g. Steyaert et al., 2007), dissolved (e.g. greenfield planning), redesigned or invented (e.g. systemic inquiry as an antidote to living and working in a projectified world – Ison, 2010).
- Consistent with learnings from participatory action research (*sensu* Colombian researcher, Orlando Fals-Borda who championed participatory action research, and saw reclaiming historical narratives as empowering⁵ historical institutions which have been lost can be resurrected through research, e.g. evidence of historical social learning in salinity management in Victoria (Wallis et al., 2013).
- There is a strong case for institutionalizing new modalities of praxis (Seddon, 2008; Ison et al., 2011; Ison et al., 2013a; Ison et al., 2014b); these do not have to be radical as shown in recent research where processes of human ethics clearance and questionnaire development, if done appropriately in multi-disciplinary teams, can act as mediating objects which break down epistemological divides (Ison et al., 2013b).
- The nature and level (i.e. upper middle management) of an intervention in organizational contexts sets the constraints and possibilities for institutionalization of any learning (J. Seddon pers. comm. 2013; Ison et al., 2014a).
- Reframing institutions as social technologies can expand understandings and practices in theoretical and methodological terms (Ison, 2010); this opens up, in addition to the new institutional economics literature, the philosophy and sociology of technology literature which facilitates a move from seeing institutions as entities to understanding their affordances in mediating human experience.
- Finally, we could ask whether some of the issues that are framed or described as power asymmetries may not be more usefully framed as a failure of institutional innovation? Why? Because in some circumstances the latter framing may leave those involved with more agency to act.

⁵ http://en.wikipedia.org/wiki/Orlando_Fals_Borda [Accessed 8 September 2014].

Of course, all these points need to be appreciated within the dominant meta-framings that shape development cooperation, e.g. productivism, security (e.g. Fischhendler and Katz, 2012), market chain, economic rationalism, etc. For example, is the assumption that sustainable intensification will make a major contribution to global food security and food sovereignty, and make the global food system more resilient in the face of predicted shocks and disturbances, an appropriate framing? Is not the ‘real politik’ the world over that parents want their children to move into other sectors than farming? Marsden (2012) advocates paying closer attention to place-based knowledge systems and the contradictory notions of ‘sustainable intensification’. This might be useful to use when framing systemic innovation for smallholders involving complex multi-scalar governance systems with different agendas, i.e. the neoliberal paradigm reflected in agricultural policy at national/state level and the particular production landscape situations as perceived by local actors at, for example, the property scale – landholders/farmers. Innovation, as social learning and institutional change within a production sub-system, can be impeded by the incongruity between variably scaled governance agendas for rural landscapes. Thus, when Hall and Clark (2010) claim that, “*the policy implications of [their study] suggest a policy agenda that recognizes adaptation capacity as the life blood of complex adaptive systems*”, this will make little sense unless accompanied by the institutionalization of appropriate praxes – what I have referred to elsewhere as ‘policy as praxis’. There is also, I suggest, a need to break out of rural-urban dualisms into institutional innovations that connect urban communities to place-based activities and narratives.

Acknowledgements

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Chapter 5

THE USE OF INNOVATION SYSTEMS IN A TECHNOLOGY DEVELOPMENT AID PROGRAMME: THE CASE OF RESEARCH INTO USE (RIU)

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Abstract

The Research Into Use (RIU) programme, sponsored by the UK's Department for International Development (DFID), examined advance thinking and theory on innovation systems (IS). After having made significant investments in research in the natural resources sector over several years, DFID was interested in demonstrating to what extent research outputs could contribute to achieving development impact. RIU shifted attention from knowledge generation to putting knowledge into productive use. An IS approach was adopted but this was not initially very clear. Learning formed the core of the programme and attention was paid on how to leverage private sector involvement. The RIU 'Best Bets' sub-programme, which supported promising proposals based on existing research outputs, was part of the experiment for enabling innovation. The main conclusions were that success was mixed, 'low hanging technological fruit' did not exist, and scientists had a major role to play in adaptive research and development (R&D). In the few cases where success was demonstrated, projects had created entrepreneurship and employment. The IS heuristic allowed programme managers to build up local networks of stakeholders which contributed to building capacity and this approach offered the best prospects for rural technology development.

Keywords: Learning, Impact, Low hanging technological fruit, Private sector

Introduction

This paper is a contribution to advancing thinking and theory on IS and building research capacity for influencing policy and practice. It explores the issues by focusing on the RIU programme. In the early 2000s, DFID had become increasingly concerned about its research expenditure in the natural resources sector. Under its Renewable Natural Resources Research Strategy (RNRRS), DFID had funded approximately 1,600 projects, largely carried out by UK research organizations, costing about US\$350 million (€320 million) between 1995 and 2005; but it seemed impossible to demonstrate how and to what extent the resultant 'knowledge' had contributed, in a practical and measurable way, to development in low income countries (LIC). RIU was initially implemented in 2006 as an attempt to 'scale out' the knowledge generated and, at the same time, to better

understand how to improve science policy processes. The estimated budget for the programme was US\$60 million (€55 million). It ended in December 2012¹.

At its inception, RIU decided to adopt an IS approach, although at that stage it was unclear what defined such an ‘approach’ or indeed what an IS actually was. In early discussions there appeared to be a wide variety of views, ranging from seeing an IS as a scientific theory (with definable parameters that could be estimated through experiment) to a loose metaphor based around general systems theory, which was used to justify an analytical style that emphasized behavioural networks of stakeholder groups involved in technological change (see Ison, 2016).

In the end, the programme eventually took the form of three linked sub-programmes focussing on sub-Saharan Africa and South Asia. Underlying all of the discussion was an issue that has bedevilled science policy since the Second World War (WW2); namely to what extent should scientific research be directly involved in practical development. This paper provides a brief historical account of the emergence and early use of the idea of an IS, before describing briefly how RIU used the idea of an IS. Lastly, the paper summarizes some of the broad conclusions reached regarding RIU’s impact.

Innovation Systems and Economic Change

The origins of the concept lie in attempts to understand the causes of economic growth and change. This became fashionable among economists since it linked to debates on how best to recover after WW2 to ensure economic progress and to assist in the development of poor countries. By the mid-1960s, it had become accepted that national investment data could not adequately explain observed economic growth. Incremental capital/output ratios varied widely across countries and well-known economists like Robert Solow and Moses Abramowitz had established, at least for USA manufacturing, that differential investment rates explained only small proportions of observed change (Solow, 1957). A related problem was that ‘growth economics’ told us very little about what actually brought about change. Formal growth models were of little help since they were mainly about cataloguing forms of macro-economic instability in the long-term and did not engage with causation and related policy factors.

But if (as Solow and others had demonstrated) investment was not the main causal factor then what could it be? The answer was ‘technological change’ or better ways of deploying resources. The stage was thus set for a research programme that is still ongoing. Initially, there were vigorous attempts within the economics profession to resurrect the role of investment but eventually these died down with the acceptance of ‘new growth theory’ in the 1980s and a general agreement that innovation was a key part of the solution. But, in a sense, this only postponed the causation issue since it did not explain widely varying international economic performance.

In an attempt to resolve the problem in the context of Japan, Freeman (1987) first put forward the idea of an IS (Freeman, 1995). He suggested that a major explanatory factor in Japan’s rapid

¹ More complete details on RIU may be found in Clark et al. (2011), Gildemacher and Mur (2012), and Clark (2013).

development was that it had built up a set of institutions that helped promote sustainable innovation and that these crossed public/private sector boundaries. His view was, and remained, that the research agenda should take the form of exploring the relevant institutional context of Japan and other East Asian newly industrialized countries with a view to making policy assessments that could be generalized in a qualitative sense. His insights were then articulated in more detail by authorities such as Lundvall (1992) and Nelson (1993).

However, while accepting this notion in a general sense, some analysts felt the notion was incomplete. For example, there was little attempt to define what is meant by a 'system' independent of its context of use. There is a considerable body of general systems theory that goes back to the early 20th century (Emery, 1970; Clark et al., 1995; Clark and Juma, 2013; Ison, 2016) but there was little or no engagement with it in relevant economic literature. This meant that objective system comparison became difficult and left policy analysis entirely to qualitative modes of intervention. It also meant leaving the so-called 'Washington Consensus' occupying the high ground of economic theory. This could pave the way in the not-too-distant future for hearing, yet again, about the need to return to free market principles.

A second problem was (and remained) that the use of IS approaches has had virtually no impact on some of the main problem areas of economic development in LICs, particularly rural agriculture. This has been partly remedied by Hall and others in recent years (Hall, 2009) but progress is slow. Hence the position taken by RIU was that the concept was a useful heuristic to be explored but its use in the specific context of rural development still had to be developed. Nevertheless, one advantage was that it placed the analytical centre of gravity with innovation rather than science and therefore the concept could be used to throw light on how formal science might engage more effectively (and institutionally) with practical development issues as they affect very poor farmers in poor countries.

The Research Into Use Programme

The approach taken by the RIU programme was to shift the focus of attention away from the generation of new knowledge to the ways in which an existing stock of knowledge could be put to productive use. What distinguished it from most technology development activities was the inclusion of three characteristics. The first was its use of the idea of an IS to guide its operations. In practise, this made an assumption that successful technology development depended on a network of organizations and individuals involved in generating, modifying, and using new knowledge. Science, though important, was only one of many necessary inputs from ancillary bodies in the private and non-governmental organization (NGO) sectors. Innovation, not science, was the centre of gravity and so projects were funded in ways that would promote the interaction and networking of all knowledge sources.

This was achieved through the establishment of national 'innovation coalitions' and 'innovation platforms' (IPs) in selected countries. The former were groups of local stakeholders that liaised with RIU management and made decisions about project choices. The latter were areas that became the focus of projects. For example, in Nigeria, the coalition consisted of scientific, private

sector and government representatives led by the agricultural research council and the choice of focus (IP) was on cowpea storage and aquaculture. In Tanzania, the lead organisation was a local NGO and the initial focus was on poultry and agricultural engineering.

Secondly, RIU was introduced as a learning programme. Unlike modern industry where the investing firm routinely accesses whatever new knowledge it needs either from its own R&D departments or external similar bodies, the small poor farmer has no comparable option. At the same time, publicly-financed extension systems have ceased to be fit for comparable purpose (Anderson, 2008). How then could an aid agency fill the gap? This was a question that needed its own investigation. Of course ‘impact’ cannot be identified *ex ante* for the obvious reason that lessons are learned through actually carrying out projects. This proved hard for a government department to manage since there was no clear initial objective that could have been easily ticked off. However, DFID has shown that it can be done.

Thirdly there were wider issues of foreign aid dependence and arguably its relative failure to create independent entrepreneurship and growth in some recipient countries (Moyo, 2009). An important aspect of RIU was that it investigated how the private sector could be leveraged into aid programmes, both as a contributory player and as potential new local start-up businesses.

Best Bets

The three characteristics are illustrated by one of RIU’s component activities, the Best Bets sub-programme². The inspiration for the RIU Best Bets initiative came from the successful and popular BBC television programme *Dragons’ Den*. Versions of this programme had been broadcast around the world under a variety of local names (*Money Tigers* in Japan; *Shark Tank* in the USA). The basic concept is that would-be entrepreneurs pitch their business ideas to a panel of wealthy and successful entrepreneurs who, subject to satisfactory due diligence, invest their own money and expertise in proposals that they find convincing, in return for an equity stake in the business. RIU Best Bets took the central tenets of *Dragons’ Den*, including ideas being pitched to an expert panel and the requirement of rigorous due diligence, but in other important aspects the procedure and principles varied significantly. One major difference was that the RIU Best Bets panellists would not invest their own resources; rather they made recommendations as to how RIU should invest its programme money³.

The objective of RIU Best Bets was to identify promising proposals, which could take existing agricultural research products and put them into use in ways that would benefit the poor (and others) in developing countries through partnerships in which private sector actors played a major role. The budget for piloting the project initiative in Africa was £5 million (€6 million).

² The two other activities were a set of African country programmes and an Asian challenge fund.

³ The RIU panel were: Judi Wakhungu, executive director of the African Centre for Technology Studies (ACTS); Muchiri Wahome (chair), managing director of Deacons (K) Limited, a leading fashion retailer in the region; Patrick Oketa, chief investment officer at the Kampala-based African Agricultural Capital; and Ali A Mufuruki, chairman and CEO of the Infotech Investment Group in Tanzania.

The proposal could be on any aspect of agriculture in Africa – including crops, livestock, fisheries or forestry – throughout the entire value chain, from production, processing, storage, and input and output markets, to consumption. In September 2009, advertisements were placed in a number of newspapers covering Eastern, Central and Southern Africa inviting the submission of Best Bets concept notes. Applicants were required to submit two page proposals, which indicated financial support being sought from RIU, but no limits were specified. There were four criteria, which had to be addressed in the concept notes, namely:

- The proposal should be grounded in rigorous research in agriculture, including fisheries and forestry
- The research originators should be involved in the programme in a significant way in order to apply their tacit knowledge and learning to the programme
- The proposal was expected to achieve significant development impact at scale in Eastern and/or Central Africa (and perhaps beyond)
- The proposal should comprise a consortium of partners (e.g. academic, public sector, NGO) led by an African institution and should include a private sector partner with evidence of support, which could be financial or in-kind.

By the submissions' deadline in early October 2009, RIU had received 105 concept notes⁴. RIU was assisted by the London-based Cambridge Economic Policy Associates – an economic and financial policy advisory business – during the screening process. A shortlist of 11 proposals was developed. In two cases, pairs of proposals that appeared to offer significant opportunity for synergy (an army worm forecasting system and an army worm control technology; and two aquaculture proposals) were invited to amalgamate their proposals. The lead organization for the short-listed proposals was asked to write a business plan following a format provided by RIU. To facilitate this, a grant of £1,500 (€1,800) was made available, which teams used in various ways, such as to bring team members together to enable them to work jointly on their plans.

Two representatives from each proposal were also supported to attend the 'Dragons' Den' event in Nairobi on 26–27 November 2009. At this event, two representatives of each of the short-listed proposals presented their idea to the independent panel drawn from leaders in the African business, finance and R&D communities. The panellists had already read the business plans. Following a 10 minute oral presentation, panellists had 20 minutes to interrogate the proposal, followed by a further 10 minutes in private to discuss the proposal among themselves. At the end, the panel announced the proposals that had been selected for RIU support, subject to due diligence, prior to finalizing contracts.

The money that RIU invested in the selected Best Bets was in the form of a grant since RIU's expected return on its investment was not financial; it was to contribute to learning. The Best Bet proposals, which RIU supported, became part of an experiment in enabling innovation.

⁴ These came from Eastern and Southern Africa. The call then went out to West Africa, which generated 20 additional proposals.

RIU researchers rigorously monitored the Best Bets with a view to teasing out useful lessons: what worked well, what worked less well and why? These lessons then formed an important part of RIU output and helped shape future policy and practice to enable research to have greater impact on agricultural innovation. The Best Bet teams were expected to work closely with RIU communication specialists and journalists to achieve widespread coverage of their success stories.

Outcomes, Impact and Policy

What have been the broad conclusions of this venture? It must be made clear from the outset, that outcomes have been patchy as some projects were successful and others were not (or at least they still need time to prove themselves). For example, a project designed to activate block treatment of infected cattle using university students only aroused the interest of venture capital sources after RIU ended. In that case, the issue was one of dealing with the spread of human infective sleeping sickness by treating the carriers of the parasite (cattle) with insecticides and drugs. These appear to deal with other aspects of animal health and have revealed that there is strong market demand among cattle owners. One Best Bet that has not taken off was the establishment of a franchise system to backstop village level fish farming in one Eastern African region. The problem was lack of adaptive research due to the loss of the original scientists from the project. This, combined with the complexity of the activity and managerial issues among the relevant innovation coalition, has meant that it may be some time before widespread technology diffusion takes place.

A second conclusion is that it quickly became evident there were no 'low hanging technological fruits' emanating from the original RNRRS projects that could have been easily put into use. Instead, a context had to be created within which the science could be embedded. Most of the initial Best Bet proposals fell through at an early stage simply because scientists wished to carry on practising science and failed to grasp the developmental nature of the required projects. But, in the selected projects, it became evident that scientists had a major role to play in adaptive R&D and mentorship connected to the original RNRRS projects. In the nine Best Bets, over 60 original RNRRS projects were used (despite the apparent lack of low hanging fruit at the start). Therefore, under the circumstances, the creation of a suitable context became key. The characteristics of which were:

1. The selection process, combined with flexible technical and financial management, enabled the Best Bets programme to develop the most appropriate pathways to achieving its objectives (in full consultation with RIU management) but without being constrained by rigid management tools. This indicates perhaps the advisability of a lighter touch to be taken in relevant technology development aid.
2. In many cases, the original scientists and their organizations continued to play an important role in subsequent technology development, especially by virtue of their tacit knowledge of the problem area, to be a mentor/adviser derived from many years' experience in the field.
3. In all cases, however, the mobilization of other linked knowledge sources proved necessary. Often these derived from NGO bodies but included government departments, other international science bodies, local scientific institutions, as well as the private sector.
4. In all cases, RIU project funding played a necessary role in covering pre-investment costs, associated with risk and related factors, as exemplified in the social costs of armyworm forecasting.

It is likely that this type of pre-competitive support will continue to be an area for necessary technology development aid.

5. The actual business of technology development was complex in all cases; it involved applications, engineering, negotiations with government regulatory bodies, accessing products through imports (in the absence of local production capacity), and dealing with the many problems that always plague new innovative ventures.
6. Private sector interests have played a key role, both as 'product champions' and ensuring economic continuity. Clearly economic incentives have an important role to play in ensuring longer-term sustainability and, in some cases, markets for established firms have expanded as new outlets have been created. In addition, there have been a range of new small businesses created as a result of RIU interventions and there are indications that new forms of financial support will be forthcoming.
7. The evidence has confirmed the generally held view that formal national government-led extension systems need reform and the private sector should play a much greater role. Improved extension systems could help to improve the pace and impact of technology development for the rural poor.
8. In some of the projects examined, national regulations and their application have proved to be a significant constraint. However, in one project there was some evidence of farmers' reluctance to use biocontrol methods. This may have been due to a lack of suitable guidelines on use of the agents. Countries still use guidelines designed for the application of chemical biocides and have difficulty making appropriate judgments concerning the use of biocontrol agents and biopesticides. The issue, however, varies across countries.
9. In many cases, RIU Best Bet projects have helped to mobilize national capacities, particularly in universities. This is important in the light of frequent criticisms of higher education and its viability in Africa, and the need to encourage local innovation. RIU's experience appears to show how higher education might play a more substantial role in economic development.

At the same time, not all of the projects succeeded in terms of output and impact. The successful ones helped create entrepreneurship and employment. Others (still ongoing) may be successful given more time, and some have clearly failed. But the experiment has generated a lot of lessons. It has, for example, shown that an aid agency (DFID) can manage risk and catalyse technology development in the most unlikely contexts. To do so may require a lighter and imaginative managerial touch. The project has also revealed a need for linking research more directly to production. In the case of the private sector, it is also clear that their input can and should make a greater contribution to international technology development for the rural poor.

As for scientific communities themselves, there is a strong case for going well beyond the science push model and for requiring scientists to play a longer-term applied role. The original RNRRS projects no doubt produced good science but results often stayed on publication shelves providing raw material for more funding from research councils and related bodies. While it is clear that committed scientists have often played a valuable developmental role, the pattern of incentives within which they work tends to minimize the impact they could potentially make.

Finally, the use of an IS heuristic in effect acted as a metaphor for the whole operation. It allowed programme managers to build up local networks of stakeholder groups who were close to the ground. This improved capacity to identify possibilities for intervention, while at the same time making practitioners more aware of challenges. Subsequent project decisions were thereby given a real time context to maximise possibilities for success. At the end of the day, it became the view of the RIU management team that it is in this type of role that the IS approach can best be used to inform prospects for rural technology development in low income countries.

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Chapter 6

BUILDING INNOVATION CAPACITY OF LOCAL ACTORS: THE CASE OF THE CHILEAN AND ARGENTINE WINE INDUSTRIES

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Abstract

An intensive, technological, modernization process has gradually permeated the wine industry. Modern winemaking draws upon a variety of new fields and has become increasingly interdisciplinary. Innovation, knowledge and technological capacity have become key for industry success in an increasingly globalized market. In terms of research and development (R&D), three main pillars of wine science have emerged: grape culture; wine production; and sensory analysis and marketing. In this context, the knowledge and skills required to produce, distribute and sell quality wines have become increasingly complex and sophisticated. The unprecedented growth of the international wine trade, witnessed in the last quarter of the 20th century, was mainly due to a group of new entrants – so-called ‘New World’ producers – that managed to compete in a market that had been dominated for centuries by established ‘Old World’ producers. This chapter examines the progress made by two of the dominant new players, Argentina and Chile, in penetrating the international market and concludes that success has been based on quality upgrading, R&D investments and the incorporation of sophisticated new machinery and equipment within an enabling policy and institutional framework.

Keywords: Globalized market, Inter-disciplinary, Institutional framework, Knowledge, Technological capacity, Skills

Introduction

This chapter explores the opportunities and challenges that technological modernization in the wine making process, and the unprecedented growth in the international wine trade, have created for emerging developing countries such as Argentina and Chile to make in-roads in the modern wine industry. It argues that entry opportunities do exist – but that taking advantage of them is increasingly difficult. It begins by illustrating how science has been used to solve problems in both viticulture and viniculture, and how various innovations have permeated all aspects of the wine

industry. After focusing on the surprising entry of Argentina and Chile, the paper describes the emergence of a ‘centralized’ innovation system in the Chilean Metropolitan Region that dominates the platform of wine-related technology, business and services. The transformation of Mendoza, the main wine region of Argentina, into a ‘learning region’, is then detailed. The concluding section looks at the Argentinean and Chilean ‘models’ from a comparative perspective, provides some final considerations regarding the viability of the long-term growth strategy of the wine industries in these countries and addresses the issue of the innovation systems (IS) approach, its relevance for industry development and implications for small growers and wine producers.

The Knowledge Intensity of the Modern Wine Industry

In terms of R&D, three main pillars of wine science seem to have emerged since the 1960s: grape culture; wine production; and sensory analysis and marketing. Firstly, it has become essential to understand the physiology and genetics of the vine, while notions of microclimatology and soil physio-chemistry are key to explaining grape quality and vineyard yields. Secondly, the role of chemicals in the winery has progressively diminished, but that of physics has increased, with a view to understanding how presses can produce a clearer juice, how gravitational flows can better preserve the integrity of the liquids and how fine filtration technologies can improve wine structure. Thirdly, the knowledge of human sensory psycho-physiology has become essential for interpreting wine quality, while the possibility of testing the organoleptic qualities of wine with electronic devices has made possible a totally new, science-based type of quality assessment (Jackson, 2008).

The highest number of innovations has probably been introduced in *viticulture*. In particular, the art of vineyard management through ‘precision viticulture techniques’ has now become the science of plot handling, whereby each block of vines within each vineyard is treated according to its individual requirements. Global positioning systems are just one high-tech example of how this can be achieved, especially in extensive vineyards, but precision viticulture also makes use of satellite imaging, yield monitoring, multispectral digital videos and state-of-the-art software. Infrared aerial images can indicate the different degrees of vegetative growth in the vineyards, and help in planning differential harvest activities. When grapes reach the winery, it is possible to track their precise source through yield monitoring data, giving the grower an unprecedented opportunity to tackle vintage variation problems from one year to the other, in terms of quality, quantity and oenological behaviour (Galet, 2000).

In order to introduce greater predictability and faster aging into wine quality, in the area of *vini-culture*, wine scientists have developed increasingly sophisticated strategies to control fermentation. For example, micro-oxygenation is a winemaking technique aimed at stimulating the slow, controlled oxidation of barrel-aging in wines that are kept in stainless-steel tanks, by adding very low levels of oxygen to a developing wine over an extended period (Peynaud, 1984). Micro-oxygenation is supposed to build optimum structure, reduce herbaceous or vegetal characters, provide colour stability and increase the roundness of the wine. This, together with long distance mechanical systems for the transport of grapes, large-scale fermentation and storage facilities, electronic instruments for quality monitoring, and global logistic capabilities, is what is required

to make economies of scale and scope a reality. As Smith (2007) argues, “producing consistent quantity in production runs involving millions of bottles is a major technological problem, which modern wine innovation has largely solved.”

In the area of *marketing*, an increasingly competitive scenario has emerged, requiring a considerable amount of commercial intelligence in order to reach the desired, targeted consumers. In the 21st century, in order to match existing supply with potential demand, it has become necessary to properly understand the complexity of shelf space margins, product life cycles, consumer behavioural patterns, sophisticated pricing strategies and modern distribution techniques (Jenster et al., 2008). In particular, there is no way a wine producer can achieve success and remain competitive in the marketplace without a thorough appreciation of human behaviour and product choice. In this context, the discipline of neurobiology of behaviour has largely contributed to a deeper understanding of consumers’ preferences and of the factors influencing the subjective definition of wine quality.

The science of *sensory analysis* has also provided crucial information on the variables that contribute to the sensory perception determining flavour preferences in foods and beverages (Bisson et al., 2002). From a simple tool for quality control, which was applied in order to detect defects and unpleasant aromas before wine reached the consumers, sensory analysis has also become an increasingly sophisticated discipline, relying on the use of specially trained human tasters as an analytical tool for understanding the relationships between chemistry, perception, preference and behaviour. Even more challenging is the scientific study of the role of non-sensory factors, such as pricing, reputation and label information, compared to the role of chemical and sensory factors in influencing consumer preferences.

The ‘Surprising’ Entry of Argentina and Chile

Towards the end of the 20th century, the structure of the wine industry was transformed. The technological revolution and globalization of the wine industry brought about tremendous changes, both on the supply and the demand sides. In the 1970s, a group of New World producers, including Australia, New Zealand and the United States, as well some developing countries such as Argentina, Chile and South Africa, gradually emerged and became known for the production of high quality, reasonably priced, relatively easy-to-drink wines. These were particularly appreciated by international consumers who, encouraged by the opening up of increasingly liberalized and free markets in the 1980s, could access high quality, affordable, high-value wines (Anderson, 2004).

The entry of developing countries, in particular Argentina, Chile and South Africa, into the international wine market was surprising considering not only the dominant position of France and a few other consolidated producers, but also the growing knowledge intensity and the deep structural changes that have characterized the wine industry over the last four decades. This should have made entry conditions for developing countries particularly prohibitive, if not impossible. In order to be successful, new entrants had to adapt to rapidly changing market forces of demand and supply at both the national and the international levels (Archibugi, 2007). They have done so by combining standard industrial methods, individual creativity and the most innovative

technologies, thereby meeting the new, selective and discriminating preference for quality wines of increasingly knowledgeable and well-informed consumers (Bisson et al., 2002).

Taking advantage of the rising demand for New World wines, Argentina and Chile have become successful and widely known wine exporters in their own right. Australia seems to have lost its dominating role among the group of New World producers, and during the last few years its export performance has been matched by that of Chile. Both Argentina and Chile have seen their wine exports grow uninterruptedly for almost two decades, in terms of both volume and value. From 1985 to 2010, the export of Chilean wines to international markets increased from 29,100 t to 586,800 t per year in terms of volume, and from US\$23 million (€20 million) to US\$1,370 billion (€1,250 billion) per year in terms of value. This is clearly reflected in the dramatic growth in world market share of Chilean wines, which has increased from 0.5% to 7.5% in less than two decades (OIV, 2011).

Argentina represents the most important wine country in Latin America in terms of cultivated acreage and per capita consumption, but the export boom of Argentine wines is more recent than that of Chile. From 1985 to 2010, Argentinean wine exports to international markets increased substantially from 17,000 t to 430,000 t in terms of volume, and from US\$10.8 million (€9.8 million) to US\$641 million (€583 million) in terms of value. However, contrary to Chile, wine in Argentina is mainly produced for domestic consumption, and wine exports represent a minor percentage of total production. In 2010, Argentina exported less than 15% of its total production (3.5% of overall world exports), compared to 73% in Chile and 48% in Australia (respectively, 7.5% and 8% of total world exports), while in 1986 Argentina exported only 1.5%.

A survey of the leading 25 Argentinean and Chilean wine exporting wineries revealed that, during the last two decades, a considerable effort was made not only to integrate the most advanced winemaking knowledge and technologies in their current practices, but also to be continuously innovative with their products and improve their positioning in the international market (Farinelli, 2013). In both wine industries, an incredible number of product, process and organizational innovations have been introduced.

In particular, the leading Argentinean and Chilean exporting wineries integrated a series of process innovations, mainly in the vinification process. For example, all 25 leading exporting wineries in both countries have adopted all of the most modern winemaking technologies (Table 1), except for gravity flows, which are quite sophisticated, expensive techniques adopted by only a minority of winemakers internationally. By contrast, in the area of product innovation, mainly in viticulture, there is a relative discrepancy, in that the Chilean wineries seem to have been much more inclined than their Argentinean counterparts to introduce modern techniques related to irrigation, yield management and clone selection – except in the introduction of new varieties, where Argentine firms clearly appear more advanced. There is not much difference in the area of organizational innovation, where the situation appears balanced.

Table 1. Degree of innovativeness of the top 25 Argentine and Chilean exporters of bottled wines, 2010

| Type | Main innovations | Top 25 Chilean wineries | Top 25 Argentine wineries |
|-----------------------------------|----------------------------------------------------------------------------------------------------------|-------------------------|---------------------------|
| Product/viticulture | Identification of best <i>terroirs</i> and best clones for each variety | 23/25 | 14/25 |
| | Introduction of new varieties (in addition to top four most widely diffused) | 16/25 | 24/25 |
| | Introduction of drip or furrow irrigation systems (<i>vs.</i> flood irrigation) | 24/25 | 14/25 |
| | Limitation of the yields for top quality brands | 22/25 | 14/25 |
| | Introduction of organic and/or biodynamic farming cultivation techniques | 19/25 | 8/25 |
| Process/viniculture | Replacement of old big casks for aging with smaller oak <i>barriques</i> imported from France and/or USA | 25/25 | 25/25 |
| | Use of stainless steel tanks for vinification | 25/25 | 25/25 |
| | Installation of refrigeration devices for both fermentation and maturation | 25/25 | 25/25 |
| | Replacement of old vertical presses with pneumatic presses | 25/25 | 24/25 |
| | Use of gravity flow mechanisms | 5/25 | 3/25 |
| Organization and marketing | Creation of new <i>terroir</i> brands | 20/25 | 12/25 |
| | Participation at international wine competitions | 25/25 | 25/25 |
| | Use of social networks (Facebook, YouTube and/or Twitter) for marketing purposes | 9/25 | 4/25 |
| | Organization of winery tours, food and wine tastings, cultural events | 24/25 | 24/25 |
| | Adoption of a sophisticated architectural design for the winery as a marketing tool | 7/25 | 8/25 |

Source: Author's survey, 2010

Despite their irrefutable success, neither the Argentinean nor the Chilean wine industries should become complacent. Both successfully navigated through the initial phase of the wine technological revolution, but that does not automatically mean that they are well prepared to meet future challenges and to sustain export growth in the long term (Rabobank, 2007). In the next phase, based on the trajectory of leading wine exporters both from the New World and the Old World, the technological frontier is expected to become much more complex and difficult, and characterized by a higher level of knowledge intensity from a systemic perspective (Mytelka, 2007). This transition can be successfully achieved only if the technical and scientific understanding of the latest developments in a wide-ranging spectrum of science and technology related disciplines is mainstreamed among all main industry stakeholders and geographic areas.

The Emergence of a 'Centralized' Innovation System in the Chilean Metropolitan Region

The majority of Chile's premium wines are produced in the three central regions that are the closest to the capital, Santiago de Chile, where most leading exporters of premium wines have their headquarters and offices – although their vineyards are often located in other regions. Like many other Latin American countries, Chile has always been capital-centred, and this characteristic is still predominant (Crowley, 2001). The wine industry shows some 'centralist' tendencies as well, and this makes Santiago the hub, not only for government but also for industry, technology and business.

Santiago hosts not only the headquarters of all the leading wine producers and exporters, but also the key, specialized suppliers of the industry. Banks and financial services, transport and shipping companies, repair services, specialized technicians and representatives of foreign equipment producers are all located in Santiago, and the farther from the capital, the more difficult it is to find machine parts, staff, or reliable services. It also hosts, almost entirely, the institutional framework that forms part of the Chilean innovation system. In the wine industry, the main institutional actors are represented by: the major national wine associations (Viñas de Chile and Chilevid); two of the three specialized universities (University of Chile and the Catholic University of Chile); the main R&D institutes, (the Chilean government agency for scientific research, Comisión Nacional de Investigación Científica y Tecnológica, and the national institute for agricultural research, Instituto Nacional de Investigación Agropecuaria); and the main public agencies involved in the promotion of the wine industry, such as Servicio Agrícola Ganadero (SAG), Dirección de Promoción de Exportaciones (ProChile) and Corporación de Fomento de la Producción (CORFO).

SAG is the branch of the Ministry of Agriculture devoted to agricultural and phytosanitary controls, and has played a fundamental role in the development of the Chilean wine industry. It enforces national laws pertaining to winemaking and vine growing, and compiles statistics on crops, production and exports, allowing growers and producers to make informed decisions. ProChile is the Chilean export promotion agency, founded in 1974 to support and coordinate export activities by small firms from all productive sectors. ProChile's support of the development of the wine industry has proved very important. ProChile has traditionally financed half of the costs of activities in promoting Chilean wines abroad and supported the joint participation of smaller wineries in international fairs. Together with SAG, ProChile was also part of a technical lobbying commission that pushed heavily for the adoption of a denomination of origin regulation in 1994.

Additionally, since the beginning of the 1990s, substantial public efforts to develop the wine industry have been channelled through CORFO, the second-tier public operational body for small and medium enterprise development, which is well known for the variety and impact of its policy instruments. Several of CORFO's projects were instrumental in stimulating the 'wine revolution' in Chile, and in bringing Chilean wines closer to international taste and quality standards (Benavente, 2006). For example, it was a CORFO project for technological innovation, called

FONTEC, that, since 1991, allowed the largest wine companies (i.e. Concha y Toro, Santa Rita, Carmen, Cusiño Macul, Santa Emiliana) to invest heavily in completely renewing their industrial equipment and incorporate modern technologies into their productive processes.

It was also a foreign direct investment project that, since 1995, allowed the same large companies to tackle strategic technological innovation issues (such as ISO 14000 certification, identification and definition of different Chilean *terroirs*, integrated and organic cultivation techniques, and the development of phylloxera and oidium resistant rootstocks), in order to achieve a relevant social and economic impact. Furthermore, in the 1990s, smaller companies were supported in developing their management and technical capabilities through specialized consultancy services and through supplier development projects, called PDPs, aimed at incentivizing grape-growers to increase the quality of grapes produced (and thus wine price and competitiveness).

Finally, it was through a CORFO project, in 1993–1997, that the second association of smaller exporting producers (Chilevid) was created and the notion of *viñas emergentes* or *boutiques* emerged for the first time, thereby addressing a long-standing, institutional sclerosis and breaking the monopoly of the largest consolidated traditional producers. Later on, CORFO also supported the creation of the Chilean wine corporation, Corporación Chilena del Vino, an organization aimed at promoting collaborative group actions to maximize competitiveness through grant projects. More recently, through CORFO, several embryonic ‘wine routes’ have started to emerge in different valleys, generating enormous benefits in terms of tourism attraction and image promotion, and enabling the building of trust and consolidation of common cluster identities.

Overall, therefore, a reasonably strong, though centralized system of wine-related actors, associations, government organizations, research centres and support institutions seems to have emerged during the last few years. This indicates that, from an institutional perspective, the public sector in the Chilean wine industry is more active than commonly perceived (Table 2). The question remains, however, to what extent such a system will be capable of supporting the development of new and existing wine regions that are situated in the regions more distant from Santiago, such as the Maule (VII) and Bio Bio (VIII) regions, and capable of giving a ‘personality’ to each wine region in the country, based on in-depth knowledge of its soils and climate, and of the different *terroirs* characterizing each valley. Furthermore, to meet the demand for diversified Chilean wine exports, new areas have been explored in order to produce different, sometimes ‘extreme’ wines, with unique qualities and flavours. Most of these areas are located in regions in the north or the south, with remote access to the main supporting institutions located in Santiago.

Table 2. Supporting institutional framework of the Chilean wine industry

| Category | Name | Operational level |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Wine associations | <ul style="list-style-type: none"> • ChileVid • Viñas de Chile • Corporación Chilena del Vino | National |
| Industry-supporting institutions | <ul style="list-style-type: none"> • Servicio Agrícola Ganadero (SAG) • Corporación de Fomento de la Producción (CORFO) • Servicio Nacional de Agricultura • Oficinas de Estudios para la Política Agraria • Servicio para la Innovación Agraria • Instituto Nacional de Investigación Agropecuaria | National |
| International promotion organizations | <ul style="list-style-type: none"> • Wines of Chile • Dirección de Promoción de Exportaciones (ProChile) | National |
| Specialized press | <ul style="list-style-type: none"> • Chile Vinos • Vendimia • La Cav • Planeta Vino • Andes Wines • Todovinos • Platos y Copas • Revista Vitivinicultura • La Vinoteca | National |
| Universities | <ul style="list-style-type: none"> • University of Chile • Catholic University of Chile • University of Talca | Regional |
| R&D organizations | <ul style="list-style-type: none"> • Vinnova • Centro Cooperativo para el Desarrollo Vitivinícola • Centro Vitivinícola de la Universidad de Chile • Centro de la Vid y del Vino de la Universidad de Talca | Regional |
| Wine routes | <ul style="list-style-type: none"> • Valle de Casablanca (www.casablancavalley.cl) • Valle del Maule (www.valledelmaule.cl) • Valle del Cachapoal (www.cachapoalwineroute.cl) • Valle de Curicó • Valle de Colchagua | Cluster |

Source: Author's compilation

The Emergence of Mendoza as the Leading Wine ‘Learning Region’ in Argentina

Argentine wine production is concentrated in the region of Mendoza, which accounts for 80% of total Argentine wine exports and for 85% of bottled wine exports. The main drivers of quality upgrading and export growth in Mendoza have been the creation of an extensive knowledge exchange across the region, collective efficiencies facilitated by a rich network of supporting institutions, and organizational structures designed to analyse and provide direction in facing common problems. Mendoza has gradually transformed itself into a ‘learning region’, capable of generating continuous innovation and rejuvenating the technical paradigm of the local wine industry, in order to meet international consumers’ tastes and comply with the standards imposed by export markets (Farinelli, 2007).

Mendoza is also the headquarters of two active business associations: Bodegas de Argentina and the Argentine viticultural union, Union Vitivinicola Argentina (UVA). Bodegas de Argentina, founded in 1995, is the union of two formerly separate wine making associations and represents most of the producers of quality and premium wines. UVA, founded in 1984, despite being open to all members of the sector, represents the majority of small bulk and table wine producers. The Mendoza region is widely praised nationally, for having adopted a strategy based on the promotion of public-private partnerships, and rules of inclusion and participatory governance. This has supported small rural producers, and helped to solve collective problems and address complex challenges in an inclusive manner.

The dynamism and vision of Mendoza’s government is symbolized by the creation, in 1996, of a public-private foundation called ProMendoza, explicitly devoted to export promotion activities. In 1994, it also promulgated a provincial law to create a Vitivinicultural Fund to support the wine industry. The Fund was originally designed to cushion the impact of deregulation policies. It then served the objective of encouraging planting conversion, export growth and domestic consumption. The Fund has also participated in preparing the Vitivinicultural Strategic Plan 2020, funded several research projects, held information campaigns and tasting events, and created a symbolic ‘airport vineyard’ with 3 ha of Malbec. Since 1993, it has also contributed to the organization of Vinandino, the industry’s most important event and the first international wine competition in the Southern Hemisphere, which takes place every 2 years in Mendoza.

Mendoza has excelled at laying the groundwork for producers throughout the region to introduce innovations, by creating networks in the local territory and exploiting producers’ geographical proximity (Salvatierra, 2006). Two specific examples of policies aimed at promoting learning and innovation stand out. The first, concerning policies conducive to local innovation and technological capacity building, system-wide, is related to Instituto Nacional de Tecnología Agropecuaria (INTA) – the federal agricultural research and extension agency founded in the late 1950s. Although INTA is a federal institution, the experimental station of Lujan de Cuyo, located in the Mendoza province, has played a prominent role in the development of the wine industry and has recently been involved in the preparation of a bottom-up National Strategic Plan for 2020, called PEVI.

INTA's involvement has been crucial in creating consensus around strategies and projects which encompass the entire range of producers in the industry, from a group of around 50 export-oriented 'boutique' wineries to a group of 8,000 small, non-vertically integrated producers of must and concentrated grape juice. This is an ambitious and valuable attempt to set the basis for the implementation of an inclusive policy, which tries to respond in a concerted manner to the upgrading needs of all actors, at different levels and according to their needs.

The second example of policies aimed at promoting learning and innovation in local firms is related to the activities of Instituto Nacional para la Vitivinicultura (INV), the National vitiviniculture institute created in 1959, and Cuyo National University. INV is a federal institution, but the regional dimension of its activities has become very prominent, at least equal to its national scope. Indeed, after the deregulation of winemaking activities in 1989, which established the complete liberalization of plantations, replantation or modification of vineyards, as well as the selling of wines, INV became the official organization in charge of guaranteeing the safety of wine products, from the vineyard to consumption. INV is also actively involved in making progress on the still embryonic and little-developed 'denomination of origin' system, thereby trying to put an end to a certain anarchy in the indication of the vintage, which is still considered irrelevant by many winemakers due to the minimal changes in climatic conditions and thus quality variations from one crop to another.

Together with INV, the Cuyo National University, also located in Mendoza, represents a main local knowledge source and has played a key role in the evolution of wine quality in the region, as well as in the consolidation of cluster networking dynamics and innovative capacities. Not only has it provided highly valued laboratory services, which over time have become increasingly diversified and self-financed, but it has also become 'embedded' in the local wine industry, with academics and practitioners often exchanging their positions in and out of the university. If one includes in this rich set of relationships between the main knowledge stakeholders in Mendoza two additional public-private teaching institutions – namely the technological institute of Mendoza, Instituto Tecnológico Universitario, and the industrial and technological development institute, Instituto de Desarrollo Industrial, Tecnológicos y de Servicios, created respectively in 2005 and 2006 to satisfy the local demand in the area of management, engineering and manufacturing – it becomes clear how uniquely 'endowed' the supporting institutional framework of Mendoza's 'learning region' is (Table 3). The main question remains, however, to what extent other emerging Argentine wine provinces will manage to replicate the same rich institutional framework, relationships of trust and interactive dynamics of Mendoza?

Table 3. Supporting institutional framework of the Argentine wine industry

| Category | Name | Operational level |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Wine associations | <ul style="list-style-type: none"> • Centro de Bodegueros de Mendoza • Bodegas de Argentina • Asociación de Cooperativas Vitivinícolas Argentina • Union Vitivinícola Argentina (UVA) • Asociación Vinateros de Mendoza • Centros de Vinateros y Bodegueros del Este | National/regional |
| Industry-supporting institutions | <ul style="list-style-type: none"> • Instituto Nacional para la Vitivinicultura (INV) • Fondo Vitivinícola Mendoza • Corporación Vitivinícola Argentina • Bolsa de Comercio de Mendoza | National/regional |
| International promotion organizations | <ul style="list-style-type: none"> • ProMendoza • Wines of Argentina | National/regional |
| Specialized press | <ul style="list-style-type: none"> • El Conocedor • Winesur • Caminos del Vino • Sommelier • Vinos & Sabores | National |
| Universities | <ul style="list-style-type: none"> • Universidad Juan Augustin Maza • Universidad Nacional de Cuyo | Regional |
| R&D organizations | <ul style="list-style-type: none"> • Instituto para el Desarrollo Rural • Instituto Nacional de Tecnología Agropecuaria (INTA) • Instituto Tecnológico Universitario • Instituto de Desarrollo Industrial, Tecnológicos y de Servicios | Regional |
| Wine routes | <ul style="list-style-type: none"> • Ruta del Vino – Mendoza • Ruta del Vino – Catamarca • Ruta del Vino – La Rioja • Ruta del Vino – San Juan | Cluster |

Source: Author's compilation

Conclusions

In the international wine industry, entry opportunities for developing countries do exist, but taking advantage of them is increasingly difficult. On the one hand, continuous quality upgrading, investments in R&D and incorporation of sophisticated new machinery and equipment are a *conditio sine qua non* (essential) to maintain market share and competitiveness at the international level. On the other hand, international consumers are demanding increasingly diversified, geographically typified wines. Thus, the capacity to adapt imported technologies to local conditions, and improve upon them through local tacit knowledge, has become essential to extracting high-quality, unique wines from each specific region.

In the Argentinean and Chilean wine industries, two very different development trajectories have emerged. In Chile, the steep export growth of quality wines was made possible by both the access to huge inflows of knowledge and technology from abroad, and by the creation of endogenous R&D capabilities. This took place under the auspices of a predominant central government, as opposed to regional governments, and under the influence of a top-down policy approach that made it difficult for regions to develop local organizations and support structures, and for clusters too far from the Santiago Metropolitan Region to develop deeper innovation capabilities through linkages with external sources of knowledge and innovation. In contrast, in Argentina, a relatively delayed but equally steep export growth of quality wines was made possible not only by a larger flow of foreign capital, technology and know-how, but also by the development of local learning capabilities and local distinctive factors, under the auspices of decentralized governments and a bottom-up policy approach that was instrumental in the creation of regionally constructed advantages and innovation capabilities, as well as cluster-based linkages and networking dynamics.

Looking at the future of the Chilean wine industry and at the sustainability of its export boom, the main question to be addressed is to what extent will Chile be capable of supporting the development of new and existing wine areas that are situated in regions more distant from Santiago, and the issue of creating a 'personality' to each wine area or region in the country. In this respect, a highly centralized IS may be inappropriate in tackling the emerging pattern of diversified demand, especially where international consumers regard wine variety and specificity as positive, priority attributes (Cusmano et al., 2009). In contrast, the traditional endowments of regions, in terms of wine culture, labour market, localized linkages and dense institutional infrastructure, seem to represent a key asset in the world of wine producers.

In the case of the Argentine wine industry, the main question with regard to the sustainability of its export boom is to what extent other emerging Argentine wine provinces will manage to replicate the same rich institutional framework, relationships of trust and interactive dynamics of the Mendoza province, which exports more than 80% of Argentine wines. Beyond Mendoza, several other provinces have seen their wine exports grow considerably during the last few years. However, building strong regional identities and innovation capabilities in large wine producers, such as Argentina, is a challenge that only well-organized wine industries with long-term vision and adequate funding can face, and only if synergies among different regional IS are put in place. Moreover, Argentina's 'inclusive' development approach, based on small producers and horizontally integrated value chains (still predominant in exporting industries such as wine, olive oil and dairy products, in contrast to exporting industries dominated by exporting giants, such as soybean, meat and cereals), should be fully endorsed by key public and private sector stakeholders, for sustainability and future success.

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Chapter 7

INNOVATION SYSTEMS AND CAPABILITY BUILDING AMONG SMALLHOLDERS: LESSONS AND INSIGHTS FROM KENYA'S FLOWER FARMERS

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Abstract

The relevance of the innovation systems (IS) approach to agriculture in developing countries is evident. It is useful for determining and explaining how different policies, institutional frameworks and combinations of actors are involved in innovative activity, and how their interactions or lack thereof contribute to, or undermine, learning and innovation. In this case study on the floriculture industry in Kenya, an IS approach was used to analyse the process of knowledge sharing between farmers and other actors in the system, and the institutional factors that shape interactive learning. Focus was placed on understanding: (a) which actors are the key sources of knowledge for farmers and why; and (b) which actors are preferred by farmers for research partnerships and what informs this preference. How these factors influenced farmers' capabilities to respond to challenges and changes in their contexts were also considered. It is concluded that organizational culture shapes the propensity of actors to interact with other actors in the system. Research organizations and universities exhibited a hierarchical culture, which restricted their interactions. Non-governmental organizations (NGO) demonstrated a 'clan culture' where teamwork is important. Input suppliers were characterized by a 'market culture' and were more results-oriented to winning market share and penetrating new markets.

Keywords: Capabilities, Learning, Institutions, Interactions, Knowledge sharing, Organizational culture

Introduction

The relevance of the IS approach to agriculture in developing countries has been demonstrated in numerous case studies (Hall et al., 2004) and promoted widely (Clark, 2001; Clark et al., 2002; Lundvall et al., 2002; Clark et al., 2003; Spielman, 2005; Hall et al., 2006). Its adoption by development actors such as the Technical Centre for Agricultural and Rural Cooperation (CTA)¹ and the

¹ Details of the CTA programme on 'Agricultural Science, Technology and Innovation Systems in the ACP' can be found at: <http://knowledge.cta.int/en/Dossiers/CTA-and-S-T/CTA-S-Tprogramme/ASTI>

World Bank² is rooted in the potential for the approach to help provide advice for policymakers on how to improve national agricultural system performance and enhance innovation for agricultural and rural development.

The results of pilot case studies supported by CTA and the World Bank demonstrate that the IS approach can be used to determine and explain how different policies, institutional frameworks and combinations of actors are involved in innovative activity, and how their interactions or lack thereof contribute to or undermine learning and innovation. These studies have concluded that the approach is helpful in identifying weaknesses that should be the object of policy response and how new policies might be designed to mitigate the problems (World Bank, 2007; Francis, 2010). In this case study on the floriculture industry in Kenya, an IS approach was used to analyse the process of knowledge sharing between farmers and other actors in the innovation system³ and the institutional factors that shape interactive learning between them.

We draw our definition of capabilities from Leonard-Barton (1992) who defines capabilities as the “knowledge set that differentiates and confers competitive advantage”. Our focus lies on understanding: (a) which system actors are the key sources of knowledge to farmers and why; and (b) which actors do farmers prefer for research partnerships⁴ and what informs this preference. Our principal argument is that access to knowledge/technologies/innovations and interactive learning (emanating from partnerships) is key to capability building. In this case study, we sought to elucidate how these two key processes influence the farmers’ capabilities to respond to challenges and changes in their contexts.

Methods and Approaches

In the larger study (Bolo, 2012), we began by reviewing the policy and legal framework and their influence on learning, innovation and capability building. This was followed by mapping the actors who are relevant for building farmers’ innovation capabilities. We drew on some of the findings of the review and the mapping exercise for the case study. In order to explore the interactions between farmers and the different actors in the case presented here, we followed three approaches. First, the organizations/actors, their mandates, functions and interactions are described so as to capture ‘what the organization says about itself’ (Roche, 1998) regarding their activities and achievements in relation to capability building. This information was obtained by interviewing the leaders/representatives of these organizations as well as from their annual reports, publicity materials (brochures), websites and strategic plans.

² The World Bank’s Department for Agriculture and Rural Development funded a series of case studies in Africa, Asia and Latin America towards operationalizing the IS approach (World Bank, 2007).

³ These include, among others, agribusinesses, exporters, research institutes, agro-chemical companies, regulatory agencies and NGOs.

⁴ The term ‘partnerships’ as used in this paper refers broadly to cooperative relationships among different actors. In this context, it refers particularly to non-equity based arrangements, including collaborations, in which each farm/firm remains a separate entity even though they agree to cooperate on certain issues.

Secondly, farmers and exporters were asked their views on the roles and performance of the various organizations in order to determine ‘what they say about different actors/actor groupings’. This was carried out with a survey using a structured questionnaire in which farmers were interviewed on their perceptions of various actors as ‘partners in research and development (R&D)’ and their ‘importance as sources of new knowledge’. Even though key informant interviews and the literature review identified various other organizations as important in the success of the cut flower sector in Kenya (for example marketing support organizations) this case study only focused on the actors that were identified as being involved in capability building or providing a supportive role in building farmer capabilities. These included R&D organizations and other actors, which have R&D as one of their key functions (such as input suppliers and NGOs)⁵. Lastly, we held face-to-face semi-structured interviews with farmers and exporters to give context to their responses in the survey.

Results

Farm Sizes, Learning and Innovation

In order to determine the size/scale of the respondents’ operations, farmers and exporters were asked to approximate the volume of their exports in 2007 according to a prescribed scale. Amongst a sample of 116 farmers and exporters interviewed, 60% were small-scale⁶, 26% were medium-scale⁷, while 14% were large-scale⁸. The volume of exports in 2007 was used as a proxy for farm sizes for a number of reasons. First, the Horticultural Crops Development Authority collects export levies from exporters based on the volume of exports. Secondly, the membership and annual subscription fees to industry associations (Fresh Produce Exporters Association of Kenya and the Kenya Flower Council) are based on volumes of exports and the Kenya Revenue Authority collects taxes based on the values of exports (these values are in themselves calculated on the basis of volume of exports). Lastly, in their partnerships with exporters, farmers are paid on the basis of the volume of flowers⁹ that meet the required standards specified in their contracts. The survey showed that species of the genus *Eryngium* (40%), *Ornithogalum* (17%), *Arabicum* (11%), *Gomphocarpus* (Mobydick, 6%) and *Rosa* (roses, 10%) were the main varieties grown. The innovations¹⁰ resulting from the partnerships are shown in Table 1 while the types of knowledge gained through these partnerships are summarized in Table 2.

⁵ The larger study mapped out all the actors involved in the cut flower innovation system and analysed their different roles. Given the emphasis of this paper on capability building, we have limited the focus to actors that are directly involved in supporting farmer capabilities.

⁶ These were defined in the questionnaire to include farmers who exported less than 10 t and exported primarily through agribusiness intermediaries (exporters).

⁷ Exporting between 10-50 t and could access export markets directly.

⁸ Exporting more than 50 t and could access export markets directly.

⁹ In the case of partnerships between small-scale farmers and exporters, the payment is calculated on the basis of number of stems of flowers sold.

¹⁰ In this study, innovation is defined as the application of knowledge to produce something new and useful. Newness and usefulness are contextual, i.e. what is new to one actor in a given context may not be new to another actor in a different context. Usefulness also depends on the needs of the particular actor and their intentions. Innovation in the context of this study therefore refers to products, processes, methods as well as access to new markets, etc.

Table 1. Type of innovations resulting from partnerships by farm categories

| Types of capabilities | Capability indicators | Small-scale | Medium-scale | Large-scale | Total responses |
|------------------------------------|---------------------------------------------------|-------------|--------------|-------------|-----------------|
| Production capabilities | Introduced new flower variety | 95.6% | 100% | 50% | 89.4% |
| | Introduced new technologies | 90.5% | 95% | 50% | 77.9% |
| | Adapted new technologies to the needs of the farm | 80.5% | 55% | 42.9% | 69% |
| | Used new combination of inputs | 82.5% | 85% | 62.5% | 81.5% |
| | Complied with new environmental standards | 78.4% | 70% | 75% | 73.7% |
| Value addition capabilities | Introduced new flower arrangements/bouquets | 16.2% | 5.6% | 12.5% | 12.2% |
| | Improved shelf/vase life of flowers | 69% | 53.8% | 44.4% | 56.9% |
| | Introduced new packaging materials | 55.6% | 47.4% | 66.7% | 48.6% |
| | Reduced number of spoiled flowers | 57.1% | 45% | 66.7% | 58% |
| Marketing capabilities | Sold flowers in new markets (domestic or exports) | 90.3% | 83.3% | 62.5% | 75% |
| | Complied with new market standards | 84.2% | 40% | 57.1% | 72.1% |

Table 2. Learning by farm sizes cross-tabulation

| | Size of farmers | | | Total | |
|------------------------|---------------------------------------------------------------------------|--------------|-------------|-------|----|
| | Small-scale | Medium-scale | Large-scale | | |
| What was learnt | New varieties, technologies, bouquets | 40 | 16 | 5 | 61 |
| | | 80% | 76.2% | 71.4% | |
| | Increase shelf/vase life, better packaging, avoid spoilage | 24 | 7 | 2 | 33 |
| | | 48% | 33.3% | 28.6% | |
| | Improve growing methods, adapt new technologies and comply with standards | 27 | 9 | 5 | 41 |
| | | 54% | 42.9% | 71.4% | |
| | New marketing strategies and comply with marketing standards | 20 | 12 | 6 | 38 |
| | | 40% | 57.1% | 85.7% | |
| | Total | 50 | 21 | 7 | 78 |

Percentages and totals are based on the number of respondents in the size category.

Percentages add up to more than 100%

Choice of R&D Partnerships and Sources of New Knowledge

The survey findings point to two trends: (a) that research organizations (both local and foreign) are generally poorly rated as ‘sources of new knowledge’ by farmers and are unlikely to be chosen by farmers as ‘partners in R&D’; and (b) that farmers obtain new knowledge more easily and readily from input suppliers, ‘other farmers’ and NGOs. Both the input suppliers and NGOs are highly rated as ‘sources of new knowledge’ and are more likely to be chosen by farmers as ‘partners in R&D’. Details of these trends are presented below:

(a) Farmers prefer NGOs and input suppliers as ‘partners in R&D’ and ‘sources of knowledge’

In total, 39% of all farmers rated ‘other farmers’ as their main partners in R&D, 24.5% preferred input suppliers and 20.7% preferred local NGOs. Differentiating the findings by farm sizes showed that ‘other farmers’ are preferred as partners in R&D by 95.8% of small-scale farmers, 100% of medium-scale farmers and 33.3% of large-scale farmers. ‘Input suppliers’ were preferred by 64.6% of small-scale farmers, 75% of medium-scale farmers and 66.7% of large-scale farmers. Local NGOs were preferred by 41.7% of small-scale farmers, 35% of medium-scale farmers, and 33.3% of large-scale farmers. A similar trend was observed when farmers were asked for their preferred ‘sources of knowledge’. Some 12.5% of small-scale farmers rated ‘other farmers’ as ‘quite important’, while 75% rated ‘other farmers’ as ‘most important’. Similarly, 34.1% of small-scale farmers rated input suppliers as ‘quite important’ while 36.6% rated them as ‘most important’. Some 8.8% of small-scale farmers rated local NGOs as ‘quite important’ while 38.2% rated local NGOs as ‘most important’. See Tables 3 and 4 for a breakdown of the responses by farm sizes.

Table 3. Choice of main partners in R&D by farm size

| | | Size of farmers | | | Total | |
|---------------------------------|---------------------------------------------------|-------------------|--------------|-------------|-------|----|
| | | Small-scale | Medium-scale | Large-scale | | |
| Main partners in R&D | Other farmers | Count | 46 | 20 | 3 | 70 |
| | | % within identity | 95.8% | 100% | 33.3% | |
| | Input suppliers | Count | 31 | 15 | 6 | 52 |
| | | % within identity | 64.6% | 75% | 66.7% | |
| | Local public universities and research institutes | Count | 1 | 1 | 4 | 6 |
| | | % within identity | 2.1% | 5% | 44.4% | |
| | Foreign universities and research institutes | Count | 5 | 0 | 1 | 6 |
| | | % within identity | 10.4% | 0% | 11.1% | |

| | | Size of farmers | | | Total | |
|---------------------------------|-----------------------------|-------------------|--------------|-------------|-------|----|
| | | Small-scale | Medium-scale | Large-scale | | |
| Main partners in R&D | Foreign private consultants | Count | 0 | 0 | 5 | 5 |
| | | % within identity | 0% | 0% | 55.6% | |
| | Local NGOs | Count | 20 | 7 | 3 | 30 |
| | | % within identity | 41.7% | 35% | 33.3% | |
| | International NGOs | Count | 2 | 0 | 0 | 2 |
| | | % within identity | 4.2% | 0% | 0% | |
| | Total | Count | 48 | 20 | 9 | 77 |

Percentages and totals are based on number of respondents in each size category.

Table 4. Importance of actors as a 'source of new knowledge' for small-scale farmers

| | Least important | Not very important | Important | Quite important | Most important | Total |
|---------------------------------------------------|-----------------|--------------------|-----------|-----------------|----------------|-------|
| Local NGOs | 12 | 2 | 4 | 3 | 13 | 34 |
| | 35.3% | 5.9% | 11.8% | 8.8% | 38.2% | 100% |
| Foreign NGOs | 13 | 1 | 3 | 0 | 7 | 24 |
| | 54.2% | 4.2% | 12.5% | 0% | 29.2% | 100% |
| Input suppliers | 3 | 4 | 5 | 14 | 15 | 41 |
| | 7.3% | 9.8% | 12.2% | 34.1% | 36.6% | 100% |
| Local private consultants | 23 | 4 | 0 | 0 | 0 | 27 |
| | 85.2% | 14.8% | 0% | 0% | 0% | 100% |
| Foreign private consultants | 20 | 0 | 0 | 0 | 2 | 22 |
| | 90.9% | 0% | 0% | 0% | 9.1% | 100% |
| Foreign universities and research institutes | 25 | 1 | 2 | 1 | 0 | 29 |
| | 86.2% | 3.4% | 6.9% | 3.4% | 0% | 100% |
| Local public universities and research institutes | 22 | 2 | 0 | 2 | 0 | 26 |
| | 84.6% | 7.7% | 0% | 7.7% | 0% | 100% |
| Farmers | 1 | 1 | 4 | 6 | 36 | 48 |
| | 2.1% | 2.1% | 8.3% | 12.5% | 75% | 100% |

(b) The role of universities and research institutes is only marginal

Overall, 3.7% of all farmers interviewed would choose local universities and research institutes as ‘partners in R&D’, 2.9% would choose foreign universities and research institutes, 2.5% would choose foreign private consultants, while 0.4% would choose local private consultants. When broken down by farm size, only 2.1% of small-scale farmers would choose local public universities and research institutes, and 10.4% would choose foreign universities and research institutes. For large-scale farmers, 44.4% would choose local public universities and research institutes and 11.1% would choose foreign universities and research institutes. When asked for their preferred ‘source of knowledge’, 84.6% of small-scale farmers rated local public universities and research institutes as ‘least important’, and 86.2% rated foreign universities and research institutes as ‘least important’ sources of knowledge.

Discussion

The contrast between the choices for partners in R&D is striking. Knowledge-generating organizations were ranked lowest as partners in R&D. Further analysis showed that whereas input suppliers are valued as partners by all farm categories, only 33% of large farmers considered ‘other farmers’ as important R&D partners, in contrast to small-scale farmers (95.8%) and medium-scale farmers (100%). On the contrary, 66.7% of large-scale farmers chose input suppliers and 55.6% chose foreign private consultants as their main R&D partners. The disaggregated data also showed that even though overall partnerships with public research institutes and universities is rated low, 44% of the large-scale farmers reported having partnerships with them. This is attributed to the fact that large-scale farmers can pay for services such as consultancies, research, soil testing, etc.

How Might we Explain These Patterns?

The analysis and discussion of these emerging trends are guided by the following questions: Why have farmers rated the R&D/training actors poorly as sources of knowledge and partners in R&D? and What are the NGOs and input suppliers doing differently?

We argue that the outcomes may be explained by the institutional configurations, particularly their organizational cultures and routines. Other analysts refer to them as the ‘traditional habits and practices of the actors’ (Mytelka, 2000; Mytelka and Farinelli, 2000; Hall et al., 2006). They influence the organization’s ability to reconfigure and re-orient its functions in light of changing contexts (Teece, 1996).

Basing their work on Mary Douglas’ cultural theory (e.g. Hood, 1998), Cameron and Quinn (1999:14) have complemented this focus on institutions and culture and observed that organizational culture “encompasses the taken-for-granted values, underlying assumptions, expectations, collective memories and definitions present in the organization. The culture reflects the prevailing ideology that people carry in their heads and conveys a sense of identity to employees, provides unwritten and often unspoken guidelines for how to get along in the organization, and enhances the stability of the social system that they experience.” They further argue that at the organizational level, “culture is reflected by what is valued, the dominant leadership styles, the

language and symbols, the procedures and routines and the definitions of success that make an organization unique.” Their book, *Diagnosing and Changing Organizational Culture: Based on the Competing Values Framework*, adds a social element to the analysis that has not been captured in IS literature. According to the framework, the organizational structure, its rules, culture and practices (including procedures), creates incentives (and disincentives) for agents (individual employees) to behave in particular ways. In many cases, the actions of the agent is shaped by the values that the organization upholds, that is, what is considered ‘proper’, ‘normal’, ‘natural’, and ‘acceptable’. Usually these are the actions that lead to higher rewards in the organization. The sets of habits and practices, routines and procedures, rules and norms determine the propensity of actors to interact with other actors, share knowledge and generally condition their behaviour. Cameron and Quinn (1999) identify four dominant organizational cultures as: (i) Clan, (ii) Hierarchy, (iii) Market, and (iv) Adhocracy (see Table 5). We draw on the work of Cameron and Quinn (1999) and broader IS literature to support our analysis of the observed trends.

Table 5. Dominant organisational cultures

The clan culture

A friendly place to work; people share and relate like an extended family.

- Success is defined in terms of sensitivity to customers and concern for people.
- The organization places a premium on teamwork, participation and consensus.

The adhocracy culture

A dynamic, entrepreneurial and creative place to work.

- Commitment to experimentation and innovation.
- Success means gaining unique and new products or services.
- The organization encourages individual initiative and freedom.

The hierarchy culture

A very formalized and structured place to work.

- Procedures govern what people do.
- Coordination and efficiency matter.
- Formal rules and policies hold the organization together.
- The long-term concern is on stability and performance with efficient, smooth operations.
- The management is concerned with secure employment and predictability.

The market culture

A results-oriented organization whose major concern is getting the job done.

- The glue that holds the organization together is an emphasis on winning.
- The long-term focus is on competitive actions and achievement of measurable goals and targets.
- Success is defined in terms of market share and penetration.

Source: Cameron and Quinn (1999)

Exploring the 'Peripheral' Role of R&D Organizations

Hall et al. (2006) have noted that the habits and practices of organizations are shaped by the historical, cultural and political settings in which they are embedded. Most of the public R&D/training organizations in Kenya were formed in the era of linear models of development characterized by top-down, hierarchical orientations. The apparent weak role for the knowledge producing organizations in supporting farmers suggests that universities and research institutes are 'still stuck' in what Gibbons et al. (1994) have called 'mode 1 science'¹¹. The characteristics of mode 1 science suited the transfer of technology (ToT) models, in which research was conducted by the universities and research institutes and the findings passed on to extension agents for onward transmission to farmers for adoption. The inadequacies of the ToT models and mode 1 type of approaches have led to 'mode 2 science'¹² to explain what Gibbons et al. (1994) and Nowotny et al. (2001) have called 'the new production of knowledge'. This view is consistent with the systems of innovation approach, which advocates for close interactions between these multiple actors as a means of promoting learning and innovation.

In Kenya, the change from the ToT models to IS approaches has been reflected in key shifts in agricultural policies witnessed from the mid-1980s. However, even though research institutes have tried (to varying degrees) to engage some other actors in their research (there are isolated cases involving NGOs and large-scale farmers), the structures of these organizations have remained largely hierarchical with strict lines of command. Their procedures are still bureaucratic with several layers of approval before any initiative can be implemented. Chambers (1989:182) attributed these 'old habits' to the combined effect of training and organizational culture, and summarized the capacity of R&D/training organizations to change:

“Normal professional training and values are deeply embedded in the transfer of technology model, with scientists deciding research priorities, generating technologies and passing it onto extension agents to transfer to farmers. Normal bureaucracy is hierarchical and centralizes, standardizes and simplifies. When the two combine, as they do in large organizations, whether in agricultural universities, international agricultural research centres, or national agricultural research systems (NARS), they have an impressive capacity to reproduce themselves and resist change.”

The NGOs and Input Suppliers: What do They do Differently?

NGOs are characterized by their small size, institutional flexibility, horizontal structures (as opposed to hierarchies) and short communication lines. These attributes have accorded them more direct contact with farmers and shorter response time to farmers' requests. On the other

¹¹ In this mode, research agendas are set by the researchers/scientists, relevance is determined by the interests of this group, and excellence is based on the cognitive authority of peer review. The research is largely disciplinary and the actors involved are largely homogenous.

¹² Mode 2 science acknowledges multiple actors, 'multiple knowledge' and multiple ways of knowing. In mode 2, knowledge is generated in the context within which it is applied and the research agenda is set by multiple actors and appeals to the wider social and economic goals. Knowledge is produced in a trans-disciplinary manner and its relevance judged on how it addresses the impending needs of its users.

hand, strong collaboration with input suppliers stems from the way input suppliers have organized their business and engagement with farmers. Other than promoting their products, they offer training and field demonstrations for farmers on dosages, safety measures on pesticide use, plant protection and good agricultural practices. Input suppliers (mainly agrochemicals) have sales and marketing staff, who are trained in agronomy and occasionally visit farmers to help identify problems in greenhouses or fields. This approach has built confidence and trust between farmers and input suppliers as comments from one farmer show:

“They (input suppliers) are willing to conduct field trials with farmers, and walk together with you in the process. When the trials fail, you don’t have to buy the products and they are willing to give you free samples to try. We have developed a good rapport with them and they take our complaints seriously unlike our universities where if you take your samples it takes forever. They have approached the market from a technical perspective not a selling perspective ... they train you for free, give you free samples and they are very active in following up with you for face-to-face visits till you are satisfied.” *Large-scale farmer, Nairobi (November 2009).*

Conclusion and Implications for Smallholder Farmers

From our analysis, it appears that the organizational culture (together with its incentive structures) shapes the propensity of the individual actors within these organizations to interact with other actors (organizations) within the wider innovation system. It can be argued that the hierarchical culture of the R&D institutes provides limited incentives for agents who would want to operate in a new and potentially ‘disruptive’ manner. In other words, there is little support for new forms of organization that do not conform to the bureaucratic procedures that characterize these organizations. The NGOs project more of a ‘clan culture’, in which success is defined more in terms of sensitivity to customers and others, and the organization places premium on teamwork, participation and consensus. The input suppliers are characterized by ‘market culture’: more results-oriented with emphasis on winning market share and penetration.

A number of questions arise from our analysis with regards to enhancing the capabilities of smallholder farmers: How can farmers demand research services in a way that makes universities and R&D institutes respond? What kind of incentives and reward structures are required to improve the interactions between farmers and R&D actors? Are there new ways of organizing R&D to make it respond quickly to farmers’ needs? We suggest two possible ways of ensuring R&D responds better to farmers’ needs:

- *Forming strong farmer associations/organizations to collate/articulate farmers’ research and training needs.* It will also give these organizations economic power by consolidating their resources and make it easier to mobilize R&D support.
- *Promoting ‘adhocratic culture’ within universities and R&D organizations.* In order to interact effectively with farmers, universities and R&D institutes will need to learn more of what Cameron and Quinn (1999) have described as an *adhocratic culture* – that is, they need to encourage individual initiative and freedom of their staff, and project a more entrepreneurial and dynamic posture with increased incentives for risk taking and commitment

to experimentation and innovation. One way of achieving this change (given the difficulty of changing entrenched bureaucracies) is to create 'interdisciplinary research centres' (Clark, 2000) within universities and R&D institutes.

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Chapter 8

POLITICAL POWER IN INNOVATION SYSTEMS: SMALLHOLDER SUSTAINABLE INTENSIFICATION AND RURAL MECHANIZATION

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Abstract

There is a need to reopen policy debates on rural mechanization. Tracing the history of rural mechanization and building on the experiences of countries in South Asia, the case is made for small-scale machinery to be used for sustainable intensification of smallholder agriculture. Innovations in rural mechanization often come from multiple sources and sectors, and special issues concerning rural engineering, innovation and promotion must be recognized. The assertion that consolidation of holdings is needed in order to increase intensification, and the lack of use of available evidence that extensive use of small-scale equipment has been taking place, were identified as some of the factors that have diverted debates on substantive policy issues concerning rural mechanization. General policy prescriptions cannot be applied across countries, as policy dialogues on rural mechanization must be context specific. It is noted that taking the political nature of science and technology (S&T) out of innovation systems (IS) and sustainable intensification is not useful. There is need to strengthen the analytical capability for carrying out research of IS based on historical and political economy studies, as well as more cost-effective methods of collecting and analysing data relating to agricultural and rural mechanization. The paper concludes by noting that rural mechanization debates are never outside of larger political debates concerning inequality and the role of sustainable broad-based rural development in economic change.

Keywords: Small-scale machinery, South Asia, Engineering, Evidence, Context-specific, Inequality, Rural development

Introduction

This chapter addresses the way forward in advancing the thinking and theory on IS, focusing specifically on ‘sustainable intensification’ and building research capacity on IS, so that policy and practice ‘benefit smallholder farmers’. This is achieved by looking at the history of intensification

of agricultural production through the spread of small-scale mechanical equipment in the agrarian/rural structures of Bangladesh and Nepal. We have been engaged in policy and practical issues of rural mechanization in South Asia for many years, and have used IS methods and techniques in our work on rural mechanization, particularly in a consortium of allied projects for the promotion of small-scale rural machinery. Reflections on experiences of using the IS framework are provided at the end of the chapter.

The authors do not have a great deal of experience in countries outside of South Asia, yet are in the midst of advising new projects in Asia, Africa and Latin America, which are just beginning and are struggling to find information, orientation and ideas for ways forward for the promotion of small-scale mechanization. The aim is to focus on the history of the intensification of production on smaller holdings in some countries and regions in South Asia, and that this will be of interest to others engaged in setting up similar projects.

Whether the ‘sustainable intensification’ of smallholders in other countries will come about in the future depends on the political contexts in which social and technical change take place, but a consideration of these issues is beyond the scope of this chapter. However, if IS theory and practice is not embedded in ongoing political processes, sustainable intensification is unlikely to be achieved.

Rural Mechanization: Biases Against Smaller Equipment

Advocacy for and promotion of large-scale mechanization is being undertaken by many actors. Besides the more dramatic cases of ‘land grabs’, where large-scale equipment is generally very evident, there is a more general bias that ‘large-scale agriculture is somehow better’. For example, when expert assessments of global food production are published, the documents are often illustrated with pictures of extensive canal irrigation systems, combine harvesters, and large four-wheel tractors (4WT) with global positioning systems for precision placement of seeds and nutrients. However, rarely seen are pictures of 5 horsepower (HP) pumpsets, a two-wheel tractor (2WT), or locally made, cheap, plastic, lay-flat pipes for the careful placement of water.

Stories about the Green Revolution often highlight the spread of high yielding crops, 4WTs, combine harvesters, deep tubewells and other large-scale equipment. This occurs in situations where governments massively subsidize the agricultural sector with cheap energy (urea, diesel, and electricity for pumping water), and subsidies for large-scale equipment. However, the stories of green revolutions in agrarian/rural economies, where the spread of small-scale mechanical equipment, rather than large-scale equipment is the dominant pattern, are largely unheard. This is not limited to South Asia. Evidence is emerging from East Asia – China, Thailand and Vietnam – of massive, small-scale mechanization, contributing, in the case of Thailand and Vietnam, to significant export of rice.

This lack of interest or more likely familiarity with smaller-scale equipment has been expressed in other ways. The Food and Agricultural Organization of the United Nations (FAO) dramatically reduced its agricultural mechanization capability in 2003, and the International Agricultural Engineering Institute at Silsoe, in the UK, closed in 2004. Until recently, FAO has also only classified agricultural mechanization using data on 4WTs. Using these criteria, Bangladesh’s agricultural

sector is hardly mechanized but the reality on the ground is that Bangladesh has the most mechanized and, counter-intuitively, labour-intensive agriculture sector in South Asia.

In many agricultural policy debates there is also an assertion that small holdings need to be consolidated in order to intensify agricultural production. The empirical evidence from Bangladesh tells a very different story: the agricultural and rural economy has been growing steadily while at the same time, holding size has been getting smaller.

The Spread of Agricultural and Rural Equipment in Bangladesh¹

Table 1 shows that over a 30-year period from the early 1980s to 2010, the number of Chinese 2WTs increased from about 500 to 420,000, while over the same period 4WTs increased from about 400 to 26,000. However the greatest expansion of small mechanized equipment was the spread of small (average 5 HP) pumpsets (a diesel engine with a pump) for shallow tube wells. In 2010, it was estimated that there were about 1,425,000 of these units.

Table 1. Number of machines used for agriculture purposes (in Bangladesh)

| Machine | 1977 | 1984 | 1989 | 1996 | 2006 | 2008 | 2009 | 2010 | 2011 |
|---------------------------------------|--------|--------|---------|---------|-----------|-----------|-----------|-----------|-----------|
| 4WT ^A | 300 | 400 | 1,000 | 2,000 | 12,500 | 14,890 | 17,905 | 21,638 | 26,369 |
| 2WT ^B | 200 | 500 | 5,000 | 100,000 | 300,000 | 343,000 | 366,700 | 400,030 | 420,027 |
| DTWC | 4,461 | 15,519 | 22,448 | 24,506 | 28,289 | 31,302 | 32,174 | 32,912 | - |
| STWD | 3,045 | 67,103 | 223,588 | 325,360 | 1,182,525 | 1,304,973 | 1,374,548 | 1,425,136 | - |
| LLPE | 28,361 | 43,651 | 57,200 | 41,816 | 119,135 | 138,630 | 146,792 | 150,613 | - |
| Treshers (Open drum) ^F | - | 500 | 3,000 | 10,000 | 130,000 | | | | 190,000 |
| Treshers (Close drum) ^G | - | 100 | 1,000 | 5,000 | 45,000 | | | | 65,000 |
| Maize sheller ^H | | | | 100 | 850 | | | | 5,000 |
| Combine harvester ^I | | | | | | ±30 | | | 100 |
| Winnower ^J | | | | | | ±500 | | | ±200 |
| Sprayer ^K | | | | | | 1,250,000 | | | 1,250,000 |
| Reaper ^L | | | | | | ±40 | | | ±50 |
| Dryer ^M | | | | | | ±500 | | | |
| PTOS ^N | | | | | 451 | 481 | 620 | 870 | 1,190 |
| VMP ^O | | | | | | | | | 45 |

Source: Reproduced from *iDE (2012):31*

¹ The numbers in the tables are not always consistent. Getting reliable estimates in a cost effective way is quite challenging. However, the discrepancies do not affect our main argument.

VMP = Versatile Multi-crop Planter

PTOS = Power tiller operated seeder

^{A, B} = Data till 2006 has been taken from Roy and Singh (2008), other data came from estimations and triangulations made during this study. It should be noted that annual import for 2WT and 4WT is around 50,000 and 10,000 respectively. In case of 4WT, only 50% of the imported machines are exclusively sold for haulage purpose and the rest does both tillage and haulage. Estimating that 2006 data represents the actual number of 4WT operating exclusively for tillage at that time, we have estimated the 4WT data in the following years considering the annual drop out from agricultural uses and also the yearly import. In case of 2WT, even though 60,000 are imported, it is estimated that nearly 60% are not being used for agriculture each year, thus potentially around 20,000 units are being added to the agriculture tillage system.

^{C, D, E} = Data came from Minor Irrigation Survey of BADC.

^{F, G, H} = Data till 2006 has been take from Roy and Singh (2008), other data has been estimated.

^{I, J, K, L, M} = Data taken from Rashid (2009) and Wahab (2011).

Table 2 reveals that only 8% of total tractor HP (2WTs and 4WTs) comes from larger equipment and the other 92% comes from smaller 2WTs. Looking at the total number of engines (tractors and small-scale irrigation pumpsets), 49% of rural and agricultural HP is provided by small-scale engines powering small pumpsets.

Table 2. Horsepower availability in agriculture by size of engine for Bangladesh and Nepal (estimates for 2010)

| Energy source | Nepal | | | Bangladesh | | |
|------------------------------------------------|-----------|-----------|---------------|------------|------------|---------------|
| | No. units | Total HP | % of total HP | No. units | Total HP | % of total HP |
| 2WTs* | 12,000 | 168,000 | 10% | 400,000 | 5,600,000 | 46% |
| 4WTs** | 30,000 | 900,000 | 53% | 15,000 | 460,000 | 4% |
| Irrigation shallow tube well pump (diesel) *** | 120,000 | 600,000 | 36% | 1,200,000 | 6,000,000 | 49% |
| Irrigation pumpsets (electric)**** | 10,000 | 20,000 | 1% | 100,000 | 200,000 | 1% |
| Total available HP | | 1,688,000 | 100% | | 12,260,000 | 100% |

Estimates of the numbers of power sources (and their HP ratings) used primarily in agricultural and processing uses, including groundwater irrigation pumps. It does not, for example, include the many engines used in Bangladesh to power riverboats, rice mills, processing, etc., although these are a vital part of Bangladesh's agriculture sector and rural economy.

*Average of 14 HP per 2WT

**Average of 30 HP per 4WT

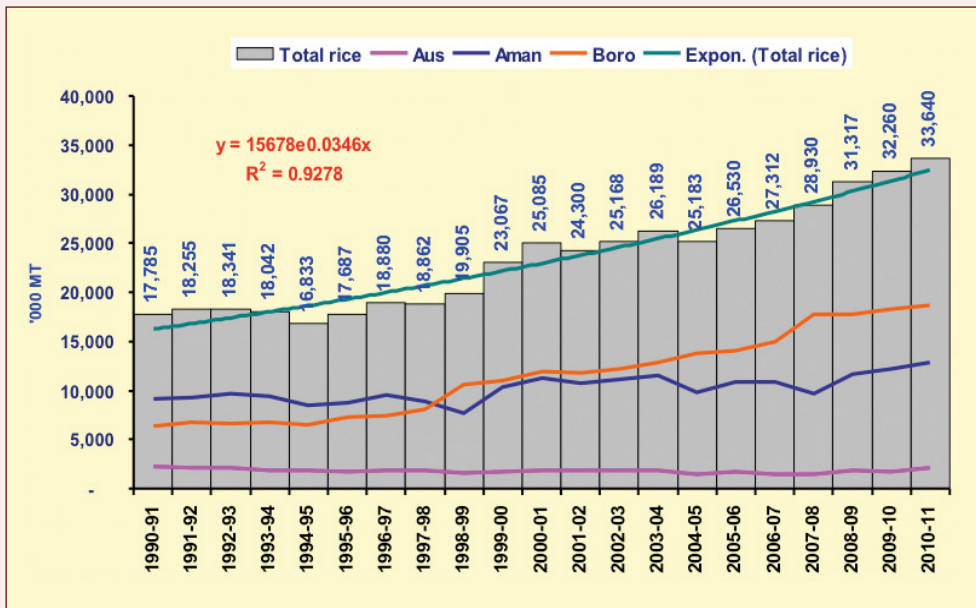
***Diesel/petrol irrigation pumpsets average 5 HP. 5-10% of the pumpsets are petrol/kerosene.

****Electric irrigation pumpsets average 2 HP.

Source: Justice and Biggs (2012):72

As an indicator of what has been happening in Bangladesh's agricultural production, the expansion of the most important crop, rice, is analysed. Figure 1 shows a more or less continuous rise in production from the early 1990s to the present day. Part of the reason for this growth was the spread of smaller-scale mechanical equipment in a highly differentiated agrarian/rural economy, where the average size of holding decreased from 2 acres (0.8 ha) in 1983/84 to 1.26 acres (0.5 ha) in 2008. It can be seen that marginal and small farmers (farms up to 2.5 acres) (1 ha) are now dominating the agrarian structure, and in 2008 made up 63% of all farms, in contrast to 53% in 1983/84 (Table 3). Additionally, mechanization (water and tillage), along with widespread shallow aquifers, have led to farming intensification and increased cropping intensity. Earlier winter fallows have now been replaced by winter ('boro') rice, and other winter crops like wheat, maize and vegetables, which now exceed – in value terms – monsoon rice production.

How has agriculture done in rice production?



Production of other crops (except pulses and oilseeds), fish, poultry and livestock products also increased.

Figure 1. The performance of rice production in Bangladesh

Source: Reproduced from Mandal (2011)

Table 3. Changing structure of farms in Bangladesh

| Farm holdings | 1983/84 | 1996 | 2008 |
|---------------------------------------------|----------------|-------------|-------------|
| No. of marginal farms (<0.5 acres) million | 2.42 | 3.35 | 4.10 |
| No. of small farms (0.5–2.5 acres) million | 4.65 | 6.07 | 8.43 |
| No. of medium farms (2.5–7.5 acres) million | 2.48 | 2.08 | 2.11 |
| No. of large farms (>7.5 acres) million | 0.50 | 0.30 | 0.23 |
| Average farm size (acres) | 2.00 | 1.50 | 1.26 |
| No. of absolute landless holdings (million) | 1.20 | 1.81 | 3.68 |

- Net cultivated area is decreasing very fast.
- Small and marginal farms are dominating, while medium and large farms are declining.
- Implications: Timely delivery of inputs, credit and extension services is an increasingly challenging task – involving private sector and NGOs.
- Farm to market linkages for dispersed small production become crucially important. Infrastructure and reform of marketing services must be initiated.

Source: Reproduced from Mandal (2011)

The spread of smaller-scale equipment has been accompanied by the spread of a wide range of markets in engine services. In this agrarian/rural economy, small-scale engines may be used for multiple purposes. Rural entrepreneurs use them on their own holdings and hire them out for multiple services. In the case of 2WTs, this might be for tillage operations, transport of people or goods, pumping water, powering threshers, etc. These service markets are often very active. It is beyond the scope of this chapter to investigate the income distribution effects of these smaller-scale mechanization processes.

The Spread of Agricultural and Rural Machinery in Nepal

The spread of mechanization in Nepal is a very different story. In addition to the great diversity of ecological conditions (Figure 2), there are tremendous differences in the languages spoken, ethnic groups, history, and the history of economic planning. However, in the context of rural mechanization of smallholder agriculture, Nepal has a history going back to the mid-1970s, when expensive Japanese and then Korean 2WTs were introduced into the Kathmandu and Pokhara valleys. Today, agriculture in these valleys is among the most intensive and productive in Nepal. Significantly, the 2WTs (whether Chinese or Japanese) have always been used for multiple purposes: for transport, as well as for tillage, threshing, and other purposes. Equally important is that there have always been strong markets for the buying and selling of tractor services. Since the introduction of Chinese 2WTs, first in the 1980s and then again in 2000 (Biggs et al., 2002), the economic rates of return have always been very high and pay back periods have generally been less than 2 years. A large system of local repair and fabrication shops slowly emerged, and this continues to keep some of the early Japanese and Korean tractors running that are 30 plus years old.

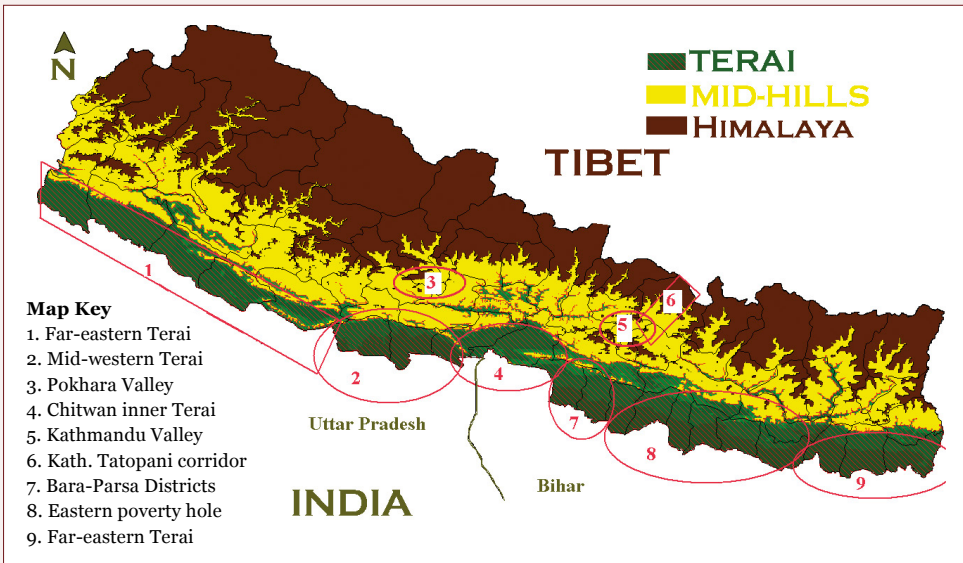


Figure 2. Map of Nepal showing different agricultural and mechanization patterns

Source: Justice and Biggs (2012):79

In spite of evidence of 20 to 30 years showing how smaller-scale equipment has helped to increase the timeliness of field operations and agricultural intensity in the Kathmandu and Pokhara valleys of Nepal, Figure 3 shows that it is only recently that 2WTs have started to spread more generally in Nepal. Currently, they only make up 10% of the total tractor HP in rural areas. This is a very different picture from Bangladesh where total HP from 2WTs makes up 46% of the total tractor HP (Table 2).

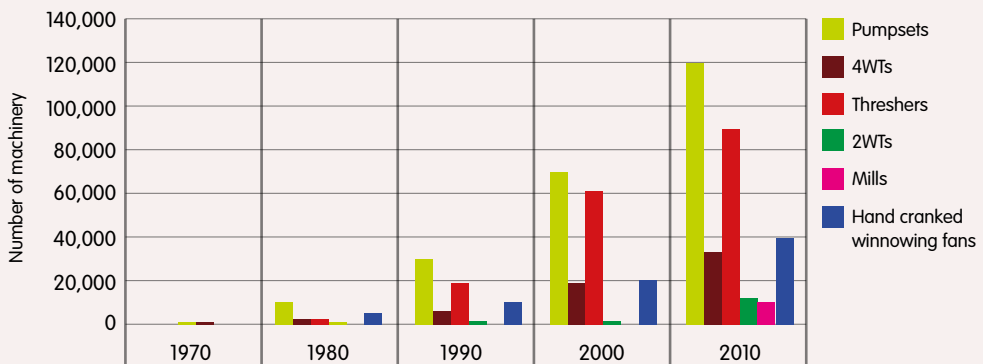


Figure 3. Spread of agricultural machinery in Nepal

Source: Reproduced from Justice and Biggs (2012):81

The widespread use of 4WTs in Nepal began in the 1970s and thousands were imported throughout the 1980s, 1990s and 2000s. Early on, most were utilized in the Terai (flatlands) for agriculture and transportation. Since the 2000s, the demand for 4WTs has remained strong, bolstered by very low import tariffs. Increasingly 4WTs are being used for transport services (estimates of up to 50%), due in part to continued and very high import duties on trucks. In the mountains 4WTs are being used for transport and haulage rather than for tillage and other agricultural operations, as the cost of providing hard top roads is very high. Another explanation for the continued spread of 4WTs in the Terai is the agrarian structure, where there is high inequality in the ownership and control over land.

Across the Terai, small-scale pumpsets have been spreading slowly since the 1980s. Until recently, they were mostly the heavy, expensive and rather ancient Lister type diesel engines from India. Surprisingly, it appears that knowledge and experience from Bangladesh, which started using cheap, good quality, lightweight, Chinese diesel engines over 25 year ago, and which promoted water markets for the careful and intensive use of irrigation water, have only recently come to Nepal. Starting in about 2008, sales of these Chinese diesel pumpsets began to climb dramatically. There are, of course, many reasons for this, but it would appear that those who influence agricultural, irrigation, and energy policy in Nepal have traditionally looked mainly towards India for ways forward, rather than to Bangladesh, China, Thailand, Vietnam and other Asian countries (Biggs et al., 2011; Biggs and Justice, 2015). Interestingly, it appears that small-scale mechanized equipment is now spreading fast in India, much of which is Indian equipment being powered by the same lightweight and inexpensive Chinese diesel engines used for many years in Bangladesh and Nepal².

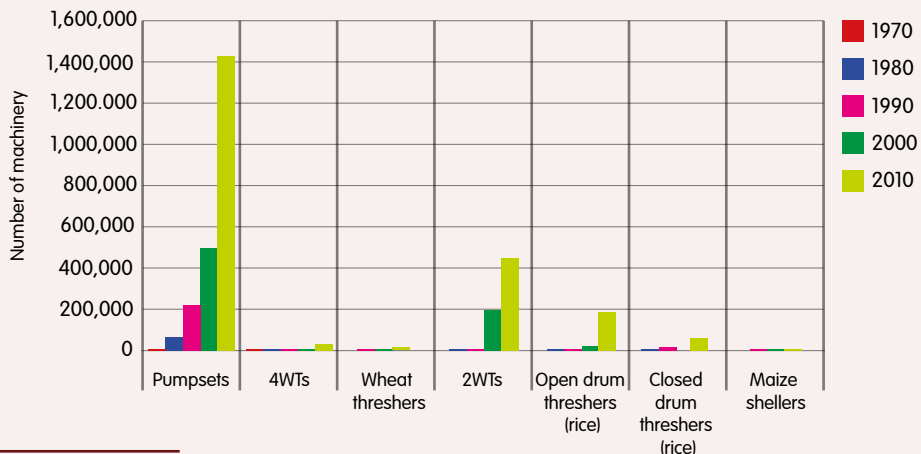


Figure 4. Spread of agricultural machinery in Bangladesh

Source: *iDE (2012)*

² For observations on agricultural mechanization in Bangladesh, China and India, and their relevance to current policy in Ghana see Diao et al. (2012).

Summary of the Spread of Smaller-scale Equipment and Service Markets

There are many key features from the spread of smaller-scale equipment and service markets, such as being marked by a long history, and great diversity by regions, national resources, policies, institutions, and trade regimes. Some key features are:

- In Bangladesh, a key policy change was to reduce import tariffs on machinery imports. In addition, local traders were not oriented towards importing Indian machinery. This was probably due to Bangladesh being a littoral state with strong maritime interests.
- Import ‘quality control’ measures on 2WTs in Bangladesh were scrapped in the late 1980s. For decades, imported small-scale Chinese engines did not meet these standards but later were found to be ‘good enough’ for millions of farmers and rural entrepreneurs.
- The private sector came in strongly and now imports thousands of pieces of small-scale equipment and rural machinery. While there was early interest from government and changes in policy, there were no continuing government or international projects to aid smaller-scale mechanization processes.
- Multiple markets for diverse services (transport, water pumping, tillage) were a key part of the rural mechanization process.
- Rural entrepreneurs own and/or operate small-scale equipment. In the case of 2WTs, these entrepreneurs are using them as mobile, multipurpose power units.
- Energy policies are a central component for understanding processes of rural mechanization and agricultural productivity and intensification. For example, when diesel prices were increased in 2007 in both Bangladesh and Nepal, farmers reduced the tillage passes, with no loss in productivity³.
- Agrarian/rural social structures are always important. In Nepal, 2WTs are generally operated by rural labourers who also manage the marketing of services and machine maintenance. However, they are owned by larger small farmers, who have access to private capital and sometimes bank loans. Up until recently in Nepal, those without land for collateral have been unable to access loans for these types of highly remunerative, smaller-scale rural investment opportunities.

Observations on the History and Debates of Rural Mechanization

Evidence from Bangladesh and, to a lesser extent, Nepal shows that the intensification of agricultural production has taken place as a result of the spread of smaller equipment and associated institutions. During this period, a number of other things were also happening:

General

Since the late 1980s there has been a decline in debates on rural mechanization and a major reduction in public sector research and development funding and extension capabilities. In the last two decades there has been a S&T public policy bias towards plant sciences and away from applied agronomy and agricultural/rural engineering. Even after the 2007 energy price increases,

³ Much of the thrust of current minimum and zero tillage agronomy is challenging ‘modern’ farming practices, which have often been encouraged by government subsidization of energy inputs to the agricultural sector.

and the renewed international interest in agricultural and rural development, many responses have centred on improving crop genetics, with little orientation towards small-scale patterns of rural mechanization.

Framing of Debates

While there has been plenty of evidence available that extensive, small-scale mechanization had been taking place, debates and discussions were, from the outset, framed in other ways. This meant that meetings were often confrontational situations, rather than debates about policy issues. Some of these framing issues include:

- Large-scale production is inherently better. Assertions have been made from the outset that the consolidation of holdings is necessary in order to increase intensification and efficiency of agricultural and rural production. But evidence from Bangladesh and many other countries/regions tells a very different empirical story.
- Characterization of small, stand-alone family farms. In the context of small-scale equipment, small farmers are sometimes characterized or idealized as small, stand-alone units, which have little contact with the outside world. The small-scale equipment enables them to do everything for themselves on their self-contained, independent, family farms. Where small-scale equipment has spread in South Asia, the situation could not be more different from this characterization. Rural entrepreneurs own the equipment, hire it out, and sometimes use it on their own holdings.
- Separation of the agricultural sector from other sectors. Small-scale equipment is used in multi-sectoral ways but bureaucracies and policy frameworks that dominate planning, and some academic institutions, make the assertion that sectors can be meaningfully separated. Perhaps one of the most obvious examples of this is the use of tractors, whether large or small. While a tractor is generally thought of as a piece of agricultural machinery, in most cases tractors are used for transport – of people and goods in various sectors – and sometimes for agricultural inputs and products. They might also be used for tillage and other agricultural operations. Rarely are these cross-sector considerations taken into account, at least in rural mechanization debates.
- (Mis)representation of the Green Revolution. At the start of the paper, we discussed how the Green Revolution is sometimes represented as a single event, taking place in one way, with improved varieties accompanied by large-scale, mechanized farming – the Punjab way. The example of Bangladesh's labour-intensive, highly mechanized – but with small-scale equipment – green revolution shows that there are many different types of green revolutions.
- Energy and water scarcity. Many agricultural policy debates in South Asia have been framed by policy prescriptions transferred from the UK, USA, or other Organisation for Economic Co-operation and Development member countries: namely that agriculture should be highly subsidized and protected. This simplistic transfer of policy prescriptions resulted in many Asian green revolutions coming about as a result of high subsidization of energy inputs (subsidized urea, diesel and sometimes free electricity for pumps for irrigation, large surface irrigation projects, and direct grants for mechanical equipment). One could say that past agricultural growth has been as much the result of a cheap energy policy for agriculture, as of

the development of improved varieties of crops. However, agricultural policy debates (whether reflecting on the past, or thinking about the future) are rarely framed in the light of these subsidized energy policy dimensions. In the future, these are issues that will become a central concern for different patterns of agricultural and rural development; especially in the light of peak oil, where fossil fuel prices will only continue to rise, as will the cost of urea and other intensive, fossil fuel inputs. Policy interest in small-scale, clean, renewable energy sources, like micro-hydro, solar and wind energy is likely to grow.

Culture of Male Dominated Agriculture and Mechanical Engineering

There are a number of characteristics of engineers that have an important bearing on policy debates on rural mechanization. They tend to be preoccupied with larger, more sophisticated equipment and show a greater interest in newer machines as opposed to smaller and older models. There are also several dimensions in their professional training that are particularly important.

Data collection and the presentation of engineering information. It appears there has been little professional training in the collection, analysis and presentation of field information on mechanization, including how to estimate national numbers of different types of equipment, or to undertake empirical studies of the spread and outcomes of different patterns of mechanization. For example, had engineers been better able and equipped to communicate their success stories, for which there are many (axial flow rice threshers, wheat threshers, axial flow pumps), it is possible that the need to reignite mechanization debates would not exist.

Prevalence of generalized stage theories of mechanization. These theories often promulgate stage wide linear processes that have little empirical basis, and often detract attention from analysing a country's specific unique context.

Proof of concept. Experiments with 'new equipment' often make little reference to existing technology and economic/social conditions, and tend to suggest sometimes that something was new, when it already existed in that context. For example, some international agricultural engineering journal articles describe 'a great idea', but never discuss whether the idea made it to market. This is a quintessential example of the linear theory of research and development, where research has no role in taking an idea any further than development.

Leaving claims unchallenged. The scientific promises to 'scale up and scale out' specific equipment and institutional models are frequently left unchallenged. One area where this often occurs is in new institutional models of ownership and management of agricultural equipment. These models typically reflect little knowledge of previous outcomes of similar types of models (e.g. group ownership and management, government hiring schemes, and a whole range of market-led business models). The prevalence of this behaviour amongst engineers and their allies makes it difficult to engage in an empirically based policy debate, where other actors might be invoking evidence from past experiences.

Cultures of Commercial/Bureaucratic/Projects

There are a whole host of cultures that come into the working of development projects and there is a large body of literature, which shows that issues such as the power of major donors, government ministries, and large funding non-governmental organizations (NGO), and the stage of the government budgetary process, can influence the technical and associated institutional options considered and promoted. These political and cultural issues are as important as any IS considerations, concerning the development of policies to promote different patterns of rural mechanization.

Interestingly, an issue that has come up more recently, in connection with the behaviour of staff in aid projects, is that agricultural and rural mechanization issues are emerging in political debates – to promote agricultural intensification for market-based value added chains, rural poverty reduction, etc. However, there is often a lack of knowledgeable engineering expertise to be brought to bear on these issues. Consequently, advice is given by people with little or no knowledge. Some of this is due to the neglect of rural engineering and mechanization over the last 20 years. For example, as far as we know there are no experienced young or mid-level professionals working in rural and agricultural mechanization in international development, as there have been no jobs in this sector for 20 years. Some of these skills may now be found in the NGO sector.

Sources of Innovation

Innovations in rural mechanization often come from multiple sources and sectors, such as cheap, lay flat plastic pipe, or local engineering innovations that can be essential to the spread of any introduced equipment. On other occasions, old technology in a new place at a new time might be as relevant as new state-of-the-art technology. In addition, in some cases engineering innovations represent a fundamentally different way of doing things, rather than a gradual modification/change of business as usual. Rural engineering innovation and promotion raise special issues, which are sometimes different from other areas of technology, and this has to be recognized.

Ways Forward

There is no general formula for ways forward. Each situation is different. Bangladesh and Nepal illustrate the diversity and complexity of each country and their differing paths to mechanization. Differences in agro-climatic resources are obvious. Nepal has large water resources from the Himalayas that can be used for irrigation in-country, or downstream by users in Bangladesh and India. Nepal also has potential for hydro-electricity energy generation, and other energy sources. Bangladesh has energy in the form of natural gas deposits. Other kinds of differences that have impacted mechanization processes include culture and behaviour. These are as important as any of the more technical resource endowment dimensions, or even the knowledge that there is now a tremendous range of mechanical equipment of all shapes and sizes (expensive and high quality or inexpensive and 'good enough' quality), which was not widely available just a decade ago. The issue then becomes one of developing and exploring 'room to manoeuvre' in any given political and institutional context.

In Nepal, there may be new opportunities for small-scale mechanization as a result of the migrant labour economy, which contributes over 25% of GDP. In rural areas particularly, many young men have left and make up the thousands of workers who leave each day for employment in the Middle East, Malaysia, etc. But local wage rates in rural areas of Nepal are rising. At the same time, migrant labourers who have seen things done in a different way in other countries are returning and thinking about what they want to do with their money and their lives in Nepal. Even though many aspire to urban lives, many also have an interest in agriculture and the rural economy, but lack information, ideas and knowledge about small-scale machinery for different types of agricultural and rural activities. In addition, some local banks are developing financial products for poor rural people, especially rural women, which go beyond micro loans, and small livestock models, but extend to small and medium size loans for equipment, with the equipment as collateral. While these banking options may be available in some other countries, they are a new product in Nepal. A recent Asian Development Bank-sponsored Agricultural Development Strategy is opening up some policy options with regards to ways forward on agricultural and rural mechanization in Nepal (Tomoko and Poshan, 2012)⁴. This is a major step forward, given that the dominant government and donor planning document since the late 1990s – the Agricultural Perspective Plan – explicitly excluded consideration of mechanization. The government has also commissioned a full review of agricultural mechanization policy and the reports are in the process of being implemented. There are no general policy prescriptions across countries. The policy discussion around rural mechanization in another country will be different, and even within Nepal will change at different points in time.

Innovations Systems Theory and Practice

About 10 years ago, the authors co-authored, with other colleagues, a paper entitled *The Changing Power Tiller Innovation System in Nepal: An Actor-Oriented Analysis* (Biggs et al., 2002). It was prepared for a workshop on agricultural and rural mechanization held at the Bangladesh Agricultural University, Mymensingh, in November 2002. The paper described histories of mechanization and illustrated how IS approaches might be used in practice.

People and organizations in powerful positions use IS frameworks and techniques selectively to promote particular economic and cultural agendas. Theories, ideas and frameworks developed on the basis of experience and evidence can be used for many purposes. These are not new findings regarding the politics of S&T. However, they do highlight that a narrow a-political preoccupation with the development of IS theory, and practice, might detract attention from strengthening the analytical capability of IS that looks at the nature of innovation in S&T. Taking the political nature of S&T out of IS would not be useful. To start including S&T in IS theory and practice would mean seeking out those people who are already working in the area of S&T studies (Jasanoff, 1996; Lewis, 1998; Latour, 2000; Mosse, 2011).

⁴ This includes the promotion of mini tillers, especially in the Hills where ecology and agrarian structures are so different from the Terai.

On a more practical level, it would be a positive step to introduce an appreciation of and ability to carry out research based on historical and economic studies within mechanical engineering training, as well as cost-effective methods for the collection and analysis of contemporary field data relating to agricultural and rural mechanization. This might well lead to an improved basis for some policy debates and a change in the behaviour of powerful actors.

Conclusion

There is a need to reopen policy debates on rural mechanization. Part of this will involve asking whether rural economic/social development and creation of worthwhile jobs in rural areas are policy goals. This might sound like a harping back to the equity policy concerns of the 1970s – and to some extent it is – but the globalization of the contemporary world makes the idea of sustainable rural economic development (with worthwhile jobs, broad-based economic activities, etc.) an even more contentious area of policy debate.

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Chapter 9

THE USES OF RESEARCH: ACTION RESEARCHING IN AND ACROSS NINE AGRO-ENTERPRISE DOMAINS. THE EXPERIENCE OF THE CONVERGENCE OF SCIENCES-STRENGTHENING INNOVATION SYSTEMS PROGRAMMES IN BENIN, GHANA AND MALI

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Abstract

This chapter justifies the application of Theory-Guided Process Inquiry (TGPI) to elucidate, with real-time documentation of a standardized set of evidence across nine cases, the process of innovation in contrasting but comparable contexts. There is a significant challenge in coordinating divergent actors' responses to rapidly changing market, climatic and development needs and opportunities in smallholder agriculture in West Africa, so that individual efforts add up to effective governance of their respective domains of interest and efficient value chains that deliver worthwhile returns to small-scale producers. In these situations, rigorous research that is responsive to local histories and contexts, and to evolving events, is needed to underpin innovation policy, practice and theory. At the same time, the research should not be too demanding of scarce research resources and capacities, nor be reliant on unrealistic demands for large sets of quality-controlled statistical data. Research encompassed two mutually informative but distinct activities: (i) research carried out by PhD students and members of the innovation platforms (IPs) established in each domain, in order to inform their own actions; and (ii) research carried out in order to understand the contributions of the IPs and other actors in bringing about transformative change. The chapter concludes with a reflection on what has been achieved through the research practices described.

Keywords: Theory-guided, Innovation platforms, Local contexts, Rigorous research, Small-scale producers, Value chains

Introduction

The Convergence of Science-Strengthening Systems of Innovation (CoS-SIS) programme is about innovation in support of smallholder farmers and associated processors in nine agro-enterprise domains, in Benin, Ghana and Mali. The programme's central assumption, drawn from the experience and analysis of the findings of a previous programme (Hounkonnou et al., 2012; Sterk et al., 2013), is as follows: "Efforts to create new opportunities for small farmers and small farmer communities, and the benefits that should flow from these to the farmers, are constrained by institutions in the communities themselves, and/or at higher levels and wider scales of interaction."

The assumption implies (at least) three things for the design and practice of research. First, interventions that act directly on identified institutional constraints may open the way to systemic changes that allow small farmers to benefit from technical and other changes at the level of the farm and farm community. We can formulate this as an implied cause-effect relationship; the attribution of the observed effects to the interventions must be reasonably evidenced. Secondly, because our interest lies in *purposeful* interventions that benefit a particular social category (various kinds of small farmers), we have to grapple with ideas about the governance of systemic change and innovation processes. Thirdly, these in turn direct attention to the following elements in causation:

- the structure of organizational arrangements and relationships at multiple scales and levels;
- histories grounded in contexts;
- the characteristics of purposeful interventions;
- the techniques in use; and
- the norms, roles, routines and practices of actors, with diverse interests.

The central purpose of this chapter is to describe the main parameters of the research activity that ensued, synthesize some of the main analyses and findings achieved, and discuss the contribution of this way of doing research to the study and practice of innovation in smallholder agriculture. Research in our case encompassed two mutually informative but distinct activities: (i) research carried out by PhD students and members of the IPs established in each domain, in order to inform their own actions; and (ii) research carried out in order to understand the contributions of the IPs and other actors in bringing about transformative change.

We first clarify what we mean by the two main concepts underlying 'systems of innovation' (SI) and 'new institutionalism', before turning to issues of the study design and research practice.

SI: Our interest in SI lies in effecting and understanding transformative changes in socio-economic systems that open opportunities for smallholder development. We have found it useful to adopt Geels' (2002; 2004) multi-level heuristic schema of socio-technical transitions that

distinguishes within a given domain of interest between: (i) *niches* in which novelties emerge within initially unstable socio-technical configurations, with low power to effect systemic change – such novelties are conceived, developed and promoted by small networks of dedicated actors, often seen as outsiders or fringe actors (or as ‘positive deviants’); (ii) *regimes* sustained by shared cognitive routines, practices and activities among broad communities of interest, that over time become stabilized and embedded in formal and informal conventions, norms, regulations, laws, rules, procedures and organizational arrangements (i.e. institutionalized); (iii) *landscapes* that form the exogenous environment beyond the direct influence of niche and regime actors – change in landscapes typically occur slowly (over decades) but also may be driven by ‘surprise’ events.

This schema has undergone numerous modifications (Geels and Schot, 2007) in response to criticisms of the original formulation, four of which we describe briefly here. First, the scheme initially was associated with a socio-political hierarchy of governance (micro-meso-macro levels). Empirical research subsequently suggested that such a neat coupling was unjustified. Secondly, the first studies that applied this schema tended to focus on regime changes forced by novelty originating in micro-level niches. Subsequent research has shown that ‘selection pressures’ on novelties may occur at any or at multiple points in the context (Klerkx et al., 2010). Thirdly, while explanatory diagrams elaborated in early publications drew attention to functional relationships (of assumed purpose), others propose that purpose cannot be the structural property of functional relationships but should be defined by actors (Fløysand and Jakobsen, 2011; Farla et al., 2012). In turn, the use of the language of ‘actor’ draws attention to how individuals and collectives behave in order to advance their purposes. Fourthly, the initial formulation and applications appeared to assume that the proponents of novelty necessarily were ‘newcomers’ seeking systemic transformation in support of their interests. Subsequent studies opened the possibility that incumbents of an existing socio-technical regime, under certain conditions, might also become the originators of novelties. Geels’ modified framework in general appears to be drawing progressively closer to the understanding of soft systems theorists (Ison, 2010; Ison, 2016). The innovation question then becomes how, and under what conditions and purposes, do novelties become stabilized in socio-technical regimes? We return to this question in the discussion.

The ‘new institutionalism’: Political scientists meanwhile have been developing an eclectic understanding of change that re-focuses attention to institutions, and specifically on how institutions shape the way that individuals and collectives mobilize resources and interests in pursuit of their purposes (Stone, 1988). The so-called ‘new institutionalism’ emphasizes power and asymmetrical relationships of power in explanations of change, identifies social causation as path-dependent, and accommodates the notion that multiple interacting factors may drive change in any instance (Avelino and Rotmans, 2009). There are two main reasons why we find this body of institutional theory useful. First, its focus and emphases help us to understand: a) institutional constraints at regime and niche levels, and the fate of technical novelties, in terms of contexts, histories and power relationships; and b) the achievements (or lack of them) of IPs in relation to the dynamic of relationships and events, internal and external to the platform. Secondly, we find the eclecticism appropriate because the social fields in which innovation processes occur are diverse and eclecticism enables CoS-SIS research activities to draw upon the varied disciplines

and research traditions of all those involved. Hall and Taylor (1996) distinguish three main theoretical and methodological contributions to the ‘new institutionalism’: historical institutionalism, rational choice institutionalism, and sociological institutionalism. Table 1 offers an overview of selected characteristics of each. Our research draws on all three (Kpéra et al., 2012; Quarmine et al., 2012).

Table 1. Selected characteristics of three strands of institutional theory

| Key assumptions | Historical institutionalism | Rational choice institutionalism | Sociological institutionalism |
|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| How do actors behave? | Behaviour bounded by actors’ worldviews. Stabilized in behavioural routines. Act as satisfiers of individual and collective purpose. Act according to degree to which they are able to mobilize resources and coalitions of interest, in ways that presume the logic of power. | Actors’ goals treated as exogenous to the analysis. Actors have fixed sets of preferences. Take instrumental action to maximize attainment of their preferences. Act strategically, in ways that presume use of the logic of calculus. | On basis of shared attitudes and values. Within networks of behavioural routines shaped by cognitive, moral, and heuristic templates. By application of practical reasoning constituted in interaction. Behaviour presumes use of the logic of social appropriateness (in which acquired or inherited cultural authority determines what is considered appropriate). |
| How do institutions arise? What do institutions do? | Emerge in struggles for power and control. Provide moral and cognitive templates for interpretation, choice and action. | Emerge through voluntary agreement. Provide actors with a greater or lesser degree of certainty. Generate information relevant to understanding the behaviour of others and reducing transaction costs. | Emerge in interactions between organizational structures, attitudes and values, for declared purposes. Provide frames of meaning through which to interpret and act upon the world. |
| Emphasis on what kinds of institution? | Procedures, rules, laws, conventions, organizational arrangements (‘the polis’). | Property rights. Rent-seeking. Incentives and sanctions (‘the market’). | Frames of meaning encoded in symbolic interactions. Rights, norms, practices, roles (‘the society’). |

| Key assumptions | Historical institutionalism | Rational choice institutionalism | Sociological institutionalism |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Why do institutions persist over time? | Are rarely the outcome of, or instituted by, explicit individual choice (thus escape direct scrutiny). As collective constructions, cannot readily be changed by an individual. | Embody something like a Nash equilibrium. Deviation makes an individual worse off than adherence. The more an institution contributes to resolution of collective action dilemmas, and the more gains from exchange that it makes possible, the more likely it is to persist. | Are distributed among and internalized by individuals and collectives, embedded at multiple temporal and spatial scales. |

Source: Constructed at a Research Associate Support Team workshop, Aburi, Ghana, June 2012. Based on Hall and Taylor (1996)

Research Design, Methods and Data Sources

Research Design

The programme sought to contribute to satisfying policymakers’ desire to know *what works?* There are major differences in how this question is approached (Anderson and Scott, 2012; Donmoyer, 2012). Those who seek answers through statistical means, for instance, favour research designs based on random assignment of treatments, avoidance of sample contamination (arising, for instance, from purposeful recruitment of targeted participants), clear specification of dependent and independent variables, and large samples. This approach offers the promise of clean, rational, unambiguous policy-relevant research of great analytic power. Its stringent operating conditions, however, mean that in practice it is applied only in relation to certain types of research questions and only where messy real life conditions can to a sufficient (and ethical) extent be controlled. Others note: (i) that because unintended consequences are ubiquitous in the social world, one cannot safely derive or deduce origins from consequences; (ii) social causation is path-dependent so that even if the same forces of change are present in different cases, their effects are mediated by contextual factors inherited from unique pasts; and (iii) assignment of ‘treatments’ and recruitment of participants typically are non-random in any purposeful action or implementation of policy.

The CoS-SIS programme perceived considerable difficulties in applying the statistical ideal of randomized treatments, or indeed any regression-based analysis. The three main difficulties identified were: the practical impossibility of random assignment of treatments to the study of innovation as a purposive activity; finding sufficiently well matched case controls for, and within, the selected agro-enterprise domains; and the high risk of contamination introduced by purposeful

recruitment of actors into the processes that CoS-SIS aspired to elicit and support. Programme partners also were insistent that the unique histories and contexts of the selected agro-enterprise domains had not merely to be ‘taken into account’ as exogenous factors but included as objects of study within the programme’s research activity. The researchers thus made an initial choice to associate research activity with the body of recent scholarship in governance and development studies that focuses on innovation in terms of “arriving at localized and informed solutions to specific constraints and needs” (Grindle, 2011: 416). This implied an action research design that offered the promise of insight into operationally-relevant policy guidance and of sufficient analytic rigour for decision-making (a tradition that is, we note, already well established in the management sciences) (Hatchuel, 2000).

The common fall-back option for within-case analysis is the case study. Individual case studies are recognized as making robust and richly insightful contributions to innovation studies. However, their limitation in terms of programmatic and policy advice is that, however many cases are included, they risk being non-commensurable, and, as situated in unique histories and contexts, incapable of generalization. There are two main, potentially complementary, responses to the challenges of research where controlled comparisons are not possible and the number of cases is small (George and Bennett, 2005). One is to ensure that the cases generate commensurable information on ‘regularities’ to allow between-case analysis, by means of well-grounded identification of the elements and processes common to each of the cases. The other is to design theory-led research (Faletti, 2006; Faletti and Lynch, 2009). The CoS-SIS programme adopted both responses. TGPI seeks to avoid the common tendency in political, social and development studies for researchers to generate empirical data and then to search around for the explanatory theory that retrospectively seems to best fit the data. On the basis of a literature review the two theories adopted to test explanations of cause and effect within and between cases were: 1) that it was the programme’s main intervention, the establishment of IPs in each domain, that caused the observed effects (i.e. an institutional innovation that creates or supports novelties in niches that could lead to regime changes); 2) that it was power relationships within and external to the IP that best explained the observed changes.

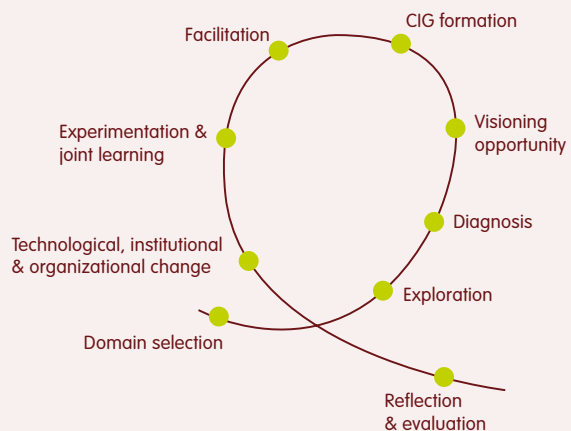


Figure 1. The ‘CoS-SIS cycle’, showing the process that the IP followed in each domain

Note: CIG (Concertation and Innovation Group)

Source: CoS-SIS (2013)

Methods and Data

Figure 1 outlines the main steps taken in the framework. First, agro-enterprise domains of potential national interest were identified in workshops with key stakeholders, policy actors and researchers in each country. Research activity was initiated by *scoping studies* in each of the selected domains (Adjei-Nsiah et al., 2013). The studies provided an initial multi-scale analysis of histories, contexts and issues of general concern. They were followed by *diagnostic studies* (Jiggins, 2012) that laid bare the main socio-technical and institutional reasons for the situations described in each domain. Subsequently, *stakeholder analysis* was applied to identify the actors in each domain who might be interested in establishing an IP (Nederlof and Pyburn, 2012). The stated purpose of the IPs was to generate the information needed to bring about transformative change, and to act upon the potential opportunities identified in the diagnostic studies. As the IPs became established their members further elaborated the reasons that were thought to sustain the institutional barriers to smallholder opportunity, *and analysed what needed to be changed, how and by whom*, i.e. this sequence of preliminary research served to define the *entry points* for action.

Each IP was facilitated by a part-time research associate, who was also responsible for recording a standard set of data, information on the process and analyses throughout the study period (Table 2). The research was operationalized by explicitly linking the two central concepts and TGPI to hypotheses about expected observations of anticipated transitions, by transparent specification of intended causal steps in effecting desired changes, and by sharing and peer reviewing data and information about the causal steps that showed evidence of effectiveness. The data and process information were presented and analysed approximately every 4 months throughout the study period by the research associates, national programme coordinators and supporting researchers at regional workshops (beginning 2010 – end 2013; n=10), encompassing eight agro-enterprise domains (from Benin (three), Ghana (two) and Mali (three) [in Ghana, toward the end of 2011 the research associate working on a ninth domain was re-assigned by his host organization to another position outside the domain and no IP was established]). Within-case analysis proceeded principally on the basis of: written background narratives; de-construction of instructive events; plotting of time paths; inventories of practical strategies adopted for immediate problem-solving; causal analyses based on elaborating alternative explanatory pathways suggested by our two TGPI theories; diagramming the persistence and variations in relationships within and external to the IPs; analysis of the verbal language used by the actors; and specification of the collective actions and decisions taken by identified actors in transitional changes. Between-case analysis was based principally on: learning workshops organized with programme partners and wider stakeholder groups; using within-case materials to draw out regularities and patterns, iteratively refine and eliminate hypotheses of causation bounded by the TGPI theories; and indicate opportunities to apply (as appropriate) mechanisms that proved effective in any one case to others and, as evidence and experience accumulated, to test out extension or expansion of the scale of operation and/or effects.

The work of the IPs was enriched by socio-technical field studies, laboratory analyses and institutional experiments conducted by PhD students working in each domain (Akpo, 2013; Amankwah, 2013; Osei-Amponsah, 2013; Quarmin, 2013; Sidibé, 2013; Togbe, 2013; Totin, 2013; Yemadje

2013; Kpéra, 2015), and by thematic studies (Adjei-Nsiah et al., 2013; Klerkx et al., 2013; van Paassen et al., 2013; Adu-Acheampong et al., 2014; van Mierlo and Totin, 2014; van Paassen et al., 2014; Röling et al., 2014). Analyses of each individual IP, and syntheses of national and programme-level experiences, will appear in *Cahiers Agricultures* (in preparation).

Table 2. TGPI methods and data sets for IPs in each of the eight agro-enterprise domains in West Africa

| Phase | Type of information recorded | Means of recording | Period |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Initiation | Scoping studies; diagnostic studies; stakeholder analyses; selection of two declared theories to explain cause-effect relationships recorded in TGPI data. | Field surveys led by post-graduate research associates (PhD studies); research associate-led studies and enquiries, in partnership with programme management team and national coordinator (theories used in analysis at regional workshops held approx. every 4 months throughout the programme). | 2009-early 2010 |
| IPs | Justification and organization of IPs in agro-enterprise domains; processes, and events related to IP activities; research assistants' observations related to these; narratives describing as factually as possible what has occurred in the IP and domain context; snapshots of power relations among key domain organizations; snapshots of inter-personal power relations; characterization of the exercise of power. | Programme documentation; IP meeting minutes; narrative reports; process analysis (whose/which decisions/actions the IP tried to change, the effects, immediate outcomes and intermediate outcomes); snapshots of IP memberships; external and internal actor linkage diagrams; matrix analyses (using six variables – one-sided dependence, mutual dependence, synergy, cooperation, competition, antagonism); critical incident analyses (based on mini-cases characterized in terms of timing, resource mobilization, skills and strategies deployed, motivations and willingness to act). | Reported and analysed every 4 months approx., from the beginning of 2011 to the end of 2013, at regional workshops. |
| Facilitation of IPs | Facilitation of: IP meetings and study visits; internal power dynamics of IPs and trust building measures; institutional experiments; shared learning processes. | Facilitator's diaries; minutes of IP meetings and study visit reports. | Reported and analysed every 4 months approx., from the beginning of 2011 to the end of 2013, at regional workshops. |

| Phase | Type of information recorded | Means of recording | Period |
|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Institutional experiments undertaken or commissioned by the IP | IP institutional experiments based on action research. | PhD studies; research associate research records; minutes of IP meetings. | Tracked, reported and analysed by research associates; every 4 months approx., from the beginning of 2011 to the end of 2013, at regional workshops. |
| Context data and analysis | Narratives of changes in context, and the processes, events, decisions taking place in the domain and larger policy environment, at national and international levels; field studies of specific local socio-technical and institutional changes within the domains and wider contexts; participation of farmer-based organizations in the IPs (Benin and Ghana). | Narrative reports and timelines, maintained by national coordinators; minutes of national programme management team meetings; PhD studies; research associate studies; thematic studies (researchers from partner universities in-country). | Reported every 4 months approx., from the beginning of 2011 to the end of 2013, at regional workshops. |
| Institutional impacts | Institutionalization of CoS-SIS concepts and practices in policy, university and domain-level organizations, value chains, and governance agencies at various levels. | Thematic studies, led by Research Associate Support Team and research associates working groups on the: <ul style="list-style-type: none"> • Role of national coordinators, programme management team, domain advisory groups, and IP ‘champions’. • Dynamics within IPs. • Interactions among multi-stakeholder IPs. • External influences on IPs. • Management of power relationships. • Facilitation. | Key informant interviews; text analysis; Research Associate Support Team meeting minutes: from programme initiation to mid-2014. |
| Programme-level data review and analysis | CoS-SIS programme: regional/international workshops and conferences | Proceedings | Four reports (2010, 2011, 2012, 2013) |

- The IPs were: Ghana – a) improving smallholder palm oil processing to attain export quality oil, and b) national cocoa sector developments; Benin – c) national cotton sector and by-pass strategies in the northern cotton zone, d) development of an oil palm seed system for smallholder plantations, and e) inland valley water management and domestic rice-market value chain development; Mali – f) value chain development for women’s sheanut cooperatives, g) crop-livestock integration, and h) tertiary canal water management.
- The Research Associate Support Team was composed of researchers from WUR in The Netherlands, University of Abomey-Calavi in Benin, Science & Technology Policy Research Institute in Ghana and the Royal Tropical Institute in The Netherlands.
- Regional workshops: 3-day workshops for the research associates, national coordinators, and Research Associate Support Team, held approximately every 4 months from the beginning of 2010 to the end of 2013, in Benin, Ghana or Mali.

Synthesis of Findings and Analyses

We report the main findings emerging from this research process under three headings: situating the IPs in processes of multi-scale institutional change; the institutional experiments; and the contribution of TGPI.

Situating the IPs in Processes of Multi-scale Institutional Change

Four findings stand out under this heading. The first is that the initial choices concerning the positioning of the IPs in the hierarchy of domain governance and public administration were based on scoping and diagnostic studies (Nederlof and Pyburn, 2012). Multi-stakeholder platforms often are positioned on the basis of the pre-analytic choices of supporting agencies with instrumental agendas (Nederlof et al., 2011). Attempts to use such platforms as instruments for ‘going to scale’ in the transfer of technologies, for instance, seems quite common (Röling et al., 2014). We later discuss the implications of this distinction for innovation processes.

Secondly, analysis of the individual narrative reports of the IPs throughout the study period reveals the extent to which the research associates, the IP members and programme leaders within each country responded to the dynamic of events in the domain context and in national political and economic developments in their drive for institutional change. In Benin, for instance, throughout the period of national elections in 2011 the three IPs could not function lest their role became ‘contaminated’ by accusations of political bias. The three IPs (for the cotton industry, which is a clearly structured domain and dominated by influential national interests, oil palm seed nurseries in a largely un-organized smallholder sector, and water management/rice value chains in an inland valley), all opted to base themselves away from national arenas, but for different reasons:

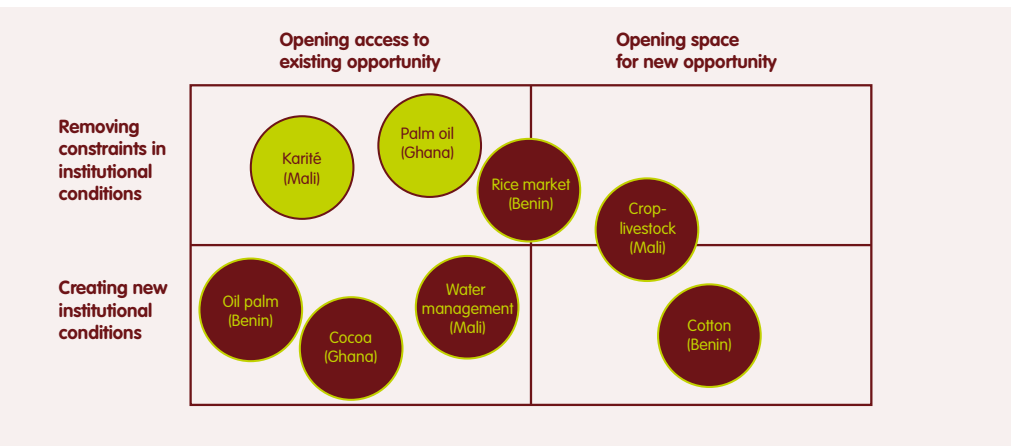
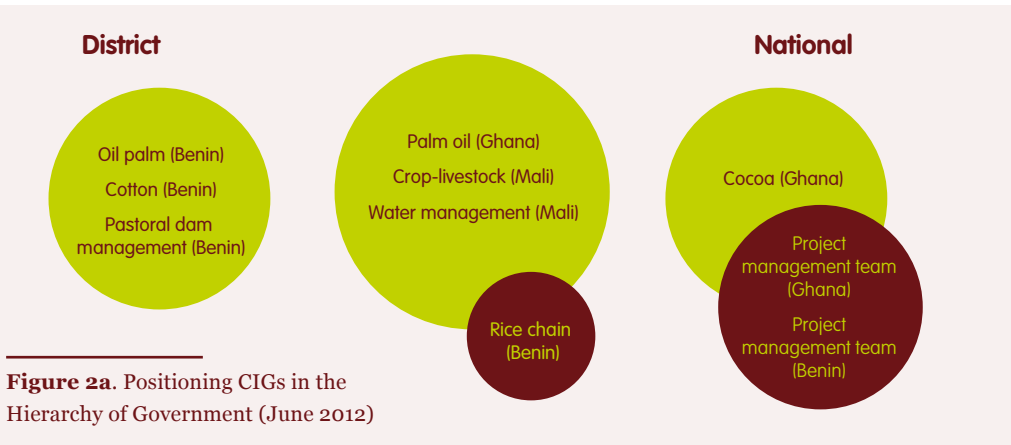
- Because the cotton sector is highly politicized and, at the start of the study, was grappling with sector-wide reform efforts, the cotton IP was located at the central district of the northern cotton zone where many farmers, despite the reforms, were abandoning the cotton industry. The dramatic intervention of the President in mid-2012 into the organizational arrangements for the cotton sector, which led to the dis-establishment of the coordinating body (the inter-profession, AIC) and the withdrawal of the import licences of the entrepreneur – who had

acquired near-monopoly control over cotton input supply and transport logistics – opened new opportunities for the members of the northern cotton IP to support the participation of farmers in national dialogues about the future of the cotton industry. The members also used their own networks of influence to push forward a ‘by-pass’ strategy to reduce northern cotton farmers’ dependence on malfunctioning national arrangements, building on two entry points: identifying, together with cotton researchers, seed varieties that farmers could multiply themselves, and that, because farmers are paid on the basis of the weight, had a higher seed cotton weight than the recommended variety; and helping women’s groups to form cooperatives to produce neem oil for pest management, in association with a locally-based private cotton entrepreneur who had set up a cotton value chain independent of the national structure.

- In contrast, because smallholder production of oil palm in Benin is largely unorganized, the IP was positioned in the heart of the main production area, as a district platform in association with the local government and oil palm research station. The impossibility of visually identifying a seedling of high productive potential had led to widespread mistrust, poor coordination and ‘suspect’ business practices among the stakeholders in the seedling supply system. Many farmers had been buying and planting seedlings that turned out to have low productivity. In order to reduce mistrust, the IP first sought to improve the transparency and sharing of technical information about seedling varieties among all concerned local actors. Only then could the IP begin to explore with stakeholders in local government, research and extension services, and the individual seedling nurseries, how to re-organize the seedling supply system. Armed with grounded empirical data on the importance of the seed system to the future of the industry, and information on how to go about setting up a reliable seed system with integrity, the IP over time began networking with higher level officials and other influential individuals to share the data and information. Eventually, development of the oil palm seed system was included in the country’s 2013 Five Year Plan, and funds were allocated to continue the work initiated by the IP.
- Stakeholders in water management and the local rice value chain in an inland valley had to take account of various ongoing contextual changes from the start, including: the government’s domestic rice pricing and staple food purchasing policy; renewed provision of food subsidies for low income households; the effect on domestic demand and supply of rice imports; and the entry of private commercial competitors, such as China, into the rice sector. It was the local municipality and NGOs that took up the challenge to find a way to develop new relationships and structures to support the production and marketing of local rice in this rapidly changing public and private commercial environment, leading to the positioning of the IP at local government level.

Thirdly, as the work of the IPs progressed they turned out to be occupying different spaces in Geel’s niche-regime-landscape schema. Novelty, it seems, can be developed in a wide range of spaces, even – as has been the case for the cocoa IP in Ghana – from within the existing institutional regime. The ‘innovation space’ appears to be related also to the degree to which the IPs have been trying to bring about institutional changes that opened access for small-scale farmers and processors to potential opportunities in the existing regime (as in the sheanut and the palm oil cases) or to create new opportunities through change in the regime itself (as in the cocoa case).

We present these three points as visual analyses (Figure 2) of the contrasting positions occupied by the IPs.



Fourthly, the TGPI data demonstrates that the scope for institutional change is determined to a considerable degree by context and thus each IP has had to ‘find its own way’ toward transformative institutional change that is achievable and meaningful in its own context by working on different institutional elements, and by strategic appreciation and response to local power dynamics (van Paassen et al., 2014). Table 3 presents the spread in the focus of each IP in terms of the institutional elements that it has tried to change. This analysis suggests that it is not enough to make general statements about ‘institutions’ when describing how transformative change can be brought about because it seems different IPs have been dealing with different elements in the change process. Table 3 none the less also suggests that while the particulars are specific to each case, regularities and patterns do emerge, that can be used in between-case analysis.

Table 3. Which institutional elements have the IPs tried to change?

| Country | | Mali | | | Benin | | Ghana | |
|---------------------------------------------------------------|-----------------------------------|---------|----------------------------|------------------|----------------------|--------|----------|-------|
| Domain | | Sheanut | Crop-livestock integration | Water management | Oil palm seed system | Cotton | Palm oil | Cocoa |
| Official and informal rules | <i>Legitimation</i> | | x | x | x | x | x | x |
| Norms | <i>Legitimation</i> | | x | | x | x | x | |
| Socio-technologies | <i>Material structures</i> | x | x | x | x | x | x | |
| Practices | <i>Material structures</i> | x | x | x | x | x | x | x |
| Incentives | <i>Material structures</i> | x | | | | | | x |
| Relationships | <i>Significance, sense-making</i> | | | x | x | x | x | |
| Rules for interpretation of meaning and knowledge development | <i>Significance, sense-making</i> | | x | | x | x | | x |

Source: Analysis made at Research Associate Support Team workshop, February 2013 using TGPI data. Based on institutional elements identified in Avelino and Rotmans (2009) and Fuchs and Glaab (2011)

The Institutional Experiments

The institutional experiments broadly speaking were based on the development and strategic sharing of new information so that decisions were made by key actors in the domain in order ‘to do different things’, and on actually trying to ‘do things differently’. Analysis of the TGPI data for the cocoa IP in Ghana reveals the interplay between these two (Adu-Acheampong et al., 2014; Adu-Acheampong et al., 2016). The members – drawn from all the main cocoa organizations – discovered early in their work that none of them knew what costs were taken into account in deciding the price paid each year to farmers for their beans. They set about filling the information gap by using their networks within Ghana to retrieve the information lodged in various organizations, and the access that one member (Cargill, the world’s largest cocoa trader) had to comparable information for all cocoa-exporting countries in West Africa. By sharing the information with the highest level of government – that the margin between costs and export prices would allow a higher price increase to farmers than the government was considering – the IP members contributed to the government’s decision in 2011 to raise the producer price considerably. The cost analysis, however, also had revealed that the centrally-controlled input supply system and annual mass spraying campaign against cocoa pests were the major cost elements, and these became the targets of the next round of investigation by the IP. The information the IP presented to the government contributed to the government’s decision to progressively privatize input supply in the cocoa sector, to change the timing of the annual price announcements to match the main harvest period of the modern cocoa tree varieties that had become widely planted, and to halt the mass spraying campaign. The spraying campaign, for instance, was shown to be based on recommendations that had not changed since the 1950s, and to be not very effective in any case, for both technical and organizational reasons (Adu-Acheampong et al., 2014). Meanwhile, a PhD student (Quarmin, 2013) set up and monitored a local experiment to show how ‘things might be done differently’, based on differential pricing for purchasing beans of different qualities, in order to determine: i) the feasibility of arrangements for doing this; ii) farmers’ response to the price incentive; and iii) the disposability of beans of lower quality. Since Ghana’s export premium on world markets is sustained by the quality of its beans, there is considerable interest in mechanisms that can maintain bean quality.

A summary of the main institutional experiments undertaken by the IPs, and their immediate effects, is presented in Table 4.

The Contribution of TGPI

We have indicated that TGPI supports within-case analysis of evidence that allows reasonable attribution of change and its effects to identified causal processes. It draws on well-established longitudinal, ethnographic practices (Hoholm and Araujo, 2011). We have also indicated that TGPI, to a considerable degree, also supports between-case analysis, in that it allows regularities and patterns to be observed and analysed for a small-N sample, generating ‘lessons’ that can be extrapolated (applied) with caution to similar situations and purposes, and used to generate hypotheses in new situations (interpolated). Our experience suggests that TGPI is well suited to situations where there are presumed to be interactive effects over space and time between actions

and context, and path dependence (Bennett and Elman, 2006), and where the researcher is interactive with the context. We have found that its limitations include the following:

- Observations cannot simply ‘include everything’. There must be explicit prior selection of what types of data to register (risking a decision that might, in retrospect, exclude the very processes that turn out to have explanatory power), and of where the boundaries are to be drawn around what counts as ‘context’;
- If interpreted literally, continuous real-time observation swamps the researchers’ capacities to register and analyse data. The period chosen for data registration means that some of the information is not recorded as processes happen. Retrospective documentation does not have equivalent status to continuous data monitoring.
- Even within agreed protocols for what data to register and when, each researcher is left pretty much on their own to make acts of selection and judgement. This means that care must be taken to make transparent the basis of such choices (especially because the research associates were not engaged full-time in this work).

TGPI has also been criticized for its presumed costs. The approximate figures extracted from the CoS-SIS programme’s financial records are as follows:

- €7,500 (US\$10,000) operational costs per year per IP;
- €3,100 (US\$4,000) in allowances per year per part-time research associate;
- €3,500 (US\$4,750) per year for each research associate’s functional costs;
- €45,500 (US\$61,000) scholarship per PhD student per year (WUR carried the coursework costs, whenever the students were in The Netherlands);
- €32,300 (US\$44,000) per PhD for field and laboratory work, and experiments, over 3 years.

By way of comparison, the Swedish University of Agricultural Sciences estimates a full PhD scholarship at €239,000 (US\$324,000), while *icipe* (the International Centre of Insect Physiology and Ecology, based in Nairobi, Kenya) estimates a full PhD scholarship at €250,000 (US\$334,000). Thus the research costs of the design adopted by CoS-SIS seem well within the normal range of expectation.

Discussion

Grindle (2011: 417) posed a number of questions that empirical research based on process inquiry has to answer: does it lead to better decisions about what to do and how? Does it identify important constraints and next steps? Does it provide effective guidance on what is likely to work, and what is not, in terms of reform of policy and institutions? Does it indicate what has to be changed, can be changed, and is resistant to change? And, where the constraints have been removed, mediated or by-passed, have the results in fact been better (however better is defined)? We examine the first three questions in turn below (see page 118).

Table 4. Summary of main institutional experiments, CoS-SIS, 2011-2012

| Agro-enterprise domain | Focus | Effects | Focus | Effects | Focus | Effects | |
|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Mali | | | | | | | |
| Sheanut | Searching for micro-finance loan to bypass gender and procedural blocks to accessing bank credit for women's co-operative in an indigenous sector disregarded by banking interests. | Working capital enabled organization of harvesting, processing, marketing chain, and training to improve co-operative management. Loan re-paid in full, on time; after second loan re-paid, co-operative no longer needed loan support. | Changing co-operative membership rules to allow access to services and income by more women harvesters and processors. | | Membership increased; supply from non-members increased; collection and processing centres rationalized. | Changing harvesting advice and size of catchment areas to accommodate natural fluxes in nut yield. | Supply more stable, increase processing efficiency and secure market opportunity. |
| Crop-livestock integration, Office du Niger | Documentation, information sharing and public discussion of official and informal rules on cattle-keeping, herd movements and grazing to address causes of increasing conflict, violence and legal cases. | Interdependence and mutual interest recognized in developing and enforcing of local conventions; number of legal cases declined to almost zero; other incidents resolved at village level based on the negotiated conventions. | Local conventions presented to Office du Niger during negotiation of the next 5-year Contrat Plan; livestock and dairying recognized officially for the first time; conventions adopted into new Contract Plan; mayors outside the experimental area request similar assistance. | | Field experiments on inter-season fodder cropping, to support emergent dairy industry in association with private milk processing centre; results indicate significant income potential even for small-scale tenants. | | |
| Water management, Office du Niger | Joint field experiment to discover the productivity and income gains from carrying out 'obligatory' tertiary canal cleaning; discussion of the reasons why farmers do not comply with the rules, and of the effects of status and power of richer farmers. | Farmer organizations begin to motivate and organize members to clean canals and sanction non-participants to reduce 'free rider' effects; rice harvest increases; other issues are surfaced. | Based on issues raised, joint field surveys of the negative effects of the application of tenancy rules, sanctions and fees imposed by Office du Niger were initiated; discussion of findings with farmer organizations and Office du Niger. | | Application of official rules and procedures adjusted; changes adopted into provisions of new Contract Plan. | | |
| Benin | | | | | | | |
| Cotton | Measuring effect of seed choice on farmers' income when payment is based on weight of seed cotton; researchers engaged in participatory variety testing with farmers. | Promotion of a new variety that optimizes seed cotton weight and lint; opportunity for farmers to multiply own seed, by-passing malfunctioning official supply system. | By-pass of malfunctioning official input system and pest management controls by supporting and training women's groups to produce neem oil; researchers conduct efficacy tests and initiate registration procedures. | | Women's groups producing, promoting and selling neem oil in increasing quantities; private sector cotton gin entrepreneur offers to promote use of neem and integrated pest management (IPM) as standard practices, as soon as registration process completed. | | |
| Oil palm seed system | Sharing of information from field surveys concerning malpractices in existing seed system, and the technical and organizational challenges of securing integrity in the system, with all actors. | Discussion about the information helps to create shared norms, reduce mistrust and motivate willingness to work together to build a seedling system with integrity. | Inventory made of locations of existing nurseries; training provided to existing and new nursery owners/workers; new register and licensing of all seedling nurseries. | | Spatial gaps closed in nursery coverage; organization of value chain between research station and nurseries guarantees quality and reduces buyers' risks. | | |
| Ghana | | | | | | | |
| Cocoa | Generating and sharing information on: (i) timing of harvest periods consequent on widespread planting of new varieties; (ii) price composition for cocoa in Ghana, and other West African producer countries, showing margins for adjusting the prices paid to farmers. | Adjustment in timing of annual announcement of prices paid to farmers; higher price payments for farmers; input supply and mass spraying costs identified as major cost elements in price formation. | Analysing the technical and organizational scope for changing the input supply and pest management systems. | | Information contributed to government decision to progressively privatize input supply and pest management; adopt IPM as standard practice. | Pilot testing of effects of incentive pricing on farmers' delivery of export quality beans and on behaviour of Licensed Buying Companies. | Analysis motivates further testing of differential pricing. |
| Palm oil | Information is presented to local government showing the harmful effects on health, environment and oil quality of local palm oil of processors' use of old tyres as fuel. | Local government adopts new by-law to ban the use of tyres as fuel, and regulate the location of processing centres. | Testing of processing waste as a fuel demonstrates its cost-effectiveness; local processors are supported to adopt local 'best processing practices' based on a study of the effects of duration of fruit storage on quality, and lab analysis of oil quality. | | New income opportunities are created for selling waste products of oil processing; local processors are shown to be able to achieve export quality palm oil; negotiations are opened with Export Promotion Council and entrepreneurs to supply export quality oil. | Local processors decide to organize themselves to meet export delivery targets and standards, register a co-operative, and take a loan to up-grade their processing equipment to meet volume and cost-efficiency goals; domestic market opportunities for oil of different qualities also increase. | |

Source: TGPI data, 2011-2013; Akpo (2013); Quarmin (2013); Osei-Amponsah (2013); Sidibé (2013); Togbe (2013); Struik and Klerkx (2014)

Does TGPI lead to better decisions about what to do and how? Does it identify important constraints and next steps? The evidence provides a strong case for concluding that it was the combination of scoping and diagnostic studies, TGPI, and institutional experiments that enabled members of the IPs and the national programme teams to function as champions of socio-technological and institutional changes. That is, the innovation processes recorded by the research associates were *research-driven in the context of a new kind of social arena that enabled diverse actors to make effective collective demands for research-based information and to make use of the information generated*. Since longer-term impacts have not yet been recorded or assessed, we cannot claim that the decisions and actions were ‘better’, beyond the intuitive sense that if, for instance, cocoa farmers receive higher payments, they are presumably ‘better off’. We can claim that the documented immediate effects are positive for smallholders and for the efficiency and effectiveness of the systems of interest. The way in which members of the IPs became actively engaged in searching for transformative responses to the challenges constituted in the context seems comparable to others’ experiences of ‘research for innovation’ (Lessem and Schieffer, 2010).

Has this way of performing research provided effective guidance on what is likely to work, and what is not, in terms of reform of policy and institutions? The answer here is clearly ‘yes’. By working explicitly on what has to be changed, can be changed, or by-passing what is resistant to change, significant new opportunities have been opened up in each agro-enterprise domain. While the IPs, as platforms that created new social spaces in which to deliberate and guide innovation processes, are the most noteworthy intervention created through the programme, we also acknowledge the contributions of individual IP members, the members of the national programme teams, the national coordinators and the regional coordinator, as champions, using their own networks of influence in the transitions documented by the programme (Klerkx et al., 2013). We further note that the destabilizing effects of other events in the regime – such as the Presidential intervention in the cotton sector in Benin – mean that IPs cannot be seen to offer automatic solutions to messy problems.

We further argue that while there is evidence, for each domain, to support substantive recommendations for policy and practice, when we aggregate the evidence for the IPs’ performance what stand out are the processes and procedures adopted. This resonates with the traditions in political philosophy that favour procedural over normative policymaking. Debates about this balance stretch back to Solon of Athens, and have been debated heatedly again since the late 18th century in the UK, European continent and the Americas (Elster, 2013; van Middelaar, 2013).

How, and under what conditions and purposes, do novelties become stabilized in socio-technical regimes? The ‘how’ was not prescribed in advance. The IPs in each case have *learned* their way to: i) moderating the effects of bias, arbitrary use of power, inefficiencies and ill-informed decisions that block opportunity for smallholders; and ii) creating the impetus for well-grounded decisions and actions to bring about institutional changes that open access to existing opportunities, or create new ones for smallholders.

The detailed information on the IPs' individual experience of 'how' will soon be presented (*Cahiers Agricultures*, in prep.). However, we have provided a partial synthesis in this chapter that suggests the following:

- Pre-existing tensions might be replicated in the membership of an IP, or might emerge as individuals seek to take self-interested advantage of the opportunities that develop or protect their existing interests. The tensions can be managed through skilful facilitation.
- The 'how' is not a pre-determined pathway. It is the diagnosis of the starting situation in the context of the domain of interest, and the purposes and entry points that members of an IP (and any supporting programme) set themselves on the basis of the diagnostic studies that begin to inform the path taken.
- The generation and sharing of a flow of information among diverse actors, and at a range of levels, iteratively determines next steps in the process of purposeful change.
- Effort to achieve open communication, transparent procedures and agreed norms of interaction are needed to create sufficient trust among members to support the functioning of an IP. This is not a 'starting condition' but an emergent property of facilitation and knowledge management efforts.
- Novelties can be created anywhere in a hierarchy of governance. IPs need to be situated in an innovation space that has potential in the context to lever the novelties that benefit smallholders, into changes in the institutional regime. The aim is to normalize such novelties in routine practice, procedures, regulations, administration, organizational arrangements, and so on.
- IPs also can work directly on changing the existing regime, on the basis of evidence showing how the system as a whole loses from the prevailing situation (although a privileged few might benefit), and proof from institutional experiments that alternative arrangements are achievable and beneficial.
- IPs are not a cure-all for governance failures. They function optimally, and their effects are sustained, to the extent that there is stability in the overall political system (or by-pass strategies can be arranged).

Conclusion

The research effort undertaken by CoS-SIS indicates that there is another way of thinking about, researching and achieving scale effects with domain-wide impact in smallholder agriculture. Research can be organized cost-effectively so that it supports processes of innovation, shared learning, and capacity-development, and yet still generates data and information of sufficient rigour to support policy processes and governance of agriculture in ways that benefit small-scale farmers and processors.

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Chapter 10

RESEARCH AND EXPERIMENTATION IN SUPPORT OF ARTISANAL PALM OIL PRODUCTION IN GHANA

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Abstract

Artisanal palm oil production is a major source of livelihood, especially for many rural women in Ghana who face challenges in meeting the quality standard for crude palm oil. High levels of free fatty acids prevent artisanal processors from accessing remunerative markets. This chapter highlights how joint experimentation and multi-stakeholder interactions within the context of the Convergence of Science-Strengthening Innovation Systems (CoS-SIS) programme were used to bring about improvements in palm oil processing. A local stakeholders' platform facilitated access to training opportunities on processing. An innovation platform (IP) comprising members drawn from both the district and national levels dealt with higher-level institutional constraints that impacted on quality palm oil production. The multi-scale stakeholder approach used by the researchers ensured the flow of knowledge at different levels; between and among the artisanal palm oil processors, the farmers, scientists, extension service providers, buyers and policymakers. The paper concludes that a multi-scale approach is effective in creating space for multiple stakeholders to interact, co-learn and innovate to improve processing and product quality and derive socio-economic and environmental benefits from artisanal palm oil production in Ghana.

Keywords: Quality, Innovation platform, Institutional constraints, Co-learn, Socio-economic benefits

Introduction

Research and development (R&D) in artisanal oil palm processing usually is primarily technically oriented and only addresses a specific constraint (Li, 2007; Adjei-Nsiah et al., 2012). However, the constraints to rural development and enhanced livelihoods are multi-faceted and complex, as they are socio-technical as well as institutional. An approach is needed that allows the constraints to be addressed in an integrated manner.

Alternative ways are needed to agricultural research and decision-making (Hounkonnou et al., 2012). Scientific knowledge alone cannot provide effective solutions; hence the involvement of

multiple stakeholders in the research process is needed to provide suitable options and shared ownership (Leeuwis and van den Ban, 2004; Lang et al., 2012). Diop (1992) and Richards (1985) offer examples of how local people's knowledge, extension and formal science have interacted productively. According to Thompson (1991), if local knowledge and stakeholders' capabilities are blended with scientific knowledge and approaches, an effective and lasting result can be achieved. The CoS-SIS programme offered a transdisciplinary approach to agricultural R&D.

Palm oil is a key ingredient in the diet of many Ghanaians and also an important industrial raw material. Small-scale farmers produce about 87% of the fresh oil palm bunches in Ghana. These are purchased by artisanal processors, usually women organized around semi-automated '*Kramer*' mills (mostly owned by men) for the production of crude palm oil (CPO). The small-scale operations produce between 60% and 80% of Ghana's CPO (GoG, 2010), but it is of poor quality mainly due to high levels of free fatty acids (FFA) (Osei-Amponsah et al., 2012). A high level of FFA is undesirable as it leads to a rancid taste and lower prices, and increases the cost of refining (Gibon et al., 2007). It also limits access to local industrial and export markets because the oil does not meet the required standards. In addition to the limited access to remunerative markets, the artisanal enterprise also poses an environmental challenge because of the unmanaged polluting effluents and poor air quality from the use of car tyres as fuel for boiling the fruits.

Ghana is also a net importer of high quality CPO; in 2012, it imported about 160,000 t (Index Mundi, 2013) suggesting that domestic demand for high quality CPO exists (GoG, 2010). To explore and exploit this market opportunity, it is necessary for artisanal processors to improve processing practices to meet the quality standards. According to Chandra and Osario-Rodarte (2007), improvements in the oil palm enterprise can be a major force for poverty reduction and rural development in the tropics. Few technical and institutional innovations have been introduced over the last decade and the artisanal processors receive very little support. This chapter is based on Osei-Amponsah et al. (2012) and Osei-Amponsah et al. (2014), and profiles PhD research which investigated how artisanal oil palm processing can be improved to enable small-scale producers in Ghana to access remunerative markets.

Methodology

The research is situated within the CoS-SIS action research programme, which aimed to experiment with ways to create enabling institutional contexts for sustainable productivity and improved livelihoods for smallholder farmers (Houkonnou et al., 2012; Jiggins et al., 2016). The programme roughly followed five main stages: exploratory and scoping studies; diagnostic and baseline study; participatory action research; facilitation of a Concertation and Innovation Group (CIG), also referred to as an IP by a post-doctoral research associate; and, monitoring and evaluation of the change process. Data collection and analysis are also presented.

Exploratory and Scoping Studies

The research activity started with an exploratory study of the oil palm sector by the research associate in one district from each of the Ashanti, Western and Eastern Regions of Ghana. This study identified constraints and opportunities in the oil palm industry in Ghana (Adjei-Nsiah

et al., 2012). This was followed by a scoping study in the Kwaebirem district of the Eastern Region to validate the findings from the exploratory study (Adjei-Nsiah et al., 2013).

All the constraints identified were categorized as social, technical and institutional issues and prioritized by various stakeholders for further R&D intervention at a specially convened workshop. The major challenge identified was 'poor access to remunerative palm oil markets', linked to the poor quality of CPO. This topic was chosen as the entry point for the diagnostic and baseline study and the lead problem for the doctoral research.

Diagnostic and Baseline Study

The diagnostic study was done in six purposively selected palm oil producing towns (Asuom, Otumi, Subi, Kade, Kusi and Takrowase) in the Kwaebirem district. It sought to understand and analyse opportunities and constraints, and to gather baseline information on the artisanal palm oil enterprise (Osei-Amponsah et al., 2012). It was found that artisanal processors store loosened fruits for periods of up to 4 weeks after harvest (medium and large-scale mills process fruits within 48 hours) and used car tyres for boiling fruits. Artisanal processors were also not linked to key stakeholders in the industry. The findings were validated at a local stakeholders' workshop, following which experimental activities were planned.

Participatory Action Research

An action research, or 'learning-by-doing', methodology was used. Action research involves collaborative research with scientists, practitioners and service users (Chambers, 2008) and creates space for bringing about change which is usually achieved through experiential learning (Kolb, 1984; Malinen, 2000). A joint experimentation group and a local stakeholders' platform were created to facilitate knowledge sharing (tacit and codified) for the purpose of experiential and peer learning.

At an artisanal mill owned by Enye Mahooden located in Takrowase (one of the study towns), a joint experiment was carried out between February and April 2011 to assess the association between the length time the fresh fruit was stored and the variation in CPO quality and yield. The mill owner was the leader of the group that also included a technician and scientist from the Oil Palm Research Institute of the Council for Scientific and Industrial Research (OPRI-CSIR), an extension agent from the town, two processors, two mill workers and the researcher. In addition, similar, but researcher-managed experiments on the variation of storage periods of fruits in relation to the quantity and the quality of palm oil, were conducted at different artisanal mills in Kusi and Kade. Three oil palm processing towns (Wenchi, Abaam and Abodom) in the district were purposively selected as control groups.

These experiments assumed that reduction in fruit storage period would lead to lower FFA level (and higher quality palm oil) and thus potentially contribute to meeting the standards required by major industries in local and export markets. The effect of four different fruit storage periods (3, 7, 14 and 21 days) on yield and FFA levels of the CPO produced, were studied. In the final phase of the experimentation process, the findings were presented to a stakeholders' platform workshop by the leader of the joint experimentation group.

Facilitation of the Two Platforms: Local Stakeholders and the CIG

A stakeholders' analysis was used to identify representatives from the various towns who were invited to the first stakeholders' workshop at which the research was introduced and the findings of the scoping study, discussed. A local stakeholders' platform was formed, based on those who expressed willingness to be part of the process. The initial participants (approximately 30) included representatives of oil palm farmers, artisanal processors, mill owners, caretakers, and mill workers (about 65% of them directly involved with processing); four research scientists (a breeder, an agronomist, a socio-economist, an entomologist) of OPRI-CSIR; an agronomist from the Forest and Horticultural Crops Research Centre of the University of Ghana, Kade; staff of the District Agriculture Development Unit of the Ministry of Food and Agriculture (DADU-MOFA) – the director, a Women In Agriculture Development (WIAD) officer, and four extension agents; a representative from the district assembly; the CoS-SIS research associate; and the researcher (the author). Later, participation grew to over 60 stakeholders when farmers, processors and mill owners, who were not initially invited, heard about the platform and decided to join. Six workshops were organized at Kade between March 2010 and November 2012.

The second stakeholders' workshop focused mainly on the validation of the findings from the diagnostic study. These included: specific activities to be carried out during the next phase of the research process which focused on the agreed priority issue; the effect of long fruit storage on palm oil yield and quality were also outlined and tasks were shared. The third, fourth and fifth workshops discussed the experimentation process and its findings. The final workshop was used as an exit strategy meeting to discuss all the outcomes of the research and what needed to be done as a follow up to the project in the district.

The CIG served as an IP. It was established to address higher level constraints facing artisanal processing that were beyond the control of the processors and to help to link them to markets. The CIG comprised representatives from both the district and national levels: oil palm farmers, processors, mill owners, Ministry of Food and Agriculture (from the district), Ghana Export Promotion Authority, Ghana Standards Authority, District Assembly, Environmental Protection Agency, and the Ghana Regional Appropriate Technology Industrial Service (at the national level), as well as the researcher, and the CoS-SIS research associate as facilitator. The CIG consisted of 10 members and the representation changed based on a person's importance in addressing a specific issue at a particular time. The CIG is different (in terms of membership and function) from the stakeholders' platform, which operated at the local level in Kwaebibirem district. In addition, the CIG organized sensitisation workshops to raise awareness on issues, and training workshops on good processing practices in the study towns.

Monitoring and Evaluating the Change Process

To understand the new roles of stakeholders, their attitudes, practices, levels of interaction and the learning that had occurred, reflective interviews were conducted with members of the experimentation groups, some platform members and officials of the governmental organizations involved in the oil palm enterprise. Reports of these interviews were analysed to track changes in the interactions among the stakeholders with reference to the baseline information. *Ex-ante*

and *ex-post* FFA levels were also done and comparisons made between experimental and control groups (see section below).

Data Collection and Analysis

Information was gathered through key informant and personal interviews, focus group discussions, and surveys using semi-structured questionnaires. The narrative information gathered was ordered by teasing out keywords, which helped to explain important issues and was also used as a means of identifying gaps for additional interviews in order to expand the details of the analysis. At the beginning and end of the study period, palm oil samples from different mills were collected from the experimental (same processors as in baseline), and control groups of processors to assess the *ex-ante* and *ex-post* FFA levels. The American Oil Chemists' Society's official method and recommended practice Ca 5a-40 (AOCS, 1990) was used to analyse FFA levels of the samples collected. The mean FFA levels and percentage palm oil yields, the comparison of the mean differences between the yields for three different extraction equipment, and different storage periods were analysed using SPSS statistics software (version 16).

Alongside the joint experimentation, a parallel researcher-managed replication experiment was carried out with three different oil extraction machines. Both experiments tested the effect of four different storage periods (3, 7, 14 and 21 days) after bunch harvest on yields and quality (FFA levels) of palm oil produced. Using the value of palm oil yields, the profitability for producing 1 t of palm oil for each of the four storage periods, at prevailing market prices was estimated, using different market prices based on the FFA levels attained for each storage period.

Results and Discussion

Learning from the Joint Experimentation

It was evident from the joint experimentation that yield increases up to a fruit storage period of 14 days, after which it decreases with longer storage. On the other hand, FFA levels increase sharply the longer the storage period is and quality decreases. Some processors tried their own experiments to find out which period gave them the highest oil yield for the same quantity of fruits normally processed. They found that the maximum palm oil yield point occurred at 10 days. At this stage in the learning process, focus shifted to how to reduce FFA levels and maximize yields of quality CPO, as the CIG facilitation on improving access to new markets had not materialized.

For all storage periods, production of CPO was found to be non-profitable for the informal Nigerian and Togolese markets that artisanal processors operated in. However, CPO production up to a 7-day storage period was the most profitable for oil sold for the local consumer market. Also, if produced at 3 days after fruits were harvested, CPO could be sold at a profit to the local industrial or export market, however production needed to be made more efficient; the current technology processors use makes loosening of the fruits difficult.

Emerging Institutional Changes

Four main institutional constraints were addressed namely: the practice of pre-processing fruit after long-term storage; limited knowledge sharing and interaction among key actors; lack of a regulatory framework and the use of tyres as a fuel source for boiling oil palm fruits; and poor access to remunerative palm oil markets.

At *ex-ante*, 91% of processors from the six study towns had never received technical training and/or attended a workshop on improving processing practices. Most processors (73%) stored fruits between 14 to 28 days at the mills. The *ex-post* survey showed that about 75% of processors in the experimental group stored fruits for shorter periods (1-2 weeks) compared to 36% of processors in the control group.

Following the stakeholder mapping exercise, it was found that the artisanal processing enterprise comprises a variety of actors at different institutional scales. At *ex-ante*, it was found that strong interactions existed among the processors and their mill workers, farmers, mill owners, local buyers, Togolese palm oil buyers and Nigerian agents. These strong interactions ensured an effective flow of information on prices of fruits, palm oil, processing practices and immaterial resources (e.g. attending and supporting activities at the funerals of bereaved families). This was the status quo in the enterprise at *ex-ante*. The DADU-MOFA, which is responsible for agricultural development in the district, and especially its WIAD officer, responsible for collaboration and dissemination of information on good processing, did not have the resources to link up with processors. OPRI-CSIR was mostly engaged in providing high yielding oil palm planting material for sale to farmers, but did not have the facilities to provide technical advice to artisanal processors for producing high quality CPO. The district assembly responsible for the enactment of by-laws on undesirable processing practices and environmental pollution had no links with the processors. Change was triggered by the options for accessing new markets, which implied the need to upgrade processing practices, use environmentally sustainable production methods, and enhance interaction among all stakeholders for knowledge sharing and uptake.

A second mapping exercise, conducted at the end of the study, revealed emerging interactions between the processors on the one hand, and the district assembly, traditional chiefs, the DADU-MOFA and OPRI-CSIR, on the other. Also, a newly created CIG linked with processors to help them access markets and stop burning tyres for fuel. The baseline showed that 86% of processors in the study towns used tyres for boiling oil palm fruits as opposed to 72% of all respondents post intervention, who use fibre cake and kernel shells as the main fuel source. Car tyres were only used by 2% of respondents in the control group.

Improved Quality of Palm Oil an Initiative to Increase Market Access

Overall, the quality of palm oil, in terms of FFA levels, from the experimental group showed much improvement; 20.4% *at ex-ante* to 11.4% (Table 1) *at ex-post*, compared to 19.6% for the control group. The FFA content was substantially reduced, although it still remained above the 5% (PORAM, 2011) desired by industries. The results suggest that further training of processors is needed for improving quality of CPO, but this is not a sufficient condition for accessing high value markets.

Table 1. Average concentrations and standard errors of free fatty acids (FFA in %) of CPO samples obtained from the overall experimental (*ex-ante* and *ex-post*) and control groups in Kwaebibirem district

| Groups (n=9, for each group) | Overall mean and standard errors of FFA concentrations (%) |
|------------------------------|------------------------------------------------------------|
| Experimental <i>ex-ante</i> | 20.4 ± 1.64 ^{a[1]} |
| Experimental <i>ex-post</i> | 11.4 ± 0.85 ^b |
| Control | 19.6 ± 1.56 ^a |

[1] Means followed by different superscripts are significantly ($P < 0.05$) different.

Conclusion and Recommendations

The joint experimentation created space for interaction and learning about processing practices, as well as for improving palm oil quality. The most effective learning takes place within trusted relationships (Vernooy et al., 2007). Collaboration between the local stakeholders and CIG created space for artisanal palm oil producers, governmental and research stakeholders to engage with each other and to set up a more inclusive agenda for improving the enterprise which kept the stakeholders (especially processors) active in the learning process over a 2-year period. The study concludes that it is profitable for processors to improve CPO quality by reducing fruit storage periods for accessing the national local consumer market and remunerative local and regional soap markets and eventually, the national industrial and export market.

Institutional constraints, such as lack of access to markets, may serve as a disincentive for innovation in the palm oil enterprise. Indeed, in the processors' window of opportunity (i.e. given their existing market outlets), they saw that enhancing CPO quantity, even if it was of inferior quality, was their best option at the time as there was no immediate opportunity to tap into the higher value market for quality oil. This means that key stakeholders such as the DADU-MOFA, the millers' association and the CIG should explore food consumer markets (schools, hotels, restaurants and individual consumers), and assist the interested processors to link up. In this case, there is a need to link artisanal processors to a wider market through the interconnected set of technical and institutional changes that enables them to produce high quality CPO.

Using a case study approach of the *ex-ante* and *ex-post* situation of the enterprise, the quality of CPO from a sample of processors who had been involved in the research had improved. In addition, institutional changes occurred due to the joint experimentation and the formation of a local stakeholders' platform, which enhanced interaction among the representatives of the research institute, government extension service and mill practitioners, especially processors, something which did not exist before. Also, processors at the local level, and the CIG, collaborated to stop processors from using car tyres as a fuel source for cooking oil palm fruits.

Different models of information sharing and interventions were found to be necessary and to complement each other to address varying levels of institutional constraints. The multi-scale stakeholder approach used in the research ensured the flow of knowledge, for example among mill practitioners, within the scientific or extension community, and also among practitioners, scientists and the extension service. The artisanal palm oil processing enterprise is able to innovate if relevant stakeholders (are willing to) interact, learn to overcome constraints and create opportunities, and change institutions, which negatively affect the enterprise. The processors have discovered new knowledge through participating in this research for producing quality CPO. They also know of new options for markets and possibilities for diversifying CPO production based on the quality requirements of a particular market. The artisanal processors are therefore in a position to make better-informed decisions about their production activities and own the process of improving and expanding their livelihood options.

They have not started selling to local industrial or export markets, but they have acquired the skills and capabilities to produce high quality CPO to meet these market requirements. Along with the CIG's facilitation activities to help processors link up with new buyers, some processors on their own have made contacts with CPO exporters and with individual consumers in Ghanaian cities. Others also produce relatively high quality palm oil for restaurants, schools, hotels and special customers in Nigeria at higher prices. These are signs of success in implementing change. In this case, production of quality CPO for remunerative markets also depends on the capability and willingness of processors to make use of available windows of opportunity. At the time of writing, some processors had produced samples of palm oil, which met the required standards based on quality analysis by buyers from Italy. The CIG, the processors and these buyers were negotiating the price of CPO produced according to these quality standards. However, the new market comes with new networks, bureaucracy and complexities. These are challenges the CIG must be mindful of and be ready to help processors cope, as they learn to negotiate a space in this new arena.

Trans-disciplinarity is recommended as the more appropriate approach to research aimed at agro-processing and rural development projects to create space for multi-stakeholder interaction as a co-learning hub for innovation. Scientists from the OPRI-CSIR in the Kwaebibirem district now have the opportunity to interact closely with farmers and processors and have started incorporating some aspects of the CoS-SIS methodology in their research activities. It is recommended that the scientists, who have followed this research process, should set up a small unit to train other scientists who want to do trans-disciplinary research, and to sustain their interactions with the processors, farmers and mill owners.

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Chapter 11

INNOVATION PLATFORM AND PRICING POLICIES: THE CASE OF COCOA IN GHANA

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Abstract

The cocoa economy in Ghana is built on small farms, hard labour and low returns. The rural population has one main concern – harvesting the ripe cocoa and selling the dry beans to a licensed company (over 25 private companies now buy the crop in all the areas of the country where it is grown). The Ghana Cocoa Board (COCOBOD) pays these traders a minimum producer price as well as a commission to cover the buyers' operating and transportation costs, and to provide some profit. But Ghana's cocoa farmers are not making the best use of technological innovations to improve production because of a number of institutional constraints including price (dis)incentives. Low producer prices impede growth and sustainable cocoa production as smallholder farmers are discouraged from making productivity enhancing investments. An examination of the pricing mechanisms in Ghana's cocoa sector by the Concertation and Innovation Group (CIG), under the Convergence of Science-Strengthening Systems of Innovation (CoS-SIS) research programme, eventually allowed this innovation platform (IP) to substantially affect the prices paid to farmers and the times in the year when these were announced, and to initiate measures that increased transparency and reduced deductions for government programmes.

Keywords: Mechanisms, Technological, Productivity enhancing investments, Transparency

Introduction

Cocoa is the chief agricultural export of Ghana and the country's main cash crop. After Côte d'Ivoire, Ghana is the second largest cocoa exporter in the world (Salm and Falola, 2002). Cocoa cultivation is not native to the country; however, Ghana's system, is one of the most modelled in the developing world (Bulir, 1998).

Cocoa production occurs in the country's forested areas mainly: the Ashanti, Brong-Ahafo, Central, Eastern, Western and Volta Regions, where rainfall is 1,000-1,500 mm per year. The crop year begins in October, when the main purchases begin, with a smaller mid-crop cycle beginning in July. All cocoa, except that which is smuggled out of the country, is sold at fixed prices to the COCOBOD. Processed cocoa in the form of natural cocoa powder, chocolate and beverages are sold or exported independently by a number of local processing companies.

Cocoa production is mainly carried out by smallholder farmers (800,000 households) (Adu-Acheampong, 2009), and although Ghana was the world's largest cocoa producer in the early 1960s, by the early 1980s Ghanaian production had dwindled almost to the point of insignificance. The drop from an average of more than 450,000 t per year to a low of 159,000 t in 1983-84 has been attributed to aging trees, widespread disease, bad weather, and low producer prices. In addition, bush fires in 1983 destroyed some 60,000 ha of cocoa farms, so that the 1983-84 crop was barely 28% of the 557,000 t recorded in 1964-65. Output then recovered to 228,000 t in 1986-87. Revised figures show that production amounted to 301,000 t in 1988-89, 293,000 t in 1990-91, and 305,000 t in 1992-93. After declining to 255,000 t in 1993-94, the crop was projected to return to the 300,000 t range in 1994-95. Ghana's market share of the commodity is 21% of the total world volume. Annual production averages 250 to 400 kg/ha, which is among the lowest in the world compared with 580 and 770 kg/ha for Côte d'Ivoire and Indonesia, respectively.

Production constraints include low prices, land tenure arrangements lowering profitability, limited farmer access to credit, poor availability of affordable and timely inputs, inadequate technical extension support, weak organizational capacity of farmers (linked to low literacy rates), and poor farmer representation at policy levels. Low producer prices impede growth and sustainable cocoa production as farmers are discouraged from making productivity enhancing investments (World Bank, 2011). Ghana's production level increased by about three times over 30 years (between 1980 and 2010) due to COCOBOD interventions to improve disease and pest control and soil fertility, and rehabilitate moribund farms. But the key to sustainable cocoa production also rests on policies adopted with respect to cocoa producer price incentives and other macro-economic instruments, such as exchange rates, export taxes, inflation and government interest rates.

This chapter examines the cocoa pricing policy as studied by the CIG of the action research programme, CoS-SIS, in Benin, Ghana and Mali, and highlights the means to increase production through provision of better incentives and welfare-enhancing schemes to improve farmers' living standards. Levying cocoa farmers for export tax, and industry costs are also discussed.

Cocoa Pricing Reforms

Following the economic crises of the 1970-80s, the government of Ghana instituted a number of liberalization reforms (in 1979) focusing on controlling the industry through the Cocoa Marketing Board. This was later dissolved and reconstituted as COCOBOD. The reforms were primarily price and cost related, i.e. who sets the price, what cost variables were used in the computation, and by what mechanisms.

History of Pricing Reforms

Young et al. (1981) reported that prior to 1945 prices were fixed by negotiations between farmer-cooperatives and multi-national cocoa buying companies, notably Cadbury. Major changes were instituted after the First and Second World Wars, which brought in their wake falling global prices. These price reductions were invariably passed on to smallholder farmers whose income levels dwindled, leading to numerous agitations at the labour front. Britain (the colonial administration at the time) addressed the problem through the then Cocoa Marketing Board with a view to addressing farmers' concerns and stabilizing their incomes. The account of the reforms by Young et al. (1981) was further elaborated by Quarmin (2013), as summarized in Table 1.

Fixing of the price for smallholder cocoa producers is now among the many functions of COCOBOD. Until 1984, pricing decisions were mainly determined by the board with the approval of the central government (Amoah, 1998). Subsequent reforms included participation of multiple actors including representatives of farmers, the licensed buying companies, the Ministry of Finance and Economic Planning, universities, government officials, hauliers, input suppliers, and COCOBOD in employing scientific approaches to determine producer prices. The objective was for producer prices to have a closer relation to the costs and margins of other actors in the supply chain, and to be at levels that motivated farmers to produce higher quality cocoa beans.

Between 1998 and 1999, the Producer Price Review Committee (PPRC) sought the views of farmers and other stakeholders to negotiate for the best prices and margins on the basis of what they had received the previous year. From 2000, the government sought to progressively increase the share of the world price for farmers. The PPRC subsequently introduced a new formula based on a percentage of the net freight on board (FOB) (net free-on-board, FOB) price COCOBOD received when exporting cocoa. The calculation involved projecting COCOBOD's gross revenue and then deducting a number of industry-related costs, as explained in Table 2. The calculated percentage of the FOB that farmers receive is supposed to cover their costs plus profit.

Table 1. Price related institutional reforms in Ghana's cocoa sector, 1960-present

| Period | Objective of price policy | Who sets the price | How are prices determined (rules) |
|--------------|-----------------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 1960-1983 | Maximize government tax revenue | Mainly COCOBOD | <i>CPrice mechanism:</i> Based on world price, farmers' expectation, government revenue, target etc. |
| 1984-1998 | Achieve positive real producer prices | Multi-stakeholder PPRC | <i>COP mechanism:</i> Estimation of average cost of production (COP) and setting price to ensure 20% profit margin |
| 1998-2000 | | Multi-stakeholder PPRC | <i>Negotiation:</i> Farmers negotiate prices with PPRC based on previous amounts received |
| 2001-present | Maintain net FOB price of more than 70% | Multi-stakeholder PPRC | <i>FOB mechanism:</i> Industry costs are deducted from net COCOBOD revenue. A proportion of the remainder, net FOB, is what farmers receive |

Source: Quarmine (2013)

The CoS-SIS CIG

The CIG (IP of key actors) operates at the national level. However, its actions are expected to influence behaviour at farmer level. The CIG has been addressing institutional and technological constraints and opportunities related to pricing in Ghana's cocoa sector. Actors were drawn from along the cocoa value chain (Figure 1). Current membership are high ranking officials at COCOBOD and its subsidiaries, the policy advisor to the Minister for Finance and Economic Planning, a farmers' representative (Paramount Chief with many sub-chiefs), the managing director of the Cocoa Input Company, high officials representing the licensed buying and processing companies, and a quality assurance officer heading the pesticide residue laboratory of the Ghana Standards Authority. The focus of the original entry point (quality-price differentiation) has changed to reflect what the CIG deems more pressing, i.e. examining the cocoa pricing policy to ensure aggregate price increase and income equity for all cocoa farmers. Numbers, positions in organizations and roles of CIG members have changed over time and this has generally worked to the CIG's advantage. The roles of various actors in the CIG are presented by Klerkx et al. (2013).

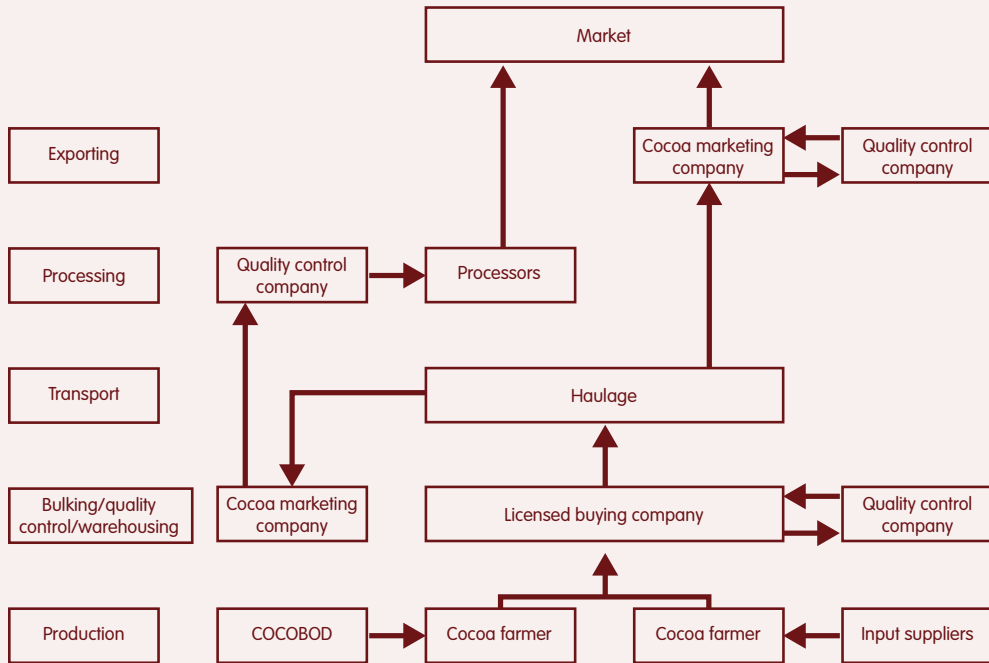


Figure 1. Ghana's cocoa supply chain map

Source: World Bank (2011)

Activities and Findings

Internal Cocoa Marketing in Ghana

The cocoa marketing process begins with the farmer and ends with export by COCOBOD as the cocoa marketing system is not fully liberalized. Some 28 COCOBOD-regulated licensed buying companies (LBCs) buy quality cocoa beans from farmers at a fixed price set by the PPRC. The LBC's receive a commission (9%), which is based on supplied cocoa volumes. At the start of the cocoa season (October each year), based on market share, LBCs receive a soft loan from COCOBOD. Increasing competition pushes LBCs to offer incentives to gain farmers' loyalty and obtain access to their cocoa. Unfortunately, LBCs cheat farmers by adjusting weighing scales, forging records in passbooks, and only partially paying farmers' bonuses. In fact, the passbooks of nearly 60% of cocoa farmers are kept by purchasing clerks of the LBCs.

Negotiating the Cocoa Producer Price Through the CIG

The CIG gathered pricing information from Cameroon and Côte d'Ivoire. In Côte d'Ivoire, there are three price regimes: (i) farm-gate prices are the household prices that roaming collectors

pay farmers and these are calculated as the average price across the six regions; (ii) indicative farm gate price is established by the government each crop season, which is used only for general guidance of farmers and is not enforced; (iii) export prices are discounted world prices set by exporters as a function of cocoa future prices on international markets, and depending on the quality of cocoa beans each season, this can be lower or higher than the world average.

The pricing policy employed by Ghana, however, is based on an artificially-set proportion of the FOB price and not based on real costs. This leaves unspecified how the FOB price translates into domestic currency. COCOBOD sets a producer price in cedis (the national currency) which, given prevailing world cocoa prices and exchange rates, meet the specified target percentage of FOB. The government, being anxious to raise its revenue the following year, might devalue the cedi, thus raising the export value of cocoa in cedi, which reduces the real value of the cocoa producer price. Usually, COCOBOD pays cocoa farmers a given percentage of the finally realized export price as a bonus if the cedi is devalued or world prices improve. Because of international quality differences, Ghanaian cocoa is usually exported at a premium, generally not exceeding 10% of the world price. Following the reforms of the 1990s, COCOBOD aimed to pay at least 70% of the FOB price after deduction of industry costs, which include the supply of inputs under the national Cocoa Disease and Pest Control programme, CODAPEC. Information gathered by CIG based on calculations using the FOB price (Table 2) indicated that the majority of cocoa farmers do not benefit from the spraying programme, and their disposable incomes are seriously eroded by repeated rising of input and labour costs, inflation and depreciation of the cedi.

Table 2. Variables in the FOB price calculation for the Ghana cocoa sector

| | |
|-----------|-------------------------------------------------------------|
| GR | Gross revenue figure |
| NR | Net revenue or net FOB projected crop size = PCS |
| FOBP (FP) | FOB price |
| ER | Exchange rate |
| PFS | Part of PCS as forward sale = 60-70% of PCS |
| TRFS | Total revenue of forward sale |
| IC | All industry related costs for jute sacks, stencil ink etc. |
| CC | CODAPEC costs |
| HTC | Fertilizer costs for Hi Tech |
| CSS | COCOBOD scholarship |
| FS | Farmers share |
| ASH | All other stakeholders |

Let PCS = 100% and PFS = 60% PCS

$FOBP = TRFS \div PFS$

$GR = PCS \times FOBP \times ER$

$NR = GR - (IC + CC + HTC + CSS)$

$NR = 100\%$, $ASH = 30\%$

$FS = NR - ASH = 70\%$

Issues Relating to the Cocoa Export Tax

Table 3 presents export and local duties on cocoa. The key question that comes up is why cocoa farmers should be subjected to a higher tax rate than non-cocoa farmers. These tax elements (variables) are inadvertently missing from FOB price calculations (see example in Table 3). The CIG asks for more transparency in the pricing. Should the government be committed to reducing overall cocoa taxation (to make more money available to the farmer), there is need to identify alternatives to cocoa export taxation – for example taxation of oil revenues.

Table 3. Some export* and local duties over a 12-year period†

| Year ending 30 September | Gross turnover | Export and local duty |
|--------------------------|----------------|-----------------------|
| 2000 | 228,991,500 | 17,881,400 |
| 2001 | 260,964,600 | 29,961,200 |
| 2002 | 327,495,100 | 33,526,600 |
| 2003 | 728,562,300 | 78,390,300 |
| 2004 | 992,199,800 | 99,720,000 |
| 2005 | 888,502,500 | 64,119,000 |
| 2006 | 1,100,691,700 | 61,600,000 |
| 2007 | 1,076,000,394 | 92,055,200 |
| 2008 | 1,411,702,318 | 46,252,800 |
| 2010 | 2,790,149,437 | 153,933,252 |
| 2011 | 4,754,198,210 | 148,679,011 |
| 2012 | 4,619,210,810 | 76,000,000 |

* Exports might include processed and other products marketed by COCOBOD.

† All values are Ghana cedi equivalents; GH¢ is the Ghana cedi after the currency redenomination in 2006.

Source: Authors' compilation based on COCOBOD annual reports. N.b. Data for 2009 was not available

Issues Relating to COCOBOD Costs

The World Bank is said to have proposed some two decades ago that COCOBOD reduces its costs to 15% of the FOB price. A ratio of COCOBOD costs on the basis of the 1950/51 FOB price was 6.5% for the period 1950/51 to 1959/60. Considering that some costs are currently higher, because of the need for more disease and pest control, soil fertility improvement, cocoa rehabilitation, and more research and extension, 15% might seem reasonable. However, producer price calculations, for the 2009/10 cocoa season seemed to suggest a much higher cost for the industry (Table 4).

The key cost items listed in Table 4 are those for disease and pest control. The absolute figures show that the costs of deductions by COCOBOD as a percentage of the net FOB price is 18.7% which is higher than 15%. Since not all farmers receive mass spraying services, and because of poor management of the contracting process and lack of supervision, both equity and effectiveness concerns were raised by the stakeholders, including the cocoa farmers' organizations. Other studies (Abankwah et al., 2010) have recommended that periodic review of the producer price to compensate for increase in general price levels in the economy will improve farmers' purchasing power.

Table 4. Farmer price calculation 2009/10

| | |
|---------------------------------------|-------------------------------------------------------------|
| Average FOB price (estimated) | US\$2,400/t (€2,150/t) |
| Exchange rate (estimated) | 1.46 cedis/US\$1 |
| Crop size (estimated) | 700,000 t |
| Total gross revenue (estimated) | US\$1,680 million (€1,500 million) |
| Deductions | |
| Disease and pest control | US\$111.3 million (€99.7 million) |
| Scholarship fund | US\$6.8 million (€6 million) |
| Jute sacks | US\$13.5 million (€12 million) |
| Cocoa shoot viral disease | US\$9.6 million (€8.6 million) |
| Cocoa Hi-Tech | US\$47.5 million (€42.5 million) |
| Child labour certification | US\$1.3 million (€1.1 million) |
| Total deductions | 277.9 million cedis/US\$190 million (€163.8 million) |
| Net FOB price | US\$2,128/t (€1,900/t) |
| Farmer price | US\$1,512/t (€1,350/t) |
| Share of net FOB | 71% |
| Percentage deduction of net FOB price | 18.7% |

Source: World Bank (2011)

Controlling Cocoa Supply through Consumption

Because the elasticity of cocoa supply is low (higher global output causes a drop in world prices), CIG proposed that COCOBOD embark on an education programme on the health benefits of cocoa to enhance consumption among Ghanaians and for inclusion of cocoa-based beverages in school feeding programmes and in farmer programmes through the LBCs.

Achievements

Price increases of 33.3% in 2010/11, 2.5% in 2011/12 and 3.4% in 2012/13 (despite declining world prices) are in line with the CIG proposition that excessive costs of CODAPEC activities, and inflation and devaluation of the cedi, erode payments to farmers. The positions and clout of CIG members did play a major part in the decision-making process. The farmer investment response to the price increase was evident as Ghana's cocoa output rose to an unprecedented 1,024,553 t in 2010/11 compared to 632,024 t recorded in 2009/10.

To ensure transparency in the system, CIG negotiated with CODAPEC and government policymakers. This led to advertisement of government input distribution in the national newspapers and the involvement of the private sector in government input distribution. The CIG is pursuing an exit strategy for CODAPEC in the not too distant future. This would mean no more mass spraying, but a system based on farmers' assessment of pest incidence. Further study and promotion of the potential of treatments used in the organic cocoa sector with the view to wider application in non-organic areas are suggested. Farmers are ready to invest in inputs and other farm operations when good prices are assured.

Conclusion

The CoS-SIS CIG in Ghana's cocoa sector has been an effective IP that operates at the national level and is able to influence pricing policy in the industry. The CIG is recognized as representing the 'voice' of the industry. The CIG's initial focus on understanding price formation mechanisms, eventually allowed it to substantially affect the prices paid to farmers and the times in the year when these prices were announced, and to initiate measures that increased transparency and reduced deductions for government programmes.

Acknowledgements

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Chapter 12

THE THEORY OF CHANGE UNDERLYING THE EFFICIENCY OF AGRICULTURAL INNOVATION PLATFORMS (IPS): THE CASE OF THE THYOLO VEGETABLE IP IN MALAWI

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Abstract

This chapter explicates the theory of change that underlines the efficacy of the innovation platform (IP) as the implementation frame of the Integrated Agricultural Research for Development (IAR4D) concept. A functional IP is a physical or virtual multi-stakeholder forum that fosters learning and joint action. It has been demonstrated to be effective in realizing socio-economic benefits for agricultural stakeholders. They interact to jointly identify the constraints limiting productivity, value addition and marketing, explore opportunities and implement options that yield mutual benefits. Within the business mode of operation, research and development (R&D) agendas become demand-driven and outputs have a higher likelihood of adoption. The Sub-Saharan Africa Challenge Program (SSA-CP) has demonstrated the effectiveness of the IAR4D model through 36 IPs that were established in eight countries. The case of the Thyolo vegetable IP in Malawi is the focus of this paper.

Keywords: IAR4D, Socio-economic benefits, Interaction, Multi-stakeholder, Learning, Sub-Saharan Africa Challenge Program

Introduction

The SSA-CP was initiated in 2004 in response to calls to improve agricultural productivity and livelihoods of smallholder farmers in Africa. It was noted that, aside from inadequate funding, the main impediment to achieving greater impact of agricultural research on development was the way the research was organized and conducted (FARA, 2008). Research, technology transfer and use, markets and policy have been treated as independent activities. Under this arrangement, knowledge generated through research was being transferred to farmers as if they were prescriptions. Consequently, R&D effort was centred on the generation of new knowledge and technologies

and transferring them to ‘end users’ (farmers). This linear model assumed that the problems of agricultural development are largely technological in nature and users are not normally involved in defining priorities, limiting the uptake of research outputs and product and process innovation.

In a true-life situation, for an inter-connected sector such as agriculture to yield development outcomes, technological, institutional and infrastructural issues must be addressed in a coordinated manner (Adekunle, 2006; Adekunle and Fatunbi, 2010; Hounkonnou et al., 2012). For example, hybrid maize varieties with a yield potential of 4 t/ha are not adopted by African smallholder farmers for several institutional and infrastructural reasons. At both the micro and macro level, African agriculture is plagued by many constraints, such as failure of the land tenure system, inadequate agricultural financing, limited access to markets, irrigation and electricity, poorly functioning farmers’ organization, and inadequate roads and other communication infrastructure. This has been compounded by trade globalization, unstable commodity prices, increasing protectionism, rising energy costs, new waves of technologies which remain out of reach, climate change, traceability and other enhanced food safety regulatory systems (Chauvin et al., 2012). Efforts to solve such problems have yielded ‘islands of success’, however, many technologies remain ‘on the shelf’ in laboratories and research institutes, while the adoption of others has been disappointing. Returns on investment in agricultural research and development (ARD) have remained below expectations (Evenson et al., 1979; Agwu et al., 2008; Anandajayasekeram et al., 2009).

In 2002, an assessment led by the Forum for Agricultural Research in Africa (FARA) attributed the problems to the way African agricultural research is conducted. In the search for alternatives, the innovation systems (IS) approach was proposed because of its multi-actor focus which places entrepreneurs (e.g. farmers) at the centre and the evidence of its effectiveness in contributing to industrial development (Henderson and Cockburn, 1996; Edquist and Johnson, 1997; Clark, 2002). However, there was little experience of applying the IS approach in the context of African agriculture. This posed a challenge, specifically in terms of shaping the appropriate framework for its implementation. FARA developed the IAR4D concept, emphasizing specific principles (Hawkins et al., 2009) and the IP was proposed as the mechanism for its implementation (Adekunle, 2006; Adekunle and Fatunbi, 2010; Adekunle et al., 2010).

FARA engaged in the CGIAR SSA-CP to establish proof of the IAR4D concept. The programme endeavoured to provide empirical answers to the following three questions:

- Does the IAR4D concept work and can it deliver international and regional public goods for end users?
- Does the IAR4D framework deliver more benefits to end users than conventional approaches (assuming those conventional R&D and extension approaches had comparable access to resources)?
- How sustainable and usable is the IAR4D approach outside the test environment (i.e. issues of scaling out for broader impact)?

In most of the SSA-CP research sites, a randomized control trial design was adopted, which raised expectations of unequivocal outcomes (Pamuk et al., 2014a). Two types of counterfactuals were

used; the conventional approach to extension was used in ‘control’ villages (type 1), and ‘clean’ villages (type 2) which had had no intervention over a ten-year period. These were studied to capture if IAR4D worked at all and if it worked better than conventional approaches. Impact was assessed by double difference, looking at before and after, and with and without. From the start, treatment and counterfactual villages were selected randomly. This chapter aims at explicating the theory of change behind the functioning of IPs and how they foster socio-economic benefits through the interaction of the different stakeholders. It analyses one of the SSA-CP’s 36 IPs as a case study to illustrate the theory of change that was used. An attempt to statistically analyse the impact of the SSA-CP for all 36 IPs across Africa can be found in Pamuk et al. (2014b).

The Thyolo Vegetable IP

In the SSA-CP Southern Africa project learning site, covering Malawi, Mozambique and Zimbabwe, the major challenge perceived was to reduce vulnerability through improved soil fertility, water use, intensification, diversification and functioning of markets and value chains. The vegetable project in Thyolo, Malawi, led by Bioversity International, is one of the three projects (each run by a task force) that was developed to resolve these constraints. The other two are: integrated soil fertility management innovations in the maize-cereal livelihood and environmental system led by the Soil Fertility Consortium for Southern Africa and efficient water and nutrient use in the cereal-based system, which is led by the International Center for Tropical Agriculture. Although the four IPs had different entry points, they all sought to address four key constraints: low productivity, inappropriate policies, natural resources degradation and failure of agricultural markets.

The task force dealing with vegetables in Thyolo (i.e. Bioversity) focused on the relative effectiveness of IPs in resolving constraints in the development, dissemination and uptake of science-based practices in vegetable production, processing and marketing. In addition to the programme-level hypotheses, Bioversity tested other specific hypotheses, such as:

- a) The incomes of farmers and the nutrition of consumers (including farmers) can be improved through increased vegetable production;
- b) Vegetable production can be increased by creating synergies among the capacities, knowledge systems, technologies and processes of different stakeholders;
- c) Within an IAR4D context, a focus on indigenous vegetables is more likely to benefit poor consumers and producers than a focus on exotic ones.

In the case of the Thyolo IP, the initial selection of stakeholders was refined by a more detailed analysis of the value chain, the actors themselves and of biophysical conditions to narrow down candidates for the IP. Major members of the IP includes non-governmental organizations (NGOs), notably World Vision, Concern Universal, Rural Livelihood Programme, Malawi Rural Finance Company, and the Centre for Integrated Community Development. The major role of the NGOs is to motivate farmers to participate in IP activities while some of them provide small loans to farmers. There are also four agro dealers, RUMARK, AGORA, Agri-Hort Suppliers Limited, and Pannar Seed Company, which provide inputs such as fertilizers, agrochemicals, and seeds. The Ministry of Agriculture and Food Security extension staff provide services to farmers and assist

in mobilizing them. Bvumbwe Research Station offers biophysical research and the University of Malawi complements these efforts with economic, policy and market research. The aggregation of stakeholders commenced with the harmonization of the market demand.

The representatives from the government at the district level also joined the IP. In addition to bringing government players closer to stakeholders in R&D, the direct involvement of government lubricated the process for approving policy proposals and ensured government participation in removing infrastructural constraints.

The Thyolo IP started with 150 farmers growing rain fed and irrigated vegetables. Farmers and buyers were involved in the selection of the commodities, with profitability as a major consideration. After prioritization, the six vegetables selected were amaranths, tomatoes, giant rape, okra, Ethiopian mustard, and cabbage. Following this, a survey was carried out to determine opportunities for marketing an increased volume of these commodities. Consequently, demand from major institutions, such as schools, hospitals, and prisons, was coordinated.

Exploratory/situational analysis conducted by platform members identified the constraints and opportunities affecting the productivity of the commodities (Table 1). It was observed that vegetable production is heavily dependent on rainfall making it a seasonal endeavour. This problem is further exacerbated by the prolonged dry season leading to reduced flexibility in organizing the production cycle. Farmers all produce at the same time and saturate the market, which often pushes the commodity price lower than the cost of production. The long distances between buyers and production sites, coupled with poor road conditions, compromise the quality of the produce brought to market. Most smallholders' produce fails to attract competitive prices.

Table 1. Summary of constraints related to vegetable production in Thyolo

| Category of constraints | Clusters of constraints | Response |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Technological | <ul style="list-style-type: none"> • Low yielding varieties of vegetables. • Poor crop management practices. | <ul style="list-style-type: none"> • High yielding varieties and improved crop management practices for selected vegetables were introduced by the World Vegetable Center (AVRDC) and Bvumbwe Research Station. |
| Institutional | <ul style="list-style-type: none"> • Farmers are dispersed and uncoordinated. • Uncoordinated input and output markets. • Lack of lending facilities. | <ul style="list-style-type: none"> • Farmers were organized around the IP for easy access to information, technologies, capacity building and marketing. • A 'vegetable pack' was introduced to ease access to inputs. • Agricultural lending was facilitated by an NGO undertaking agricultural lending. • Output markets were coordinated. |
| Infrastructural | <ul style="list-style-type: none"> • Poor road network. • Poor communication. • Lack of electricity. • Problems with irrigation facilities. | <ul style="list-style-type: none"> • The IP improved communication and stimulated farmers to use irrigation. • The government constructed a road to create access to markets. |

The problems that were identified all had technological, institutional and infrastructural dimensions and thus required inputs and commitment from the different stakeholders assembled on the IP. An action plan integrating the activities of the stakeholders, including a common IAR4D agenda, was developed and adopted by all stakeholders.

Low productivity was addressed by AVRDC, which introduced new varieties. The lack of access to inputs was addressed by introducing a 'vegetable pack', an institutional innovation, through which the input dealers provided all inputs that a farmer needs to plant 0.5 acres (0.2 ha) of vegetables. It contained vegetable seeds, fertilizers and fungicides in one box, lowering the transaction costs incurred by farmers. The microfinance agency provided seasonal credit to farmers to enable them to purchase the vegetable packs they needed and also to end market players, all of whom are represented on the IP.

Training needs of different actors on the platform were identified. For researchers these included: marketing chain analysis, cropping systems, nutrition, variety evaluation, germplasm characterization and genetic enhancement, management of socio-economic and consumption surveys, seed production, irrigation techniques, and documentation of indigenous knowledge. Other skills that were listed include facilitation skills, communication skills, data collection and analysis, participatory monitoring and evaluation skills, report writing skills, community mobilization and visioning among others. At the community level different courses were identified, including resource mobilization, water and soil conservation skills, germplasm collection and evaluation, nutrition, vegetable seed production, group dynamics, group and individual savings, leadership skills and marketing skills.

Facilitation and Leadership

The role of a facilitator is vital to ensure there is good interaction among IP members. Most will experience the classical stages of group development suggested by Tuckman (1965). The IP moves from 'forming' to 'storming', when frictions of various types create challenges of conflict resolution for facilitation. Walls separating institutions break down to give room for better understanding and mutual trust. They then move from 'norming' to 'performing', when they seem to have mastered their roles and commence to derive benefits from their activities. Each stage holds different challenges for the facilitator.

In the case of the Thyolo IP, a number of IAR4D stakeholders worked as a team under the auspices of Bioversity International. This team initially catalysed the interaction among the different stakeholders to jointly set goals, develop a business plan, identify the problems and source solutions, and organize the work groups and ad-hoc committees as required. It also assisted in team building, conflict resolution, and linking specific roles of the actors to the general goal, and ensured that the research agenda addressing biological, socio-economic, natural resource management (NRM), or institutional issues was followed. Other activities included the identification of capacity building needs. At the higher management level, some activities were organized that complemented the business models of the IP, such as a vegetable seed fair, vegetable consumption surveys, and identification of indigenous vegetables.

Two basic components of the management of an IP are helpful for cohesion: *strategic management*, which relates to the issues of linkages and the strategic focus of the IP, and *operational management*, which concerns the way the group adopts flexible arrangements in following planned activities. Initially the facilitating team for the Thyolo IP undertook both functions, but as the members became more familiar with one another and with working together, they took over some of the functions related to guidance and determination of the strategic direction for the IP. At this stage, the IP elected its own leaders while the facilitating team assumed the role of backstopping the elected leaders.

In general terms, the Thyolo IP like other IPs evolved through three stages: initiation, consolidation and rapid growth (Figure 1) but at different speeds.

At *initiation*, partners come together and begin to understand how to work with each other. The group conducts some of the analyses, which might be considered new and somewhat superfluous by farmers. The private sector becomes uncomfortable with all the time spent on the preparatory analysis. The R&D organization takes the leadership role and makes a conscious effort to sustain the interest of other partners through effective communication on the importance of the preparatory analysis.

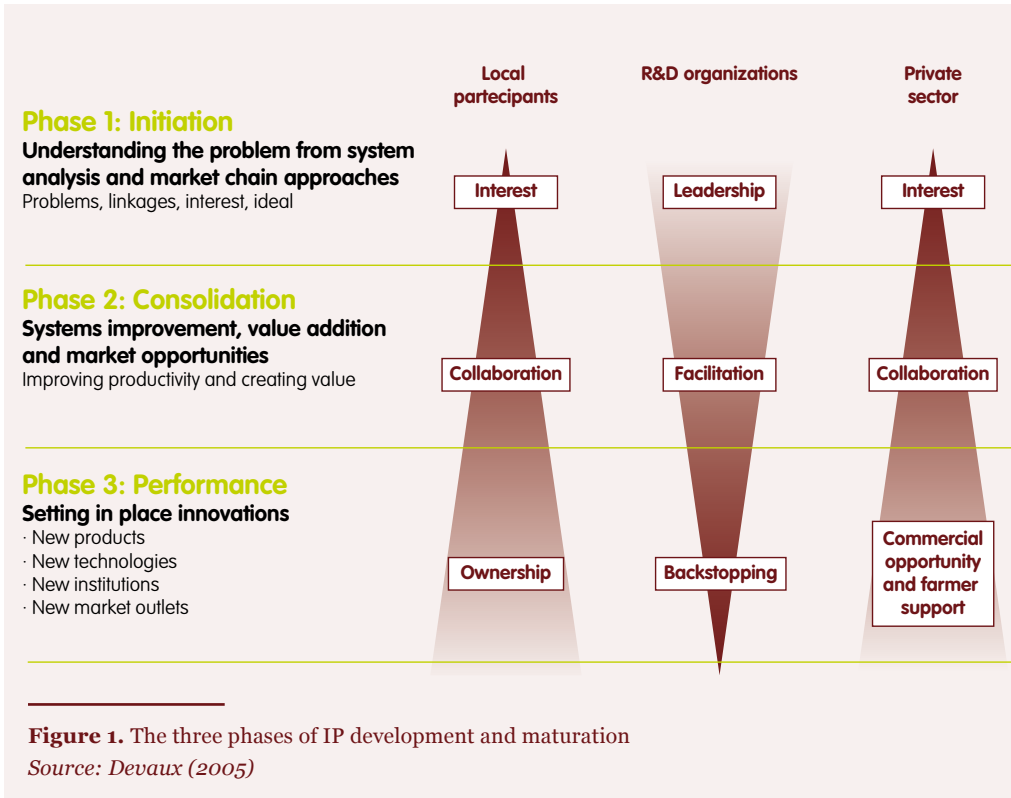
During *consolidation* farmers and other stakeholders begin to see evidence of the value addition and market opportunities. This stage opens stakeholders' eyes to the benefits of the IP and leads to increased interest. The length of this phase depends on the facilitation skills of the initiators of the IP.

During the *rapid growth* phase, new products, technologies, institutions and market outlets start to accrue. Commercial opportunities for farmers and other private sector actors become clearer. Farmers start to take ownership, and the role of the facilitating R&D team dwindles to backstopping, especially with respect to strategic issues relating to fore-sighting, establishing backward linkages to research, and leapfrogging the group into bigger innovation cycles.

It has been observed that IPs, which start off with a certain level of formality tend to innovate more rapidly and attain maturity more quickly.

The leadership and facilitation of the Thyolo IP were based on the 'farmer-led and researcher-backstopped' model. Farmers were given a prominent role to play in the leadership and governance of the IP, while the initiating 'R&D team' backstopped the process. Looking at the 36 IPs within the whole SSA-CP, four additional leadership typologies were observed:

- Government or policymaker led with backstopping from R&D.
- R&D led.
- Input dealer led with backstopping from R&D.
- Output-market led with R&D backstopping.



An analysis across the SSA-CP suggests that IPs led by farmers are quick to introduce formal structures such as by-laws, memorandums of understanding, and a central purse to which payment of periodic dues are made to sustain IP administration, etc. The early emergence of formal structures in IPs that are led by farmers could be attributed to a more rapid development of trust among IP members, especially the farmers who feel free to challenge each other. This invariably translates into indicators of maturity. Platforms led by non-farmers are likely to move at a slower pace because as ‘outsiders’ they tend to be more hesitant – ‘politically correct’ – when challenging farmers and other members. In addition, they often easily fall back on experiences they garnered from other social groups to which they belong.

The leadership model also greatly influences scalability: scaling out implies convening similar IPs in other locations to generate similar outcomes, while scaling-up implies the expansion of the same IP in terms of increasing the size of the participating groups. Scaling up therefore may require increasing the number of participating farmers or of other private sector players, including output marketers. Government agencies enhance scaling up and scaling out of IPs when they help in opening up political and geographical boundaries, which confine the operations of the IP. Similarly, scaling can be more easily achieved by engaging new outlet or input markets. Over all, IPs that are facilitated or supported by government agencies have demonstrated more rapid spread upwards and sideways.

Evaluation of the Thyolo IP

The functioning of an IP is best measured by continuous monitoring of the interaction of actors in terms of their communication and knowledge sharing. Njuki et al. (2010) proposed a framework for monitoring progress of an IP. It makes use of several instruments, including questionnaires to monitor and evaluate various IP processes, and assess the strength of the facilitation. A score ranging from 0 (poorest) to 10 (highest) was used to indicate the degree of performance. Data collected were routinely subjected to summary statistics from which inferences were drawn to enhance management at both the IP and programme levels. Table 2 shows the changes in mean scores observed for different functional aspects (facilitation, information sharing and understanding of critical issues) over a 2-year period for the Thyolo IP.

Table 2. Changes in the functioning of the IP

| Aspect | Mean scores (Year 1) | Mean scores (Year 2) | t statistics | Level of significance |
|----------------------------------|----------------------|----------------------|--------------|-----------------------|
| Facilitation | 8.4 (1.02) | 9.5 (0.76) | -7.5 | 0 |
| Information sharing | 8 (1.29) | 9.27 (0.83) | -6.7 | 0 |
| Understanding of critical issues | 7.6 (1.47) | 8.8 (1.39) | -6.2 | 0 |

Value in parenthesis = standard deviations

At inception, the IP actors had a clear understanding of the critical issues being addressed, and a good appreciation of the information sharing mechanisms that were used and of the facilitation process. The mean scores continued to improve over the years. Knowledge acquisition and use are vital for the success of the IP. Table 3 shows how the different types of knowledge that are required for innovation changed. In the Thyolo IP, understanding of the IP approach itself, and of markets, NRM and policy changed significantly and positively in the 2 years under consideration.

Table 3. Changes in knowledge of critical issues

| Aspect | Mean scores (Year 1) | Mean scores (Year 2) | t statistics | Level of significance |
|----------------------------|----------------------|----------------------|--------------|-----------------------|
| Knowledge of IAR4D | 7.8 (1.27) | 9.2 (0.8) | -6.9 | 0 |
| Knowledge of markets | 8.7 (0.97) | 9.7 (0.55) | -5.2 | 0 |
| Knowledge of NRM | 5.3 (1.23) | 6.2 (1.55) | -4.7 | 0 |
| Knowledge of policy issues | 6.4 (1.33) | 7.8 (1.33) | -6.9 | 0 |

Value in parenthesis = standard deviations

Experience with other IPs within the SSA-CP shows that knowledge of other thematic issues becomes important as the IPs encounter different challenges, for instance, while knowledge of nutrition and gender can be considered to be crosscutting, knowledge of product development and value adding become pertinent when the available market has become saturated. Table 4 shows how the level of involvement of the actors in related activities in the Thyolo IP has changed during the period under review.

Table 4. Changes in process variables

| Aspect | Mean scores (Year 1) | Mean scores (Year 2) | t statistics | Level of significance |
|--------------------------------|----------------------|----------------------|--------------|-----------------------|
| Participation in IP activities | 7.4 (1.82) | 8.4 (1.62) | -6.8 | 0 |
| Contribution to decisions | 8.1 (0.98) | 8.8 (0.65) | -3.4 | 0.0025 |
| Participation in research | 8.2 (1.24) | 9.2 (1.12) | -4.8193 | 0.001 |

Value in parenthesis = standard deviations

Significant improvement was observed in the participation of IP actors in research and related activities. The registers also confirmed high attendance rates of actors in planning meetings, annual reviews, and market surveys. Not only do they participate, they also significantly contribute to decision-making. The IP seems to have inculcated a commonality that overcomes diversity in culture (of doing business) and in knowledge, and also allows actors to pursue inclusive and coordinated problem-solving. A critical factor that keeps the public and the private sectors partners together seems to be the IP’s business model. The interest of the partners increases as they see and explore the opportunities to make profit from the business activities of the IP and enhance their livelihoods. Farmers on the IP have been excited by the opportunity offered by the IP model to develop or access ‘best-bet’ production technologies, process or market their commodities, and access the required inputs, affordable lending and insurance, as well as transparent markets. The IP approach allows the complete ‘Innovation Sphere’ to be embraced, in which the farmer is an equal partner, who works with other stakeholders in the public and private sector, to foster a win-win-win situation for all stakeholders on the platform, thereby giving farmers the ‘voice’ they lack in the linear approach.

Social network analysis was used to determine the extent of interaction among stakeholders in the villages near Bvumbe. Control villages were of two types: ‘clean’ villages in which no significant interventions had taken place, and ‘conventional’ villages in which traditional extension programmes had been implemented. Figure 2 shows a higher density of social interaction among the villagers participating in an IP activity compared to those in the control villages. This intensity of interaction promotes innovation and benefits stakeholders. The differences in the scores for the IP villages compared to both conventional villages and clean villages were significant. In the

second year of the IP's operation, in the IP villages, the average income of each participating farmer was US\$2,350 (€2,140) (giving a total of US\$2.8 million (€2.5 million) for 1,200 farmers) compared to US\$800 (€730) for farmers in conventional villages and US\$250 (€230) for those from clean villages. At the same time, the input dealer made an extra profit of US\$48,000 (€44,000) and three microfinance agencies together made a profit of US\$220,000 (€200,000) profit from interest on loans provided to participating farmers.

In theory and practice, innovation emerges at the interface of the different stakeholders on the IP. Things 'come together' when novel technologies are developed, promoted and used in an environment that assures the supply of required complementary inputs, policy guidelines and infrastructural support. Such innovation becomes sustainable when the necessary conditions are sustained through continued interaction of the stakeholders to come up with solutions to new problems that will emerge from solving previous problems.

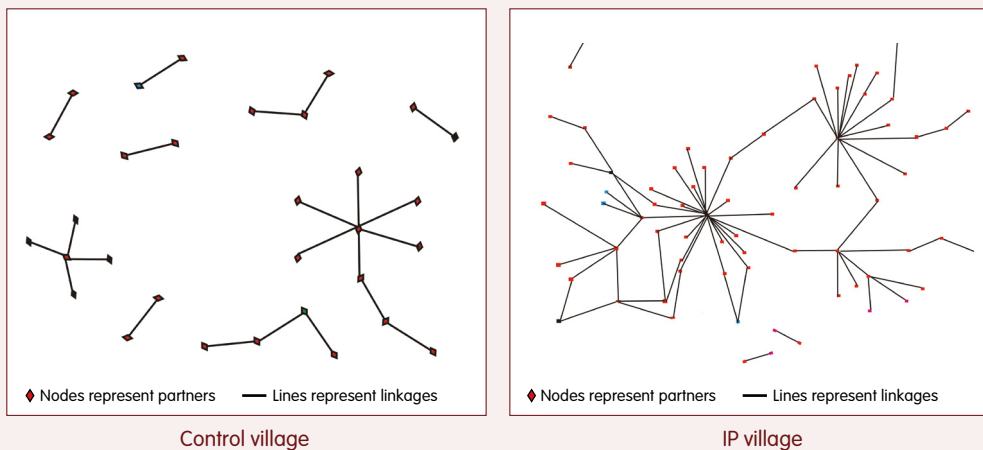


Figure 2. Social network analysis comparing an IP village with a control village

Linking Research

Although the IP approach could focus on development, the IP in Thyolo was initiated by R&D agencies and pursued IAR4D. It basically undertook adaptive research as well as research on institutional issues including those related to policy and markets. The adaptive research activities were fed by the basic and applied research carried out in AVRDC and other institutes. Together, this integration created a new model for configuring research input, which produced great benefits across the continent.

The research activities also created strong linkages leading to synergy and complementarity, not only among CGIAR centres but also between these and national agricultural research organizations (NARO). The lead agency, Bioversity International, developed strong linkages with AVRDC

and NAROs such as the research station in Bvumbwe, to develop and deliver improved varieties in response to the needs of farmers and other stakeholders in the IP.

The Theory of Change Behind the IP Approach

The theory of change on which the IP approach is based concentrates on effective partnerships in the provision of holistic solutions to IAR4D issues. In particular, R&D agencies must pay attention to technological, institutional and infrastructural dimensions of development. The multidimensional and multi-institutional nature of constraints to agricultural development necessitates such an approach. Engagement of all stakeholders in the innovation process is vital, but is only effective when the dichotomy in interest between the public and the private sector practitioners is understood and addressed. Spielman and Grebner (2006) made several recommendations to ensure a positive private sector contribution to IAR4D. In addition to their propositions, is the need to support smallholders and subsistence producers in moving to scalable enterprises. This is feasible, given supportive policies and effective input and output markets. Thus the theory of change emphasizes, as a first indicator of success, a balanced partnership, which is ready to take on all dimensions of the enabling environment for smallholder development. In this environment, activities are implemented in a complementary manner leading to the derivation of outputs. Further integration of activities, transforms outputs into outcomes and impacts. Evaluation results of the work of SSA-CP have shown that the rate of this transformation is faster for IPs than for conventional (extension) approaches.

Effective engagement and interaction of all stakeholders on an IP is necessary to, in an iterative manner, identify problems, prioritize them, source solutions, implement them and learn lessons. The successful operationalization of the IP approach depends to a great deal on the vision and the competence of the facilitator to overcome the usually fuzzy initial period. The experience of the SSA-CP in using the IP as the operational approach for implementing IAR4D suggests that innovation is faster when farmers and other private sector practitioners develop a sense of ownership early on (Adekunle and Fatunbi, 2010). Thus the second indicator for success is the effective operationalization of the IP approach in terms of both implementation and strategy.

In summary, the effective use of an IP approach potentially can generate technological, institutional and infrastructural innovations, with socio-economic benefits in terms of increased yields and incomes and improved livelihoods, which, in turn, contribute to household and national food security, health and well-being, poverty reduction and job and wealth creation.

Conclusions

Given global challenges such as food security, poverty and environmental degradation, African agriculture more than at any other time is required to deliver developmental outcomes for the continent and possibly the world. Current low agricultural productivity is a major limiting factor. If agricultural productivity, processing and marketing could be increased by a significant margin, the continent can feed itself and respond to global market demand.

The IP model relies on the IS approach and embraces multi-institutional and multi-stakeholder engagement to identify problems as well as opportunities, and to provide solutions, using a combination of soft and hard sciences. The IP itself constitutes an institutional innovation that allows stakeholders to interact and generate socio-economic benefits for all partners.

The model is challenging in that it asks the traditional R&D actors to embrace a paradigm change. The most prominent aspect of which is the willingness to acquire the skills needed to work with other partners in an interactive mode and to see them as having equal right to make decisions on R&D issues. Research needs to work with non-traditional partners, especially the private sector actors, to ensure that research is driven by demand from end users, and that the focus shifts from outputs to outcomes and impact.

In addition, the success of the IP model strongly depends on the skills and competencies of the facilitator and the facilitation model embraced. The facilitator requires a great deal of social skills to manage people's expectations and conflicts. Such skills require investment in capacity development for facilitators.

Despite such challenges, on the basis of our experience in the SSA-CP, the IP model has potential to respond to seemingly intractable problems of African agricultural development. It seems to have the capacity to quite rapidly yield socio-economic benefits from R&D efforts. It fosters productivity gains while sustaining the natural resource base. It generates increased incomes for farmers and other stakeholders, and provides employment opportunities in the agrarian sector. It also provides the framework for effective public-private sector partnerships. Finally, it seems capable of contributing to the transformation of subsistence farmers into small and medium-scale entrepreneurs.

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Chapter 13

INNOVATION PLATFORMS FOR SMALLHOLDERS IN MAIZE AND CASSAVA VALUE CHAINS: DONATA'S EXPERIENCES IN WEST AND CENTRAL AFRICA

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Abstract

Organizational and institutional challenges continue to limit the widespread use and adoption of promising technologies and practices in smallholder agriculture in many parts of sub-Saharan Africa. The chapter draws on lessons learned from the Dissemination of New Agricultural Technologies in Africa (DONATA) initiative in 14 countries in West and Central Africa and specifically on the experiences of the maize innovation platforms (IP) in Burkina Faso and, to a limited extent, highlights achievements in the maize and cassava IPs in The Gambia, Mali, and Sierra Leone. For both maize and cassava, the IPs led to: increased yields and incomes of smallholders; improved confidence, trust and recognition among IP actors and peers; and enabled institutions to inform and influence regional and national policy decisions in agricultural productivity programmes. New products, including disease-free, 'shiny bright' (buyer and consumer visual preference), A-quality grain maize, enabled the farmer organization in Burkina Faso, Fédération Nian Zwè (FNZ), to compete in supplying quality grain to traders, agro-food product processors and local poultry businesses. Farmer seed and grain maize entrepreneurs have emerged from the IPs in Burkina Faso and some of them have started to invest in non-farm businesses. In Mali, farmers have started to trust seeds from private companies, and farmer seed entrepreneurs have emerged and built strong relationships with a local seed company, FASO KABA, in the production, processing, certification and marketing of quality seed maize.

Keywords: Trust, Institutions, Policy, Seed, Grain, Burkina Faso, Mali

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Introduction

Agriculture provides employment for the majority of the people in sub-Saharan Africa, yet the productivity of the sector has generally remained below its potential. The research community has developed technologies with proven ability to improve yields, but the institutional conditions do not enable farmers to capture much of this potential (Giller et al., 2011). The performance of the agricultural sector has started to show positive trends in a number of African countries (Wiggin and Slater, 2011) yet many national agricultural research systems (NARS) are not able to provide research of the quality required. The linear research-extension-farmer linkages and technology transfer championed by public extension services in the 1960s and 1970s (Chambers et al., 1989), as well as 'training and visit' extension promoted by the World Bank in parts of Africa in the 1980s, have not been effective but the practices largely remain. Hounkonnou et al. (2012) suggest that technologies are not the main bottleneck but that institutional constraints prevent farmers and other beneficiaries from putting technologies to use and improving their livelihoods.

The strategic policy orientation of the Comprehensive Africa Agriculture Development Programme (CAADP) has explored new ways in which African agricultural service delivery could be organized. CAADP and the Framework for African Agricultural Productivity (FAAP), call for robust engagement of broad-based agricultural research and development stakeholders, in partnership with other actors, to improve rural infrastructure, institutions and policies including access to markets, land and water, capacity strengthening, and information and communication technology (ICT).

In response to the aspirations of CAADP and FAAP, the Forum for Agricultural Research in Africa (FARA) argued that the root of the problem may be the way research is conducted (Clark, 2002; Hall, 2005; FARA, 2006; EIARD, 2009; Clark, 2016). FARA proposed that the research sector move away from the 'business-as-usual' model of knowledge generation by scientists, knowledge transfer by extension, and knowledge adoption by farmers, in favour of an Integrated Agricultural Research for Development (IAR4D) paradigm. IAR4D was adopted by sub-regional organizations including the Council for Agricultural Research and Development in West and Central Africa (CORAF/WECARD) and its 22 constituent NARS.

IAR4D is a set of principles that informs: i) perspectives, knowledge and actions of stakeholders around a common objective; ii) collaborative learning through collective action; iii) analysis, action and change across the economic, social and environmental dimensions of livelihoods, and welfare of end users and consumers; and iv) analysis, action and change at different levels of spatial, economic, and social organization. IAR4D is based on innovation systems (IS) thinking and has been put into practice through the use of IPs in smallholder value chains, food systems and natural resource management (Adekunle, 2016; Sanyang et al., 2016).

There are other ways of looking at IS, which include: agricultural research for development (AR4D) and/or research for development (R4D) by advanced research institutes and international centres; agricultural IS as promoted by the World Bank; the Agriculture Science, Technology & Innovation approach of the Technical Centre for Agricultural and Rural Cooperation (CTA)

(Francis, 2016); and the Convergence of Science-Strengthening Innovation Systems (CoS-SIS) approach of the partnership of Wageningen University and Research (WUR), the Université d'Abomey à Calavi, the University of Ghana at Legon, the Institut Polytechnique Rurale at Kati-bougou and technical institutes in Benin, Ghana and Mali (Jiggins et al., 2016). IPs applied in value chains and food systems are referred to by various practitioners as R4D platforms, innovation clusters, Concertation and Innovation Groups, innovation networks, and business clusters, to name but a few. Each of these can represent different perspectives on pathways to innovation.

However, the IAR4D-IS paradigm is not a blueprint, but rather a perspective that sees research as part of a wider innovation system that is needed to transform agriculture. Is change linear or non-linear? Predictable or not predictable? Controlled or emergent? Technical or political (Woodhill, 2010)? If the desired change can be controlled and is predictable we need to develop detailed blueprints for action and make sure they are followed. The development literature is, however, strongly shifting away from this view (Easterly, 2006).

The challenge of agricultural service delivery for the benefit of poor smallholders is not limited to the way research, advisory service, and farmers are organized. The robust engagement of state and non-state actors in multi-stakeholder processes and value chains promises to deliver approaches and tools that can sustainably boost agricultural productivity and improve livelihoods.

In this chapter, we suggest that technological, organizational and institutional innovations must go hand-in-hand to catalyse transformation and entrepreneurship in maize and cassava value chains and food systems. The evidence presented is based on 5-year experience with DONATA in 14 countries in West and Central Africa. The IP, a learning-by-doing tool, through which actors with a common interest interact, build relationships and learn together, has been used to stimulate new products, businesses, services, institutions, policies, and financial instruments that offer opportunities to smallholders to improve their livelihoods. The paper largely draws on the highly mature and best performing maize IPs in poor smallholder agriculture in the Province de la Sissili in Burkina Faso and, from time to time, makes reference to maize and cassava IPs in Gambia, Mali, and Sierra Leone.

Materials, Methods and Data Sources

IPs in maize and cassava value chains and food systems were established in 14 countries in two phases: the first phase started with seven countries (Burkina Faso and Mali for maize; and Cameroon, Côte d'Ivoire, Republic of Congo, Senegal and Sierra Leone for cassava) in 2008. Based on the experience of the start-up countries and the demand to extend DONATA to additional countries, in 2010 IPs were started in Benin, The Gambia, Guinea and Togo for maize; and in Chad, Ghana and Liberia for cassava. Because of the similarity in the facilitation and management of the maize and cassava IPs across the 14 countries, and the highly performing and mature maize IPs in the Province de la Sissili in Burkina Faso these were the subject of the study.

Through the active participation of various farmers' and processors' organizations (FNZ, the Société Nationale de Gestion des Stocks de Sécurité, Association des Transformateurs du

Burkina, the Association des Aviculteurs de Ouagadougou, the Association des Transporteurs de la Sissili), advisory services, policymakers in local government, banks and microfinance institutions, the media as well as the Institut de l'Environnement et de Recherches Agricoles (INERA), the IPs (Figure 1) were started in maize by making available start-up seed of composite hybrid and open pollinated maize varieties and inorganic fertilizers to poor smallholder famers, together with enhanced soil fertility management. Demonstration plots by INERA, and farmers' own plots of 0.25 ha per participating farmer, were used to start the IP process. Each participating farmer received 5 kg of quality seed maize, 50 kg of compound fertilizer, and 25 kg of urea for use on their plots. INERA trained the FNZ facilitators who, in turn, trained the farmer IP actors in maize production techniques. DONATA funds were used by INERA to multiply seeds of farmer-preferred maize varieties and fertilizers only in the first year, after which the farmers themselves organized the acquisition of seeds and fertilizers through interaction with input dealers in the IPs. There was no conditionality for the participation of the actors in the IP process. While the facilitation of the IPs was carried out by various organizations, including INERA, their day-to-day management was assured by INERA as the focal point for DONATA in Burkina Faso.

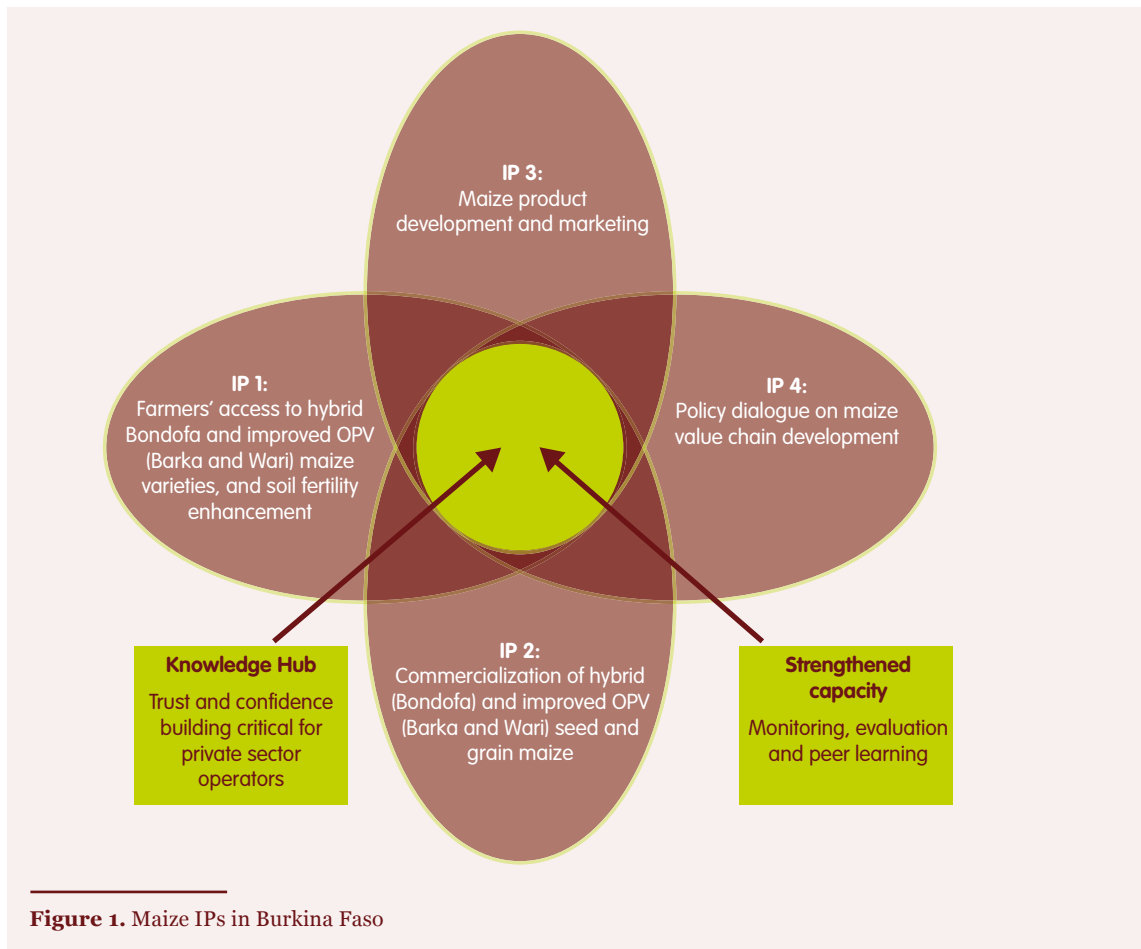


Figure 1. Maize IPs in Burkina Faso

The entry points for maize IPs were farmer access to quality seed maize and soil fertility enhancement. In the third to fourth year of DONATA in Burkina Faso, this shifted to processing and value adding while, in the fourth to fifth year, the emphasis shifted again to policy engagement, as the IP became more dynamic and responsive to the needs of the stakeholders (Table 1). The processing and value-adding IP facilitated interaction among IP actors on local agro-food product development and marketing, while the policy engagement IP addressed the active involvement of the local government through the office of the *Haut Commissariat* (local government) in the province of Sissili and heads of technical departments of the central government in the same province. The processing and local food products development and marketing IP on grain maize on its own, or in combination with other grain legumes, was facilitated through the small and medium women and men processors with the active participation of other relevant IP actors. These processing actors interacted and developed relationships with the largely production-based actors and contributed to influencing FNZ farmers to shift from producing shrivelled and diseased B-grade grain maize to unshrivelled, disease-free and shiny bright A-grade grain maize to capture a significant share of the grain maize market in Burkina Faso. The policy dialogue IP catalysed interaction and good relationships among the different groups of stakeholders through the *cadre de concertation* (consultation framework) directly facilitated by the *Haut Commissariat* of Sissili with the active participation of technical heads of departments and civil society. Much of the IP issues discussed were conflicts, especially between producers and livestock herders, and the need for feeder roads to facilitate the transportation of grains to markets.

Table 1. Stakeholder analysis of the maize IP in Burkina Faso

| IP actors | Key role | IP 1 entry point: Quality seed and fertilizer access by farmers | IP 2 entry point: Quality seed and grain maize businesses | IP 3 entry point: Product development and marketing | IP 4 entry point: Policy engagement on maize value chain development at regional level |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| IP focal person | <ul style="list-style-type: none"> Managing the IP and accounting for funds | <ul style="list-style-type: none"> INERA (research) | <ul style="list-style-type: none"> INERA (research) | <ul style="list-style-type: none"> INERA (research) | |
| Farmer organization | <ul style="list-style-type: none"> Promoting seed and grain maize production by FNZ extension agents | <ul style="list-style-type: none"> FNZ farmer organization | <ul style="list-style-type: none"> FNZ farmer organization | <ul style="list-style-type: none"> FNZ representative | |
| Agri-businesses | <ul style="list-style-type: none"> Contracts to supply maize to local markets and national food reserves Processing and adding value to maize based products for the local market | <ul style="list-style-type: none"> Association provinciale des commerçants de céréales (ATCB) | <ul style="list-style-type: none"> ATCB Société Nationale de Gestion du Stock de Sécurité Alimentaire Comité inter-professionnel des filières céréales et niébé du Burkina Faso | <ul style="list-style-type: none"> ATCB Centrale de transformation des produits agricoles Djigui Espoir Association Femme-Enfants plus Etablissement Sapientia La Céréalière du Faso | |

| IP actors | Key role | IP 1 entry point: Quality seed and fertilizer access by farmers | IP 2 entry point: Quality seed and grain maize businesses | IP 3 entry point: Product development and marketing | IP 4 entry point: Policy engagement on maize value chain development at regional level |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transporters | <ul style="list-style-type: none"> Facilitating collection and delivery of seed and grain maize, and inputs and output products | <ul style="list-style-type: none"> Association des transporteurs de la Sissili | <ul style="list-style-type: none"> Association des transporteurs de la Sissili | <ul style="list-style-type: none"> Transporteurs de Ouagadougou | |
| Public extension | <ul style="list-style-type: none"> Improving the technical skills of FNZ extension agents Assessing consumer preferences for maize based agro-food products | <ul style="list-style-type: none"> SNVCA (extension) | | <ul style="list-style-type: none"> Anthropologist/ sociologist | |
| Research | <ul style="list-style-type: none"> Training of extension agents and champion farmers Assessing nutritional changes in households | <ul style="list-style-type: none"> INERA (research) | <ul style="list-style-type: none"> INERA (research) | <ul style="list-style-type: none"> Nutritionist - Département de la technologie alimentaire L'Institut de Recherche en Sciences Appliquées et Technologies INERA | |
| Policy | <ul style="list-style-type: none"> Enhancing trust and confidence building among IP actors | <ul style="list-style-type: none"> Local government | <ul style="list-style-type: none"> Local government | <ul style="list-style-type: none"> Direction de la nutrition du Ministère de la santé | <ul style="list-style-type: none"> Haute Commissariat Representatives of civil society Heads of technical services and departments |
| Micro-finance | <ul style="list-style-type: none"> Making credit available to IP actors (farmers) | <ul style="list-style-type: none"> RBS Bank EcoBank FNZ members | <ul style="list-style-type: none"> RBS Bank EcoBank FNZ members | <ul style="list-style-type: none"> RBS Bank EcoBank | |
| Media | <ul style="list-style-type: none"> Sensitization and information dissemination among IP actors Promoting the visibility of the IP in the maize value chain | <ul style="list-style-type: none"> Christian Relief and Development Organization La radio évangélique développement (RED), Sissili Agence d'information du Burkina (AIB) | <ul style="list-style-type: none"> Christian Relief and Development Organization La RED, Sissili AIB | <ul style="list-style-type: none"> National TV National radio Burkina <i>Sidwaya</i> (national state daily journal) | |
| Retailers/consumers | <ul style="list-style-type: none"> Feedback on consumer behavioural changes and perception | | | <ul style="list-style-type: none"> Mini-markets | |

In 2009, microfinance institutions involved in the IP disbursed only CFA 4 million in credit through FNZ. This amount increased to CFA 100 million (€150,000) in 2012, due mainly to the high level of confidence and trust among IP actors, as well as the high rate of loan repayment by FNZ farmers to microfinance institutions. The need for collateral was waived by microfinance institutions because FNZ ensured loan repayment by its individual members.

The DONATA IPs systematically engage IP actors based on the constraint and/or opportunity at a point in time, and link them through networking and collaborative learning to enable them to share experiences on similar, yet different, entry points on the same value chain and/or food system. This minimizes disinterest among relevant stakeholders, especially private sector agri-businesses, which may not be critical players at a point in time and space. This is one aspect of the IP that makes it different from mapping and engaging value chain actors in chain coordination and business development.

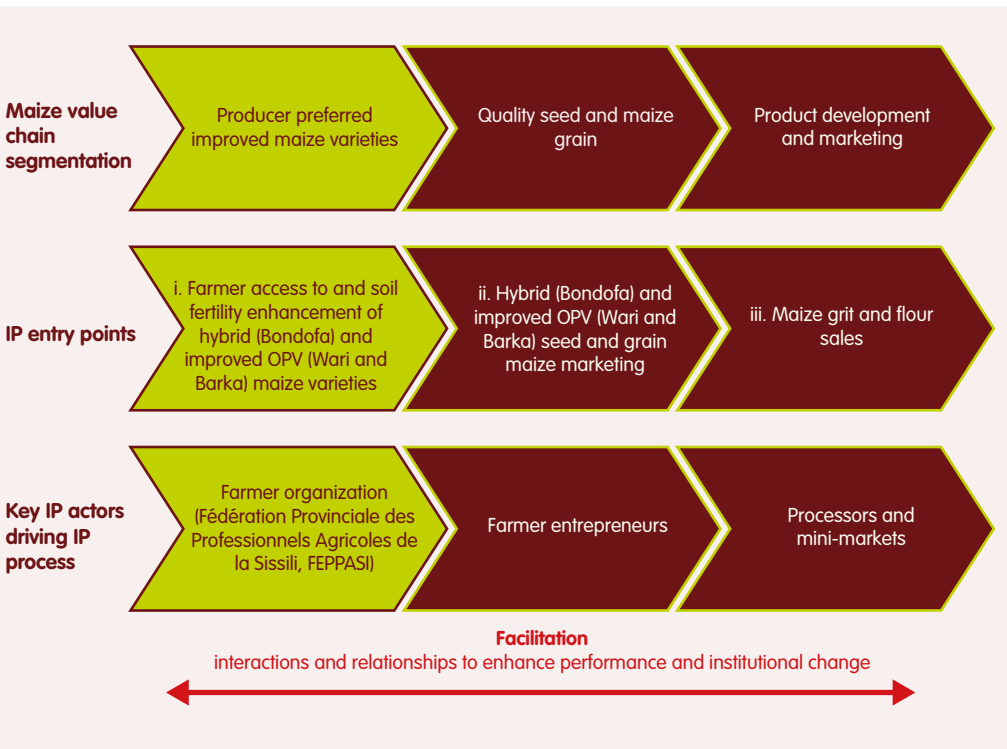


Figure 2. Maize value chain IP in Burkina Faso

In order to catalyse a culture of entrepreneurship in maize value chain development, participatory value chain analysis (Figure 2) was carried to determine the critical interventions necessary to promote quality seed and grain maize production, as well as agro-food product development and marketing. The four priority entry points below informed the start-up phase of the IPs over a period of 3-4 years (Figure 1):

- a) Farmer access to hybrid (Bondofa) and open-pollinated varieties (OPV) (Barka and Wari) of maize, and the means to enhance soil fertility.
- b) Commercialization of quality seed and grain maize of these varieties by farmer entrepreneurs.
- c) Maize-based agro-food product development and marketing by smallholder processors.
- d) Policy engagement in maize value chain development.

Within 4-5 years, 13 IPs were created with a focus on these entry points across communities in Sissili and Ouagadougou. The stakeholders involved, and their roles, based on each entry point, are shown in Table 1. INERA provided the improved maize varieties and facilitated the experiential learning on quality seed and grain maize production through 0.5 ha demonstration plots, farmer field schools, and field days, to name a few. This enabled individual FNZ members to access hybrid and OPV seed maize and each cultivated at least 1 ha of maize, compared to 0.25 ha proposed in the DONATA protocol. The non-governmental organization (NGO), CREDO, informed actors and rural communities on good agricultural practices through the Sissili rural radio, while the local press – *Radio Evangile Développement* and *Agence d'Information du Burkina* – provided targeted information to the population within and outside Sissili. The active engagement of policymakers (*Haut Commissariat*) through the local government enabled broader issues of feeder roads and conflicts between farmers and livestock herders to be discussed through a *cadre de concertation* (consultations) involving civil society groups and government officers.

Results and Discussion

Over 90 multi-stakeholder IPs were created and facilitated in maize and cassava value chains and food systems in 14 countries in West and Central Africa between 2008 and 2012. Over 20,000 direct beneficiaries, of whom 40% were females, were involved in the DONATA IPs. These IP actors largely comprise farmers, many of whom are members of self-organized farmer organizations/groups despite the fact that some of these are weak and others strong, and representatives of women and men processors among other actors. Through systematic facilitation of interactions among IP actors, relationships and trust were enhanced. The 13 IPs in Burkina Faso alone represent over 50% of the DONATA IP actors with 10,450 beneficiaries of whom 6,100 were male and 4,350 female. The average grain maize yield of 1.7 t/ha obtained in 2008 increased to 4.0 t/ha within 5 years in the Province de la Sissili. Similarly, average seed maize yield remained 2 t/ha until 2012 when it increased to 2.6 t/ha. Gross incomes for A-quality grain and seed maize respectively for the IP actors in Burkina Faso increased from US\$1,643 (€1,495) in 2008 to US\$4,321,674 (€3,932,491) in 2012 (Table 2).

Across the 14 countries in West and Central Africa, average maize yields varied from 1- 5 t/ha while average cassava tuber yields of 20-35 t/ha were obtained over farmer practice. The quality and quantity of processed products was incrementally enhanced. Some of the small and medium sized enterprises (SME) processed agro-food products including flour, couscous, grit, baby weaning food from grain maize, as well as gari, fofou, placali, and quality flour from cassava tubers. Although some are traditional foods, some were newly introduced to a number of communities.

Table 2. Yield and gross income of the maize IP: The case of DONATA in Leo, Province de la Sissili, Burkina Faso

| Year | | 2008 | 2009 | 2010 | 2011* | 2012 | 2013 |
|-----------------------------|--------------|-----------------------|-----------------------|---------------------------|-----------------------------|-------------------------------|-------------------------------|
| Beneficiary | | NA | 700 | 6,250 | 8,500 | 10,450 | 13,063 |
| | | | 530 M | 4,687 M | 5,600 M | 6,100 M | 8,752 M |
| | | | 170 F | 1,563 F | 2,900 F | 4,350 F | 4,311 F |
| Average yield (t/ha) | Grain | 1.7 | 2.5 | 4 | 3.7 | 3.8 | 3.9 |
| | Seed | - | 2 | 2 | 2 | 2.6 | 2.5 |
| Total production (t) | Grain | - | - | 4,358 | 11,759 | 19,690 | 21,650 |
| | Seed | 2 | 8 | 170 | 220 | 2,176 | 2,390 |
| Marketing (t) | Grain | - | - | 2,000 | 2,500 | 6,580 | 10,800 |
| | Seed | 2 | 8 | 170 | 220 | 2,176 | 2,390 |
| Gross income | Grain | NA | NA | US\$543,933 (€483,965) | US\$784,518 (€698,029) | US\$2,056,250 (€1,829,651) | US\$3,380,400 (€3,007,824) |
| | Seed | US\$1,673 (€1,488) | US\$6,694 (€5,956) | US\$177,824 (€158,229) | US\$230,125 (€204,754) | US\$2,265,424 (€2,015,737) | US\$2,487,990 (€2,213,851) |
| | Total | US\$1,673 (€1,488) | US\$6,694 (€5,956) | US\$721,757 (€642,225) | US\$1,014,643 (€902,829) | US\$4,321,674 (€3,845,355) | US\$5,868,390 (€5,221,783) |

*drought year

NA = not available, M = male, F = female

Table 3. Typology and performance of DONATA IPs in maize and cassava value chains and food systems in West and Central Africa

| Crop/country | | Mature and highly performing | Maturing and progressing well | Moderately mature and progressing well | Weak and struggling |
|---------------------|-------------------|-------------------------------------|--------------------------------------|-----------------------------------------------|----------------------------|
| Maize | Burkina Faso | *** | | | |
| | Mali | | *** | | |
| | Gambia | | *** | | |
| | Guinea | | ** | | |
| | Benin | | | ** | |
| | Togo | | | * | |
| Cassava | Sierra Leone | ** | | | |
| | Côte d'Ivoire | | | * | |
| | Republic of Congo | | | * | |
| | Cameroon | | * | | |
| | Ghana | | | ** | |
| | Chad | | | | * |
| | Liberia | | | | * |
| | Senegal | | | | * |

*differentiates the level of performance among IPs for each country in each category.

Scale: * - low; ** - medium and *** - high

The typology and performance of IPs in the 14 countries can be categorized as mature and highly performing, maturing and progressing well, moderately mature and progressing well, and weak and struggling (Table 3).

Facilitation of interaction among IP actors, especially in Burkina Faso, has improved relationships, recognition and respect, and built confidence and trust among the diverse social and economic operators in the maize and cassava value chains and food systems. In Burkina Faso, for example, Karim Kabore was a technician at INERA but lost his job through redundancy. He returned to his community and started seed production of food crops. Because he was not well known in the farming community, he used to take his seeds kilometres away to the extension office in Province de la Sissili for sale to other farmers. When Karim joined the maize IP, he became well recognized and trusted by his peers and they started to buy seeds from him directly. He has opened an input shop in his community, expanded his business, and acquired an additional tractor.

Among the 18 emerging farmer entrepreneurs in quality seed and grain maize production and commercialization in Burkina Faso, a primary school dropout and an emerging entrepreneur in the maize IP in the Province of Sissili was struggling to feed his family and contemplated moving to Côte d'Ivoire to work in the commercial crops sector. However, he became an active maize IP actor in 2008 and acquired improved high yielding, drought tolerant maize varieties and enhanced technical and organizational skills in maize production and commercialization. His maize yield increased from 3.5 to 5 t/ha and his acreage expanded from 0.25 to 28 ha for the production of A-quality grain maize. He was able to hire labour, including women, especially during harvesting and is no longer dependent on microfinance institutions in the IP. Part of his produce is retained for sale when grain prices are high and the proceeds used to buy inputs such as fertilizers for the next years maize crop. He created small businesses in his village, including a cellular phone charging facility and a local restaurant on the main road, began rearing 100 guinea fowls on his maize farm, and was able to place his children in a private school. He also became the president (chairman) of FNZ in Sissili.

Similarly, small and medium-scale seed entrepreneurs (small: rainfed agriculture; medium: rainfed in combination with irrigation) used to pay CFA 10,000 (€18/US\$20) per growing season to certify their seeds for sale to the public. This fee is no longer required.

In the cassava IP in Sierra Leone, farmers used to produce and market the tubers on their own. When cassava stakeholders engaged in the IP process facilitated by the Sierra Leone Agricultural Research Institute, the interaction and building of new relationships led to emerging trust among chain actors. They got to know who buys cassava and processes the tubers, and who transports and takes the products to the market. This reduced duplication of roles and enhanced synergy and efficiency among actors.

Farmers in Mali routinely plant seeds saved from the last season because of their resistance to use of 'imported' seed, which they perceived as genetically modified crops. This restricted their interaction and relationship with indigenous small seed businesses. The maize IP actors in Bougouni

and other locations in the south of Mali, started to engage with a local seed business, FASO KABA, facilitated by the Alliance for Green Revolution in Africa (AGRA). Through the involvement of the locally elected *Maire* (mayor) in the maize IP in Bougouni, for example, who is also a producer and buys seed from FASO KABA among other sources, producers in the maize IP started to trust seeds from FASO KABA. To further strengthen this relationship and offer hope for smallholder farmers, FASO KABA, as a key IP actor, contracted emerging farmer seed producers and entrepreneurs within the IP and offered credit, such as fertilizer, to producers in the maize IP. In turn, FASO KABA buys quality seed maize from the emerging seed entrepreneurs and transports, cleans, processes, labels and packages it at its seed processing facility, and ensures certification by the national seed service. It does all this despite having its own seed production farm. Emerging seed entrepreneurs in the IP reported that 80% of their seed was bought by FASO KABA and only 20% by other local businesses.

The involvement of policymakers, especially at local government level through the *Haut Commissariat* in the Province de la Sissili, created confidence and trust among the IP actors and helped shape local and national decision-making on using IPs as pathways to increased food security, incomes and change in smallholder agriculture. In 2012, the Ministry of Scientific Research and Innovation (MRSI) in Burkina Faso in collaboration with CORAF/WECARD and the Australian Agency for International Development, organized an inter-ministerial learning session, involving policy advisers and policymakers, on using IPs as a vehicle for change in government policy in agriculture, health, water, housing and rural development in general. A ministerial decision by MRSI and the Ministry of Agriculture and Food Security in Burkina Faso directed INERA and the Nouveau Système d'Appui-Conseil et de Vulgarisation Agricole (SNVCA) (extension) to establish IPs in rice, maize, cowpea, shea butter, onion, livestock and meat through the West Africa Agriculture Productivity Program (WAAPP). This is now progressively implemented despite the challenges in creating and facilitating functional IPs. For the first time, the Ministry of Economy and Finance of Burkina Faso allocated a special fund to MRSI to address innovation for rural development. Similar policy decisions have been taken in Sierra Leone in cassava and rice through the WAAPP, as well as in Gambia in maize, rice, and groundnut. In Sierra Leone, in particular, a bill for the use of IP as a key extension tool has been drafted for consideration by parliament.

The key success factors of the maize and cassava IPs include:

- a) farmers and agro-food product processors are at the centre of the IPs;
- b) farmer access to high yielding and stress tolerant improved maize and cassava varieties, and fertilizers;
- c) self-organized farmer groups cultivating 0.5-1 ha of improved maize and cassava varieties;
- d) local market opportunities to produce and sell quality seed and grain maize, fresh cassava tubers, and locally processed agro-food products;
- e) active involvement of locally based agro-food processors and transporters;
- f) champions of change, e.g. the president of the FNZ farmers' organization in Burkina Faso;
- g) FNZ's own extension agents are providing advisory services;
- h) robust policy engagement at local government level in the case of the Province of Sissili in Burkina Faso, as well as in The Gambia and Sierra Leone;

- i) farmer technical skills enhancement through research;
- j) end user access to information through community radio;
- k) adult education to improve the literacy skills of FNZ members in Burkina Faso.

The maize and cassava IPs are a powerful tool to promote the adoption of agricultural technologies and practices (Ekboir and Parellada, 2001; Hall et al., 2001; Clark, 2002; Watts et al., 2003). The IP provided the diverse social and economic operators an opportunity to discuss and understand each other's perceptions, competing interests, associated risks and access to resources. All three have been reported by Spielman and von Grebmer (2006) as primary impediments to partnerships. The Grains Association in Ghana, a common platform to strengthen sectoral development, suggested that functional multi-stakeholder processes, founded on the basic principles of sharing costs, benefits and risks among partners, enhance synergy and increase efficiency among actors (Guyver and MacCarthy, 2011). Roothaert and Magado (2011) further suggest that the key factors of success in a cassava production project in Uganda have been the development of farmer organizational structures that are rooted in the community and the creation of value addition processes that are linked to markets. It was observed that where the maize and cassava IPs in DONATA were started around self-organized farmer and processor organizations/groups, those IPs performed better than IPs that were directly created by the project, and this has implications for sustainability and ownership.

Access to resources and incentives, considered of secondary impediments to partnership by Spielman and von Grebmer (2006), were in fact found to be of high importance in the functioning of IPs. For example, the focal persons and their organization facilitating the IPs were not always transparent in terms of use of the allocated funds and in sharing information and knowledge. In many cases, they facilitated activities for which other IP actors had a comparative advantage. If the IP is to be sustainable, enhancing leadership and governance skills of the IP actors must be an integral part of the process. The focal IP organizations were not able to adequately respond to issues relating to governance and business skills development of the actors and did not actively engage the requisite skills to get this done. There were many other obstacles to overcome, including timely disbursement of funds to the IPs and delays in the justification for how the money was spent.

CORAF/WECARD facilitated peer learning visits, experiential learning and sharing for IP actors in the maize value chain and food system IPs in Burkina Faso and The Gambia which changed the perspectives of peers in other national systems and enhanced their skills for creating and facilitating functional IPs.

Conclusions, Recommendations and Implications

Maize and cassava-based technology on its own will not result in the level of change and impact that is needed to improve smallholder agriculture and livelihoods. Multi-stakeholder processes, including IPs around key value chains and food systems, are needed to diagnose constraints, explore opportunities, investigate solutions, and catalyse collaborative learning and collective action. In this regard, agro-food product processors and farmer entrepreneurs, many of whom are smallholders, will continue to play a pivotal role in innovation and entrepreneurship for food and

nutrition security and increased incomes in African agriculture. Institutions at the community and regional levels are critical to the innovation process and can influence the wider national system.

Access to microfinance is necessary for producers to access inputs. However, on its own microfinance cannot sufficiently address the systematic bottlenecks in the output market because of the large volume of produce and products to be processed and sold. In this case, investment finance is necessary and commercial banks are better positioned to provide such services to businesses in the IPs. Furthermore, ICTs, strong linkages with other non-agriculture sectors (such as energy and feeder roads to drive SMEs), and adult education, among others, are necessary pre-conditions for sustainable entrepreneurship and farm family business development.

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Chapter 14

MAKING SENSE OF INNOVATION PROCESSES IN AFRICAN SMALLHOLDER AGRICULTURE

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Abstract

The European-funded Framework Programme 7 project, Joint Learning in Innovation Systems in African Agriculture (JOLISAA), assessed agricultural innovation experiences focused on smallholders in Benin, Kenya, and South Africa. Fifty-six cases were characterized through review of grey literature and interviews with resource persons, according to a common analytical framework inspired by the innovation systems (IS) perspective. Thirteen of the cases were assessed in greater depth through semi-structured interviews, focus group discussions and multi-stakeholder workshops. The cases covered a wide diversity of experiences in terms of types, domains, scales, timelines, initiators of innovation and stakeholders involved. Findings revealed multiple triggers and drivers of innovation. For external stakeholders, key triggers included likelihood of offering a technological fix to an existing problem and availability of funding. For local people, access to input and output markets was a powerful trigger and driver. Market types and dynamics varied greatly. Developing functional value chains and accessing markets proved particularly challenging, especially for poorer and weakly organized farmers. Over long periods, determinants of innovation changed dynamically and often unpredictably, including motivations of key stakeholders, triggers, drivers and stakeholder arrangements. The direction of innovation evolved, often moving from a technology entry point to more organizational or institutional issues. A recurring challenge for fostering innovation is whether and how to build on local initiatives and knowledge, and how to sustain externally driven innovation processes beyond the project time frame. A major conclusion from JOLISAA is that innovation has to be seen as a continuously evolving process of 'innovation bundles' (a combination of different types of innovation) of various kinds, rather than as a pre-planned, and usually, narrowly-defined technical intervention. Consequently, open-ended, flexible approaches to innovation are needed with the

potential to engage meaningfully over a long time with local stakeholders and bearers of local innovation dynamics, so that they take full charge of the innovation process and direction.

Keywords: Analytical framework, Flexible, Triggers, Drivers, Local innovation, Markets

Introduction and Objectives

Using an IS approach or perspective has become fashionable both for understanding and fostering agricultural innovation. Over the past two decades, scholars, development professionals and a wide array of organizations have increasingly paid attention to innovation and how it can best be nurtured in different contexts (World Bank, 2006; Geels and Schot, 2007; Waters-Bayer et al., 2011; Adekunle et al., 2012; Hounkounou et al., 2012; Klerkx et al., 2012; World Bank, 2012; Touzard et al., 2014). Creating and maintaining a dynamic innovation scene seems essential to adapt to a fast-changing world in which climate change, food security, increasing urbanization, globalization, or environmental concerns, all contribute to re-assessing the values, performance and current practices of economic actors and sectors (Malerba, 2007).

Yet the IS concept remains fuzzy, and its application is not without problems. Furthermore, relatively little is documented about how innovation processes unfold in smallholder agriculture. Numerous studies have revealed that innovation takes place within heterogeneous networks of researchers, farmers, private entrepreneurs, non-governmental organizations (NGO), government agents and other stakeholders (Hall and Clark, 2010). In such networks, stakeholders interact in a non-linear, iterative and non-predictable fashion to solve pressing problems, adapt to new conditions or take advantage of new opportunities. The focus and outcome of such interactions usually consist of a mix of technical, organizational and institutional innovations developed and refined 'on the go', often quite different from what the initiators envisaged. Hounkounou et al. (2012) further stressed the primary importance of institutional factors in hindering innovation in a developing country context such as in West Africa.

Within such a background, the EU-funded JOLISAA¹ project endeavoured to assess recent innovation experiences in smallholder farming in Benin, Kenya and South Africa involving multiple stakeholders (Triomphe et al., 2013). The aim was to find out how innovation unfolds, what roles different stakeholders play, what knowledge and other resources each of them contribute, what effects the innovations bring, and what conditions favour or impede innovation processes. Based on such an understanding, JOLISAA developed concrete recommendations for policy, research and practice.

This chapter tries to make sense of the added value and challenges of applying an IS perspective by summarizing the key insights about innovation processes gained from an initial analysis of the results produced by the JOLISAA project. It also draws lessons and recommendations about how best to assess and support innovation.

¹ See www.jolisaa.net for a comprehensive overview of the project's approach and results

Materials, Methods and Data Sources

JOLISAA undertook its assessment in five major, partly overlapping, phases (Figure 1): 1) development of an analytical framework; 2) inventory of innovation cases; 3) collaborative case assessment; 4) cross-analysis of cases; and 5) development of policy recommendations.

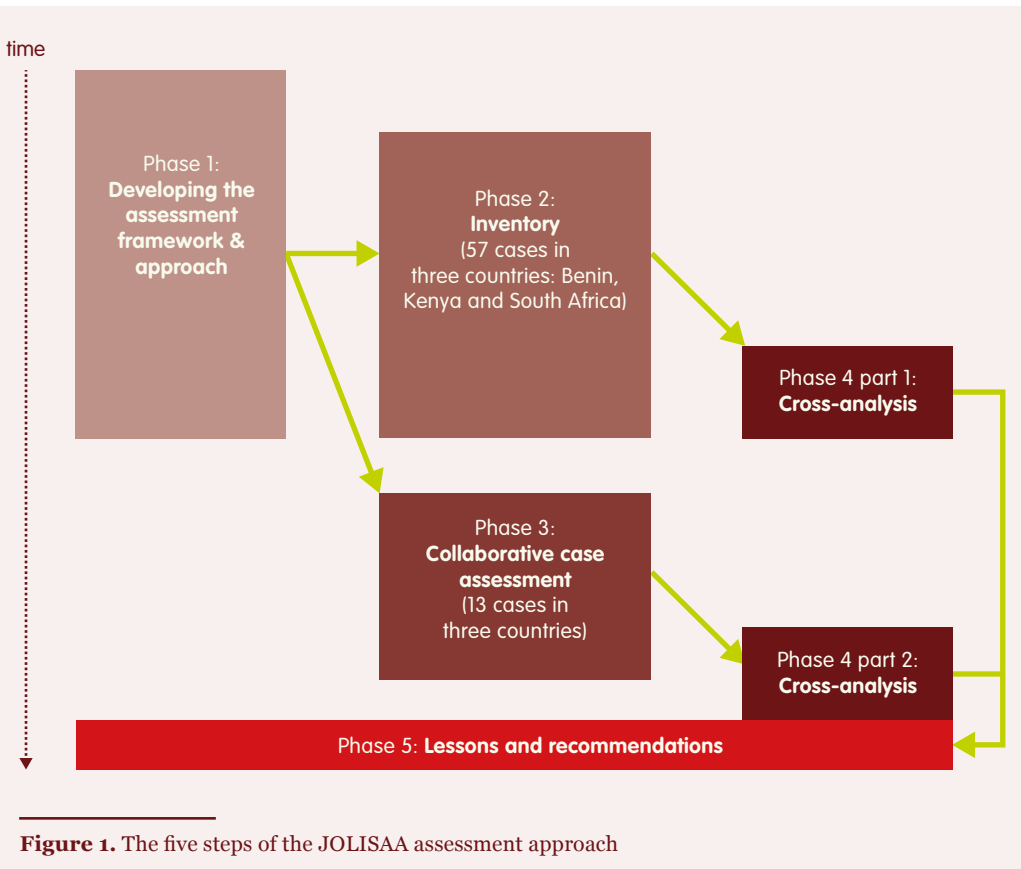


Figure 1. The five steps of the JOLISAA assessment approach

Analytical Framework

To facilitate subsequent cross-analysis among cases and countries, JOLISAA started by developing a common analytical framework for describing and assessing the various experiences. The framework was divided into two successive sets of guidelines and instruments; one for the inventory and one for the collaborative assessment (see below). It draws on the IS concept and perspective (Hall et al., 2003; World Bank, 2006; World Bank, 2012) and actor-network theory (Latour, 2005). Among others, it focuses on: innovation type, nature and domain; stakeholders, their roles and interactions; innovation triggers and drivers; innovation history; and results and outcomes obtained (Table 1). For the collaborative case assessment (phase 3), whenever possible, concrete suggestions were developed for contributing to a possible way forward in terms of how the innovation process could be boosted/pursued. However, given its short duration and resource limitations, JOLISAA did not engage in actual action-research.

Table 1. Main categories and variables used in the assessment framework

| Theme/dimension/variable | What JOLISAA wanted to know about it |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Local innovation context | General agro-environmental and socio-economic information |
| Innovation: type, nature, domain | What was the diversity of innovations addressed? |
| Stakeholders' roles and interactions | Who have been leading or active stakeholders? What type of coordination took place among stakeholders? |
| Role of local knowledge | What role has local knowledge played? |
| Innovation triggers and drivers | What have been the key triggers and drivers of the innovation process? |
| Innovation dynamics | What have been the key phases the innovation process went through? |
| Scale at which innovation is taking place | Did the innovation process take place mainly at local, regional or national scale, or at several scales? |
| Results and 'impact' obtained | What have been the effects so far, positive or negative, intended or not, in the different dimensions? |

Source: Adapted from Triomphe et al. (2013)

Inventory of Innovation Experiences

The main criteria for considering cases for inclusion in the three national inventories of agricultural innovation experiences were: 1) smallholder and other resource-poor rural stakeholders actively involved; 2) at least three different types of stakeholders involved; and 3) at least 3 years' experience beyond the initial stages of innovation. Cases were sought through: a literature search; interactions with resource persons in universities, research institutes and networks within the national agricultural innovation landscape; drawing on JOLISAA national team members' prior knowledge of specific innovation cases; and seeking innovation within a given region, area or farming system in each country. Field visits were also made to supplement the available documentation. The products of the inventory are two-fold: short qualitative semi-structured narratives describing the 57 cases, and a Microsoft Excel database in which each case is characterized through a series of semi-quantitative descriptors.

Collaborative Case Assessment of Selected Innovation Cases

Out of the 57 cases inventorised in the three countries, the JOLISAA team selected 13 for collaborative case assessment (CCA), in which representatives of local stakeholders were involved alongside JOLISAA researchers and MSc students. The cases selected (Table 2) represented the seemingly richest and most complementary sets of experiences, as well as the ones that had been the most dynamic over recent years and had key stakeholders interested in joint learning about their respective cases. These cases were assessed with respect to the actual roles and contributions of the different actors, the nature of linkages between them, the history and dynamics of the innovation process over time in relation to external factors, and the role of local knowledge and creativity. The assessment was also forward-looking: it identified specific recommendations for moving the innovation process forward.

Table 2. Diversity of cases selected for collaborative assessment within the JOLISAA project framework

| Country | Domain: natural resource management | Domain: new value chains |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Benin | <ul style="list-style-type: none"> • Integrated soil fertility management for new high-value products (~ 15 years) • Indigenous intensification in aquatic agricultural <i>hwedo</i> system through chilli pepper (several decades) | <ul style="list-style-type: none"> • Parboiled rice value chain (~ 10 years) • Soybean food multiple value chains (~ 40 years) |
| Kenya | <ul style="list-style-type: none"> • Using by-products for soil rehabilitation and securing access to lime (10 years) • Prosopis management for charcoal and fodder value chains (~ 30 years) | <ul style="list-style-type: none"> • Analysis of the innovation process linked with the activation of a natural resource in Baringo, Kenya (~ 30 years) • Gadam sorghum for beer and other processed food (~ 8 years) • Mango production, processing and marketing (~ 20 years) • Solar cooling of milk (~ 5 years) |
| South Africa | <ul style="list-style-type: none"> • Rainwater harvesting techniques for field and vegetables crops (~ 10 years) • Soil fertility management experimentation through development of an innovative participatory extension approach (~ 15 years) | <ul style="list-style-type: none"> • Bulk buying combined with credit and saving groups (4 years) |

Notes: years indicate time frame considered for assessing the innovation process.

See www.jolisaa.net for access to individual case study reports

CCA methods used included, among others, a mix of collective and individual semi-structured interviews, focus group discussions with key stakeholders, multi-stakeholder assessment workshops, direct observations and a bibliographic review of grey literature related to the cases.

Challenges for Assessing Innovation Experiences and Implementing an IS Perspective in Practice

During the assessment process, and notwithstanding significant resource limitations, which affected the choice of methods and the duration and intensity of the assessment phase, the JOLISAA partners faced several major challenges which affected the outcome in various ways.

For one, it proved to be a major challenge to develop a common understanding of innovation-related concepts and an ability to use proposed case assessment methods based on an IS perspective. Despite JOLISAA's efforts, success was only partial. Their different disciplines and professions led those who interacted within the JOLISAA framework to use such concepts as innovation processes and systems, stakeholders, enabling environment, and local knowledge in different ways, and this translated into a sizeable heterogeneity in the way cases have been assessed. Furthermore, limited generic research and IS skills (especially among young professionals), and high turnover rates of staff within national and case-specific assessment teams, also made appropriation and application of concepts and methods challenging.

In addition, capturing the detailed history of an innovation case over a fairly long period, rather than drawing a static picture, was not always possible: it would have involved prolonged and

sophisticated data collection. In addition, the data collection instruments for drawing a rich historic picture of innovation processes, and the subsequent data analysis tools, were beyond the reach of the JOLISAA project.

Results and Discussions

Between them, the 57 cases inventorized and the sub-set of 13 CCAs covered a wide diversity of experiences in terms of type (technical, organizational, institutional), domain (cropping, live-stock-keeping, fishery, processing, marketing), scale (local, national, regional) and duration of the innovation process (a few years to several decades) (Table 1). Several key features are discussed below: the diversity of stakeholders involved in innovation; the diversity of innovation triggers and the occurrence of market-driven innovation; the typically long timeframes of innovation processes; the common occurrence of ‘innovation bundles’; and the often close relationship between innovation processes and externally-funded projects.

The stakeholders in innovation typically included a mix of individual farmer-innovators, one or more community-based or farmer organizations (some of them externally triggered for innovation purposes), researchers, extension services, NGOs, private entrepreneurs, government, and externally-funded projects (usually as an umbrella/coordinating body). Depending on the specific case and phase of innovation, leading and active stakeholders varied. For instance, researchers, an NGO, or a project might be very active in the initial stages (on-farm experimentation, building capacity, facilitating interactions, etc.), while farmers and their organizations or a business stakeholder tended to become more active in later phases. In many cases, one of the stakeholders (typically an externally-funded project) played the role of intermediary (Klerkx and Leeuwis, 2008) to facilitate interaction among the stakeholders. Formal research did not usually initiate or play a leading role in many innovation cases; rather, ideas and initiatives came from different sources, including farmers. Policymakers and private sector actors were seldom among the active stakeholders. This may reflect that ‘conventional’ actors still dominate initiatives focusing on smallholder agriculture, as well as the relative scarcity of specific pro-innovation public policies in the three countries. It could also reflect a sample bias, due to the limited connections of national JOLISAA teams with ‘non-conventional’ partners. In any case, this topic would require further inquiry to understand better if and why this has indeed been the case. In addition, JOLISAA found few truly farmer-led innovation processes, probably because such cases were less visible and less likely to be documented.

Most cases had a mix of different triggers for innovation. Degradation of natural resources (e.g. declining soil fertility, dwindling supply of water, disappearing forest) was a common trigger. Others included seizing a local or global market opportunity, creating or improving a value chain, and introducing an improved technology or practice (e.g. new livestock breed, new way of processing rice). Changes in policy were rarely mentioned as triggers, yet they played a significant role as drivers (positive but also negative) of the overall process.

In many (if not most) cases, the relevant time frame for understanding the innovation process easily spanned at least one, and often, several decades. Over time, the innovation processes

often seemed to go through successive phases (Figure 2) at an uneven pace – sometimes very rapid, sometimes almost dormant – under the influence of external and internal factors (e.g. resource availability, constantly changing drivers in the overall environment, or key individuals and stakeholders coming in and out of the innovation scene). Consequently, innovation stories tend to be rather complex (more so than what the initial inventory had uncovered), with different stakeholders having different perceptions of what has happened and why. The soybean case in Benin (Floquet et al., 2014) illustrates the intricate intertwining of innovation types and phases over time, as well as the wildly evolving nature of innovations developed by different stakeholder groups, prominently including small-scale women processors (Figure 2).

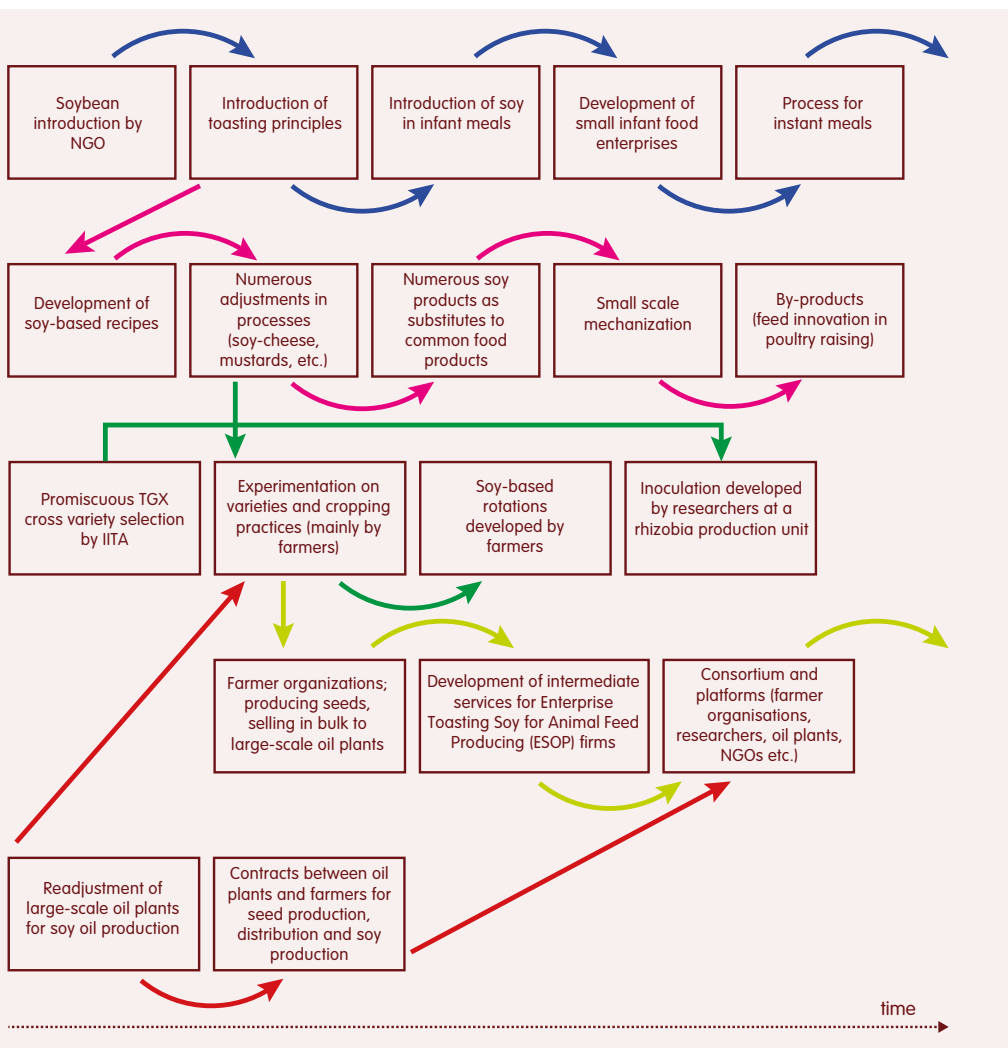


Figure 2. Technical, organizational and institutional innovations inducing each other within the soy innovation process in Benin

Source: Floquet et al. (2014)

Another issue is how much publicly supported and funded innovation processes take into account the local innovation landscape and dynamics. In the aloe case in Kenya, the effort to build a certified aloe value chain, driven by external research and development (R&D) actors, interacted only a little with the locally-driven aloe innovation process for a number of reasons, despite the notable achievements of the latter (Figure 3) (Chengole et al., 2014a).

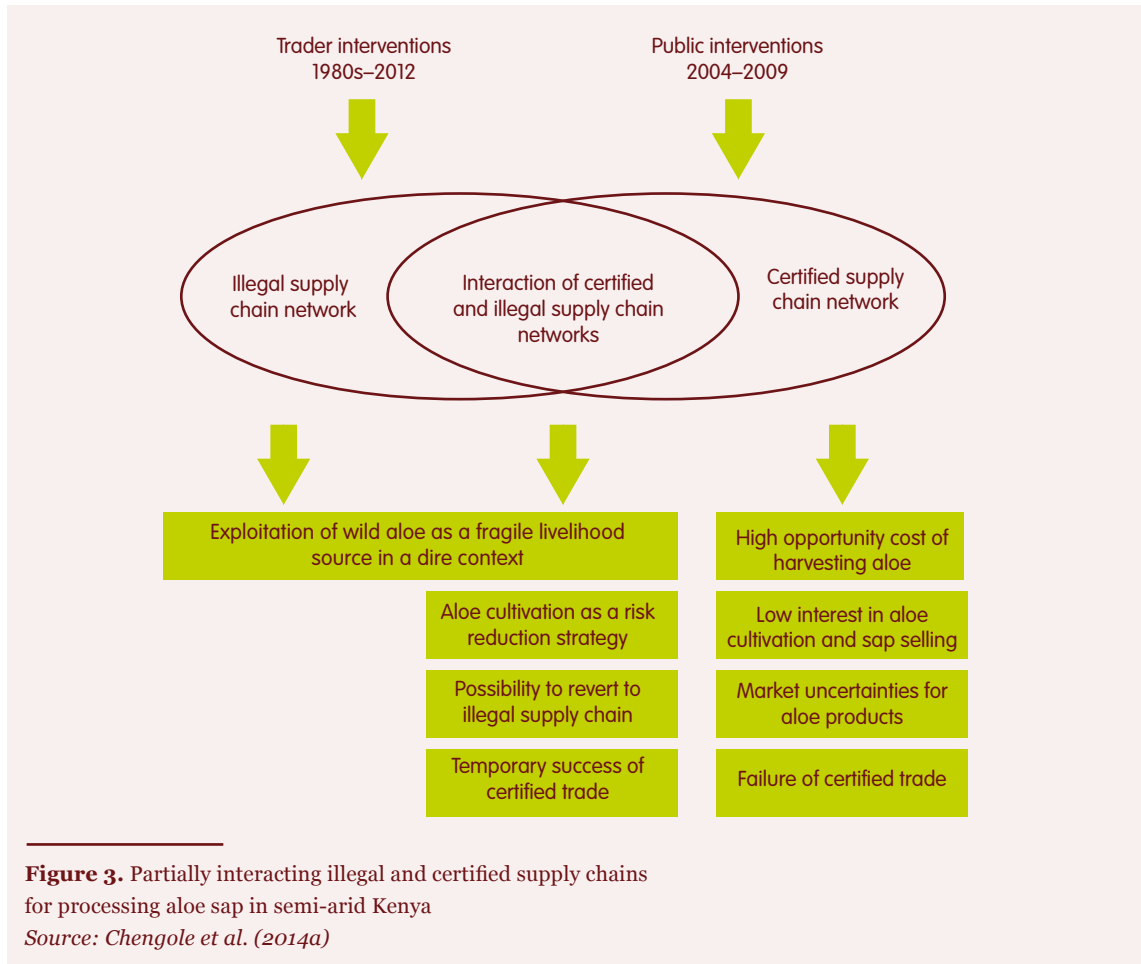


Figure 3. Partially interacting illegal and certified supply chains for processing aloe sap in semi-arid Kenya
 Source: Chengole et al. (2014a)

Outcomes resulting from a given innovation process typically exhibited several interwoven and interdependent dimensions: technical (e.g. a new variety), organizational (e.g. farmers acting collectively to acquire inputs or sell their produce), and institutional (e.g. new coordination mechanism), as the ‘simple’ prosopis case illustrates (Figure 4) (Chengole et al., 2014b). These various dimensions emerged organically over time as the innovation process unfolded from a specific entry point (often a new technology). New dimensions usually resulted from new stakeholders coming on board, or from stakeholders starting to change their practices and, in so doing, needing to make other transformations or wanting to take advantage of the evolving environment in which they operated. We refer to these combinations as ‘innovation bundles’.

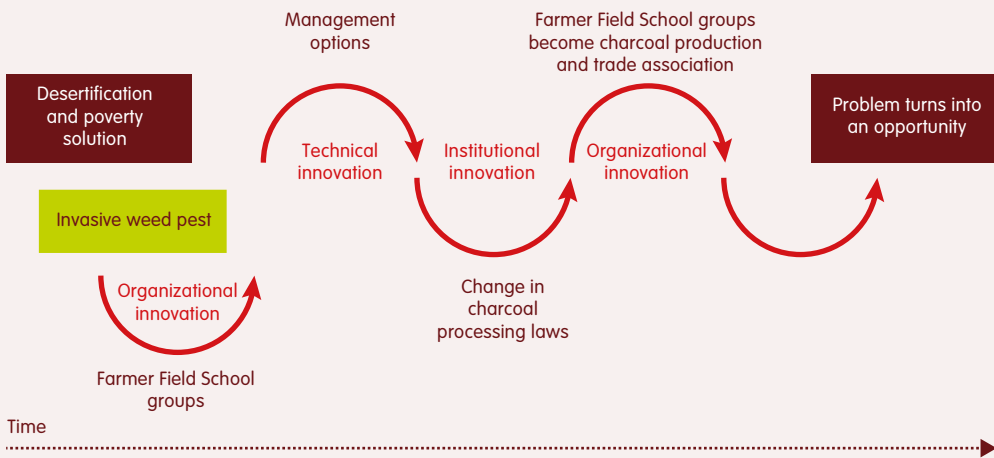


Figure 4. Sequencing of technical, organizational and institutional innovation in the *Prosopis* case in Kenya

Source: Chengole et al. (2014b)

Many innovation cases that were well documented and well known had a strong link with externally funded projects. The chaotic abundance, and succession of ‘projects’, aiming to stimulate innovation is typical for developing countries. As public funding for innovation is scarce across Africa, public institutions and NGOs depend heavily on external support to carry out innovation-related activities, while smallholders are usually too poor to pursue innovation at a significant scale on their own. Projects can be important for creating innovation dynamics embedded in a temporary favourable environment, shielding the process from the usual inhibiting or disabling factors and drivers. In doing so, they may thus allow a minimum critical mass to be reached or initial bottlenecks to be overcome. However, projects often artificially promote short-term use of technologies that may not be sustainable, trigger opportunistic behaviour from some stakeholders, lead to an aid mentality and overlook more endogenous, low-cost, and potentially more sustainable, innovation pathways and outcomes. Projects may also have difficulties in formulating objectives and designing activities that are truly in line with the demands and needs of local stakeholders. Finally, most projects typically seem to underestimate what it takes to implement an exit strategy to prevent the collapse of the emerging, yet fragile, innovation process the project has nurtured. Another unexpected consequence of this overabundance of projects is that researchers and other formal agricultural research and development actors tend to be relatively blind to innovations that have happened outside formal projects and arrangements. Yet, such innovations might be essential for understanding the eventual success of an innovation process and for sustaining its momentum, as illustrated by the diverse fortunes of the various aloe exploitation routes (whether or not they were undertaken with support from the public R&D actors) in the Baringo district of Kenya (Chengole et al., 2014a).

Conclusions, Recommendations and Implications

Altogether, the results of JOLISAA confirm that in the three African countries of study, many diverse multi-stakeholder innovation initiatives have taken place in recent years or are still ongoing, something others have also observed (Adekunle et al., 2012; Hounkounou et al., 2012). By actively engaging with a broad range of actors beyond conventional research and extension, smallholder farmers acquire new capacities and skills, and receive stimulation and support to pursue innovation, leading to improved production, income and livelihoods, and to better management of natural resources. Despite the associated challenges, many of the actors with whom farmers collaborate seem increasingly aware of the need for, and benefit from, tighter and better collaboration with farmers and their organizations, as well as with each other, and have started to acquire the corresponding attitudes, skills and approaches. Strengthened and more extensive collaboration allows innovation initiatives to deal with complex problems and challenges that cannot be effectively handled otherwise, such as sustainable production and processing, secure access to new markets, climate change, food security and poverty reduction.

The assessments conducted under the JOLISAA framework also provide useful lessons for policymakers, researchers and development practitioners about what innovation dynamics and processes are all about, how to assess them, and how to support them in ways that build upon the knowledge, creativity and existing linkages of smallholders. In doing so, the aim is to render smallholders more resilient to rapid and even sudden changes. Some major specific lessons and recommendations drawn by JOLISAA include:

- **Build on innovation ‘in the social wild’:** With little or no support from public R&D institutions, many smallholders actively innovate individually and collectively to solve problems, improve their farming and income, and grasp opportunities. Yet many such initiatives take place ‘under the radar’, ‘in the social wild’ (Sherwood et al., 2012) and are ignored by state, non-state, the private sector and even farmer organizations trying to develop and diffuse agricultural technologies (Figure 2). Local innovations that fit the wide variety of contexts of African agriculture need to be better recognized, valued and encouraged. Interventions should build on them and on the associated local knowledge and energies as a starting point for fostering sustainable, locally-led and locally-supported innovation processes.
- **Support unpredictable innovation processes:** Innovation cannot be planned from the outset, as it evolves in unpredictable and often unexpected ways over long periods of time and is specific to a changing context. In supporting innovation, formal R&D actors should make use of highly flexible, open-ended and iterative approaches adapted to local conditions. Moreover, innovation does not happen in a linear way. JOLISAA studies show that innovation pathways took new and unexpected directions over many years, or even decades, as they unfolded within and mostly outside the framework of external interventions. Any attempt to foster innovation processes through public intervention should hence recognize such unexpected deviations and act accordingly. This asks for less emphasis on rigid pre-planned prescriptions about what to do and more readiness to adjust priorities, approaches and modalities of support along the way in an iterative and flexible manner, reflecting changing dynamics and opportunities.

- **Address the multiple dimensions of innovation:** JOLISAA cases show that beyond new technologies, innovation has important social and organizational dimensions that are closely intertwined and cannot be addressed in isolation from each other, if innovation is to be successful. Social and institutional change (such as new ways for farmers to organize themselves and access markets, or new rules and policies) is always needed so that new technologies can be fully integrated into local practice. Consequently, taking a holistic view of innovation gives a better chance of producing outcomes that are more relevant for smallholder farmers and other local actors. In addition to generating and transferring technology, support should therefore go to enabling and accompanying organizational and institutional changes that make innovation possible and successful and may drive large-scale diffusion and adaptation of technological and social innovations.

Such lessons and recommendations are being shared widely and add to those already found by other programmes such as Conversion of Science-System of Innovation (Jiggins et al., 2016), or the Research Into Use programme funded by the UK Department for International Development (Clark, 2016). Our hope is that, eventually, some of them may help change the approaches of donors, governments and public or not-for profit R&D institutions for the better.

Finally, JOLISAA results also show the value of using an IS perspective in uncovering key factors related to the nature and dynamics of ‘real’ innovation processes, even though implementing such an approach on a large scale may prove challenging. The hope is that more researchers and practitioners will be willing and better able to prepare themselves to meet and overcome such challenges in the future. Acquiring such capacity is key to increasing the detailed knowledge of the dynamics of contemporary African agriculture and with it, the potential to improve the pace, relevance and reach of many innovation initiatives.

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Chapter 15

THE JOURNEY TO R4D: AN INSTITUTIONAL HISTORY OF AN AUSTRALIAN INITIATIVE ON FOOD SECURITY IN AFRICA

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Abstract

Recent years have seen a growing interest in agricultural research for development (R4D) initiatives designed to address the need to make more effective use of research investments in the development process. While there remains some ambiguity about the precise nature of R4D, it is nevertheless clear that a shift to this approach is going to require considerable institutional change in research practice. This chapter presents a brief case study of the experiences of a group of Australian, African and international agricultural research organizations which, together, initiated an explicit R4D programme. A key feature of this case study is the contestation that arises in the journey to R4D, with different points of view and patterns of practice vying for legitimacy and prominence. Contestation and negotiation is always a feature of bringing new practices into use and reflects that institutions are continuously 'in the making'. Orchestrating 'conversations' with key R4D stakeholders about emerging modalities of research, and fuelling these conversations with evidence of the impact of new practices, would help progress the institutional change process needed to sustain a more effective deployment of research in the development process.

Keywords: Research for development, Innovation, Institutional change, Impact, Contestation

Introduction

Recent years have seen a growing interest in a cluster of ‘for development’ (4D) agricultural research initiatives designed to address the need to make more effective use of research investments in the development process. These initiatives are branded in different ways: agricultural research for development (AR4D); integrated agricultural research for development (IAR4D) or simply R4D (the term we use in this chapter).

The discourse associated with R4D draws from a range of existing ideas: participatory approaches, action research, social learning and innovation systems (IS). An ambition to be systems-oriented is usually explicit. However, the precise nature of these R4D approaches in both conception and practice remains fluid and ambiguous and can often be little more than a statement of intent (Hall et al., 2012). What is clear is that making the ambition of R4D a reality is not a case of simply developing and applying a set of tools, although these may well help. Rather, it demands rethinking traditional agricultural research and development (R&D) practices and the institutional arrangements that underpin them (Hawkins et al., 2009).

This chapter presents a brief case study of the experiences of a group of Australian, African and international agricultural research organizations which, together, initiated an explicit R4D programme. The case study – of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Australian Department of Foreign Affairs and Trade (DFAT) Africa Food Security Initiative (AFSI) within a broader Australian programme on Food Security in Africa – involved a partnership between CSIRO and Biosciences eastern and central Africa (BecA) Hub in Eastern Africa, and CSIRO and West and Central African Council for Agricultural Research and Development (CORAF/WECARD) in West and Central Africa, with financial support from DFAT¹.

The scope of the chapter is not to document the considerable research portfolio and development successes supported by AFSI (McMillan, 2011; Adakal et al., 2013; Etwire et al., 2013; Harvey, 2013). Instead the focus is to reveal the challenges and implications of the institutional change agenda associated with the shift to R4D practice. These deliberations draw on an independent mid-term review² of AFSI completed in 2012 (AusAID, 2012) and thereafter on the process of redesigning AFSI to better gear it towards enhancing the implementation of an R4D approach. The key message is that such a shift is a contested space. The chapter attempts to capture this contestation by articulating a number of different viewpoints and tensions that emerged during the implementation of AFSI. The chapter concludes that, while ‘how to’ manuals on R4D have a role to play, of greater importance are efforts to orchestrate constructive dialogue among R4D stakeholders to resolve differences and move forward. These dialogues need to be underpinned by an evidence-base of the impact effectiveness of different research modalities and be conducted in the reflective R4D spirit of ‘learning by doing’.

¹ AusAID commissioned AFSI in 2010 and was merged into DFAT in 2013.

² The review was led by the lead author of this mid-term review, prior to joining CSIRO in 2014.

Origins and Understandings of R4D

The practice of agricultural research in international development has a long history of progressive development of approaches aimed at addressing the challenge of making more effective use of science as a driver of agricultural-led growth (Biggs and Clay, 1981; World Bank, 2006; Ison and Russell, 2007; Röling, 2008; World Bank, 2008; Hounkonnou et al., 2012). The origins of R4D can probably be traced back to the late 1990s and the crisis that agricultural research was facing at that time. This was an era of declining funding and research organizations were under increasing scrutiny to not just deliver research outputs, but also to demonstrate their impacts on poverty. Over the intervening years, a range of 4D-styled research approaches have emerged in response to the ongoing search for more effective ways of using research in the agricultural innovation process: AR4D (Mbabu and Ochieng, 2006; Daane, 2009); IAR4D (FARA, 2007; Hawkins et al., 2009; Adekunle et al., 2014); or simply R4D.

Definitions of these modalities of research vary considerably, although they generally point to systems thinking as a founding concept (Hawkins et al., 2009; Foran et al., 2014). Depending on the operational traditions and the epistemologies of advocates and practitioners, different R4D modalities give different emphasis to farmer empowerment, learning and capacity building and the role of research as the key operational focus. Recent reviews of the R4D documentation (Hall et al., 2012; Foran et al., 2014) point out that R4D is not a disciplinary approach in the conventional sense, but a modality of research informed by a systemic understanding of innovation and change that requires interaction and learning at multiple levels. A key challenge, for many organizations that seek to adopt R4D is that, in general, definitions are fluid, and conceptual underpinnings are contested and largely lack the protocols required to inform new modalities of research practice.

Adopting a more systemic modality of research practice implies a move out of the comfort zone of tried disciplinary protocols and the systematic adoption and application of 'tried and tested' tools. It implies moving into the domain of broad principles to shape practice in contexts characterized by uncertainty and complex patterns of interactions between stakeholders and their social, institutional and physical environment. Not surprisingly, this level of ambiguity and unfamiliarity of working systemically (rather than systematically) has led to many organizations latching onto specific 'R4D tools'. These tools have then become synonymous with R4D. Most notable among these tools is the idea of an innovation platform (IP)³, an idea that, for many, has come to be itself a definition of R4D (Tenywa et al., 2011).

Like R4D, there are different definitions of IPs (FARA, 2007; Nederlof et al., 2011), but all acknowledge physical or virtual, vertical and horizontal linkages, and interactions between homogenous and heterogeneous stakeholders to provide solutions to challenges and to identify opportunities in the target platform (Ison et al., 2014). All too often, however, these definitions overlook the

³ An IP is a mechanism to foster the interactions that facilitate information exchange and learning among different actors, which then leads to innovation. Such platforms usually have a generic organizing theme that focuses on a shared challenge or opportunity, which the platform seeks to address through innovation (Röling, 1994).

broader learning system dimensions implied by the systemic framing of R4D (Hall, 2011; Hall and Mbabu, 2012; Clark, 2016). As a result, IPs are increasingly used as a tool that bolts on to the end of the technology delivery pipeline, without any appreciation of the wider institutional learning and change agenda implied by R4D (Röling et al., 2014). Without institutional change, existing modalities of research remain unaltered, challenging the scale and sustainability of outcomes and impacts achieved.

What Would Idealized R4D Look Like in Practice?

There will likely be no general agreement on the precise nature of R4D practice. However, the discourse around the topic and the proposition that IS can be an underpinning concept suggests that projects and programmes in this framing would have a number of key characteristic features. These features include⁴:

1. **Expanded scope of research and learning:** Projects are both multidisciplinary (combining different skills) and interdisciplinary (combining concepts from different disciplines) in order to investigate biophysical phenomena as part of the wider IS of institutions, markets, and policy and development processes. Projects use diagnostic tools to define systems research questions and entry point activities and identify relevant partners and stakeholders.
2. **In-built impact pathways:** Projects are designed to combine R&D activities through partnerships and networking. This networking develops links to users of research and other sources of information and learning as well as complementary investments and activities that strengthen impact. Projects use multi-stakeholder approaches, including IPs, to define and address objectives in ways that encourage wider stakeholder collaboration at different levels – farmer, research community, development community, market actors and policymakers.
3. **Capacity building in organizing for learning:** Projects and programmes experiment with ways of organizing learning to improve the effectiveness of using R4D. Projects and programmes use research, process monitoring, knowledge management, innovation communication and training to improve and share lessons on the effectiveness of multi-stakeholder and other approaches that support technical, organizational, institutional and policy learning.
4. **Multiple pathways to impact:** Projects achieve impacts as a result of innovations emerging in production, marketing and consumption systems in the domain of project activities. Projects can also have impacts by contributing to the development of the capacity of R4D systems by generating lessons that stimulate institutional and policy changes. Social capital developed among project actors leads to impact as it enhances the capacity of actors to organize when novel situations emerge demanding a R4D response.

⁴ This list of idealised R4D characteristics was developed by the lead author (AusAID, 2012) based on observations, IS concepts and previous programme experience (Hall et al., 2008).

5. ***Funding and design frameworks that support flexibility and adaptive management:*** A flexible design enables projects to navigate the evolving development context within which R&D are undertaken. Funding structures allow resources to be redirected towards emerging opportunities. Monitoring and evaluation (M&E) frameworks are designed to capture unexpected outcomes. Project cycles are of sufficient length to allow the strengthening of partnerships that underpin innovation and impact. Projects may be led by research organizations or by development or commercial organizations, depending on the context.

6. ***A framing that integrates different types of research and action and integrates different types of learning:*** The above characteristics of idealized R4D projects suggest that the ambition to better use R4D requires a framework that helps with two types of integration. The first concerns the integration of research (of different types) with market and capacity development activities. The second concerns integrating different forms of learning so that there is a continuous process of both technical change, but also a continuous process of strengthening the capacity to use R4D. This capacity has policy and institutional dimensions. R4D does not give primacy to any particular mode of research (basic, adaptive, communicative, demand-driven, supply-driven) or development practice (public-led, private-led, top down, bottom up). Instead, it is about assembling the tools, resources, organizations and modalities that are appropriate to supporting, at a particular moment in time, a systemic engagement with development opportunities and challenges being tackled.

This view of R4D implies a new and different role for research that, in addition to knowledge and technology generation, involves brokering, capacity building and designing the ‘systems’ that enable innovation (Hounkonnou et al., 2012). New skills and competencies as well as new configurations of relationships – both within the research community and between the research community and others in the innovation landscape – are obligatory. Also required are new notions of what research investment can and should deliver and over what timeframes. This, in turn, has implications for accountability, funding timelines and M&E arrangements. With the success of this approach resting on such a daunting set of institutional changes, the shift to R4D is and will continue to be both challenging and prolonged. Given the varying ‘starting points’ and historically-derived practices and perspectives of the organizations engaging in AFSI (our case study), such challenges clearly needed to be met.

Origins and Features of AFSI

In response to the food price shocks of 2007/08 (Mitchell, 2008), the Australian Government established the AFSI in 2009 that included a linked set of two partnership programmes led by CSIRO with R4D organizations – CORAF/WECARD and BecA Hub. The partners and their roles are described in Box 1. The CSIRO-led AFSI⁵ ran from 2010 to 2014 and aimed to improve food security and agricultural productivity in Africa through joint research, working with and building the capacity of the African partner organizations. The partnership had a number of key design principles:

⁵ Total funding for the programme was A\$30.7 million (€21 million), of which A\$1.9 million (€1.3 million) was provided by CSIRO.

- It had an overarching development objective that was to be delivered through research, with impact indicators couched in the same terms as Australia's Africa Food Security Strategy (household welfare indicators).
- It sought to align with existing African R&D organizations, programmes, plans and systems and associated regional and sub-regional development plans, particularly the Comprehensive Africa Agriculture Development Programme – an initiative launched by the African Union Commission in 2002 (Badiane et al., 2011).
- As part of this alignment the programme had a strong capacity building emphasis, seeking to strengthen research expertise, but also addressing institutional development needs in partner organizations and related delivery systems.
- It had a strong systems orientation, both in terms of research approaches adopted, but also in terms of engagement in impact pathways and the use of an M&E approach adapted to this systems orientation.
- The partnership used a combination of competitive and commissioning processes to identify research projects that addressed the priorities of the African partner organizations.

These principles, articulated in the partnership document, do not have the level of detail or emphasis needed to align with the six R4D characteristics mentioned earlier. These do, however, signal a shift to achieving development impacts within the life of a research programme; albeit a research programme that, at the time, was envisaged as extending beyond the current phase.

In West Africa the partnership developed seven projects; one on seed systems, one on animal health (tick control), a policy pathways project and four on integrated crop livestock systems. In Eastern Africa it developed seven projects; three on animal health, three on nutrition and one on food safety.

CSIRO was involved in the selection and development of these projects in collaboration with its partners. Once approved, CSIRO identified expertise, both from within CSIRO and Australia more generally, to collaborate and mentor these projects. CSIRO also provided a range of institutional development support, including: collaborating and mentoring in M&E, impact pathway analysis, communication/engagement, research ethics and, in West Africa, the implementation of an IAR4D approach. As well as the informal capacity building which occurred at all levels of the partnership, CSIRO helped organize and design formal capacity building efforts, most notably in Eastern Africa, where it established a novel bioscience fellowship programme for young African scientists⁶.

A further activity within the programme was a cross-partnership learning project. This was originally conceived as an embedded part of the M&E system, with the rationale of elevating learning on using R4D to become a research inquiry in its own right. However, this learning component did not become fully implemented as there were divergent views about its value to the overall

⁶ The Africa Biosciences Challenge Fund is managed by the BecA-ILRI Hub <http://hub.africabiosciences.org/component/students/?view=studentdetails&layout=studentmap>

agenda of the programme. During AFSI implementation the learning project operated with a restricted mandate of exploring lessons for CSIRO on the R4D process (Ison et al., 2014).

Box 1. About the partners

CSIRO is Australia's national public research organization and a world leader in basic and applied science, including farming systems research and biosciences applications to improve agricultural productivity and sustainability, animal health, plant improvement and human nutrition. CSIRO's role in the programme was both as the managing agency and as a source of research and related capacity building expertise.

The partner organization in West and Central Africa was CORAF/WECARD, a sub-regional agricultural organization mandated to coordinate agricultural research and technology dissemination by 22 national agricultural research institutes in West and Central Africa. In 2014, CORAF/WECARD started its second operational plan, to further roll out IAR4D among its members.

The partner in Eastern Africa was BecA Hub, a joint activity of African Union/New Partnership for Africa's Development and the International Livestock Research Institute (ILRI). The BecA Hub is a shared agricultural research and biosciences platform located at the Nairobi campus of ILRI. BecA provides access to first class research laboratories for African scientists and post-graduate fellows to conduct their research in Africa and address African agricultural/food security problems. The research projects implemented at the BecA Hub are directed towards delivering products useful for improving productivity and ensuring food security for small-holder farmers and regional communities in Africa.

R4D in the Partnership

While CSIRO has a long history of undertaking farming systems research in Africa (McCown et al., 1992; Whitbread et al., 2010), leading the AFSI partnerships represented a new undertaking for the organization. The dual roles of managing the design and implementation of a substantial government programme and being an active partner in the research met CSIRO's strategic aspiration to proactively contribute to whole-of-government responses to issues around Australia's portfolio of agricultural R4D initiatives. This new positioning of CSIRO realigned its relationships within Australia's development community and provided the opportunity for it to highlight research as a legitimate path to development impacts. AFSI represents a discernible shift in CSIRO from a provider of farming systems research to an aspiring broker in IS and R4D approaches that deliver development results.

The AFSI partnerships in West and Eastern Africa approached R4D in different ways, which reflected the mandates and organizational focus of the two partnering African organizations. In West Africa the partnership design had an overall objective of "assisting CORAF/WECARD to more effectively discharge its responsibility to drive improved agricultural research in West and Central Africa." CORAF/WECARD's then strategic plan (CORAF/WECARD, 2007) mapped out how this responsibility would be addressed and placed significant emphasis on the explicit use of an IAR4D approach. The elements of which were described as "engagement and partnership with

a full range of stakeholders, targeting change and adoption of new practices at various scales from on-farm to policy, and an embedded capacity building and learning focus for all stakeholders.”

This objective of helping CORAF/WECARD “discharge its responsibility” was critical as it implied a very specific programme logic relating to the way CORAF/WECARD was using IAR4D to drive its strategic and operational plans. The essence of this was that CORAF/WECARD would not only support a portfolio of R4D projects seeking to have impact in the domain of these projects, but it would also use these as a way of learning about how to have impact and use this to drive the transformation of its 22 member agricultural R&D organizations in the region. In other words, projects were not only seeking to achieve direct immediate impacts by working with communities and others, but were also seeking to have long-term and large-scale impacts by stimulating institutional and policy changes in the wider agricultural R&D landscape.

At the time of the mid-term review it was found that this logic was poorly understood in the partnership programme and, indeed, CORAF/WECARD was itself struggling to implement this logic in its operational plan (AusAID, 2012). However, what it meant was that CSIRO, following the principle of working with the partner organization’s extant commitments, agreed to work with CORAF/WECARD’s IAR4D approach. CORAF/WECARD’s main IAR4D implementation tool was the IP and it also became the main implementation vehicle adopted in the partnership programme.

The use of IPs was new territory for both the West African R&D organizations leading the partnership projects, but also for most CSIRO scientists. As part of the partnership programme CORAF/WECARD organized IP training for its projects with the help of an external consultant. This, however, focused on the organizational issues of establishing and running IPs and did not explore the wider role of platforms as ways of stimulating institutional and policy changes in the broader R4D system. In other words the emphasis was on (IA)R4D tools rather than on the framing of research as part of an integrated and interactive innovation process operating from farm to policy domains (i.e. IS research).

The mid-term review (AusAID, 2012) also found considerable debate and confusion among researchers in the projects about what IA4RD actually implied. Some saw it as merely a way of transferring research results. Some saw it as a way of empowering farmers. Others saw it as another way of operationalizing farming systems research. IAR4D was mainly seen as synonymous with IPs. With limited guidance on IAR4D, either in CORAF/WECARD or CSIRO, many research participants were frustrated by the approach, seeing it as a distraction rather than a way of reframing research as part of a wider process of innovation and change.

In addition to IPs, CORAF/WECARD had put in place other programme structures to help address the learning dimension of the IAR4D approach, notably communication and knowledge management programmes and an M&E programme. However, these programmes functioned along conventional lines, the former being focused on technical information dissemination and public relations and the latter mainly focused on accountability indicators (IDL, 2013). The net result was that, despite good intentions, the systemic dimension of R4D and its implied

impact pathway, through policy and institutional change in regional R&D systems, was not well supported by the partnership. This shortfall was due in part to poor conceptual understanding of IAR4D and to capacity and institutional challenges that the partnership was unable to address or did not give sufficient attention to. The earlier mentioned learning project could have played a key role in driving systemic learning, but CSIRO was unable to internally legitimize the learning project as an embedded element of the programme (Ison et al., 2014).

CORAF/WECARD's Dissemination of New Agricultural Technologies in Africa programme, which ran parallel to the AFSI collaboration with CSIRO, also featured IPs that were built around the dissemination of hybrid maize and varieties of cassava that were resistant to Cassava Mosaic Virus (Sanyang et al., 2016). This programme also faced a number of challenges in its reliance on IPs as its main intervention vehicle.

In the Eastern African partnership the adoption of a distinctive R4D approach was less explicitly articulated. However, the objective of the partnership was aligned to BecA's business plan, current at the time of the design, which stated its ultimate goal as "harnessing and applying modern biosciences and related innovations to increase the productivity and sustainability of agricultural systems in Africa". This implied a desire to go beyond research discovery and engage with stakeholders in the process of innovation and impact. In practice, the Eastern Africa partnership projects made an explicit attempt to define impact pathways at the outset of the research process; they placed a strong emphasis on developing partnerships with a diverse range of stakeholders in impact pathways, including from the private sector and the policy arena. They also attempted to set up monitoring and learning arrangements to improve the impact performance of research and programme investments.

The institutional setting of the BecA partnership as a bioscience programme meant that AFSI projects were operationalized and challenged in different ways to the West African partnership. The concept of platforms was used here (although not always explicitly called IPs) but one of these was conceived as a technology platform; for example, as an aflatoxin diagnostic platform⁷. This reflected BecA's mandate of building a critical mass of bioscience expertise in Africa. Aligned with its mandate were paths to impact for most projects where stakeholders participated more as recipients of 'innovations' from bioscience rather than as part and parcel of the innovation process. A notable exception was a project on African swine fever that succeeded in developing meaningful modes of collaboration with stakeholders (Ison et al., 2013).

M&E arrangements also followed conventional lines. In some projects, despite impact pathway logic based on the development of coalitions of stakeholders, the M&E arrangements did not emphasize collecting data on the development of these stakeholder coalitions, which could have helped fine-tune the projects' implementation approach.

⁷ A regional mycotoxin analytical platform was established to enable reduced aflatoxin contamination of Kenyan and Tanzanian maize <http://hub.africabiosciences.org/activities/research/299-capacity-and-action-for-aflatoxin-reduction-in-eastern-africa-caarea>

The partnership also established a highly successful capacity building programme for young African bio-scientists. From the outset the programme was designed to have a strong focus on building the research capacity of under-represented organizations and scientists (especially women) in the BecA region. Fellowships and training largely focused on building skills in bioscience applications. The focus was not on exposing scientists to the policy and institutional challenges of developing effective delivery systems for their research. This is not to suggest that bio-scientists should become innovation specialists. Rather it suggests that bio-scientists of the future need to understand the systemic challenges of research and innovation in complex application environments that impinge on the utility and effectiveness of science. There is an equally important case to be made for ensuring that social scientists need a stronger grounding in biophysical aspects of innovation and impact. This would help professional interactions among disciplines.

The mid-term review (AusAID, 2012) also observed that many bio-scientists working on the partnership saw the 4D discussions as a distraction to laboratory-based investigations. They had some justification for this frustration. However, it was also observed that limited access to social and economic expertise meant that there were limited opportunities to link laboratory-based work with development stakeholders, and limited skills to investigate the effectiveness of impact delivery arrangements.

Mid-Term Progress

The mid-term review (AusAID, 2012) found that in both West and Eastern Africa the partnership had made useful steps in moving towards R4D. Highly appreciated and genuine partnerships had been developed between CSIRO and its African partners and a relevant portfolio of research projects had been established. Most encouraging of all was that CSIRO and its partners acknowledged that they were struggling with the implementation of an R4D approach and that the time was now right to shift more firmly in this direction. The mid-term review recognized the scope and willingness for mid-course correction and made a number of observations and recommendations specific to each partnership, as well as a generic set applicable to the partnership as a whole:

- ***Further attention needs to be given to intervention logic and impact pathways.*** In particular, a continuous critical analysis of impact pathways and their effectiveness was encouraged, rather than simply asking for a potential pathway as a funding requirement at the project proposal stage.
- ***A specific research agenda on how to achieve impact should be established.*** A learning focus will have a double effect: enhancing the impact of research done through adaptive management feedback loops, while also identifying lessons for wider application and building capacity in AR4D.
- ***The research envelope must be expanded to deliver impact and investigate delivery mechanisms.*** It was recommended that in the partnership portfolio, some projects needed to be focused more on near impact activities and less on foundational research. These projects should actively involve impact pathway stakeholders throughout the research process and aspire to deliver impact during the life of the programme. The rationale was also that it was

necessary to achieve impact in order for delivery mechanisms to be understood and engaged and this, in turn, would inform future programme design.

- ***More attention should be given to policy, institutional and livelihood aspects of research.*** The review noted that effective conduct, delivery, adoption and impact of research were subject to complexity in spheres beyond biological sciences. It was recommended that the partnership needed to better access and use expertise on policy, institutional and livelihood dimensions of its research in order to maximize potential impacts.
- ***The support provided by CSIRO needed to be revised.*** The review did not express a criticism of the quality of expertise provided by CSIRO, but noted that a wider set of expertise was required and that CSIRO needed to act as a broker of excellence in addition to being a supplier of expertise in areas where it had an acknowledged comparative advantage.

In charting a possible way forward the review also suggested establishing an R4D learning hub to serve both partnerships. The logic behind this was to enable lessons to be shared on how to use research to achieve impact. These lessons could be used to influence wider policy and programme design in the region and the international community more widely and that this would create another impact pathway with wide-scale reach.

The Redesign of AFSI

After the mid-term review was completed in late 2012, a prolonged redesign process took place. The redesign process was punctuated and prolonged by a change in the Government in Australia, the subsequent merging of the Australian Agency for International Development with DFAT, and a consequent change in Australian aid priorities.

The process of redesign involved partnership responses to the mid-term review and a formal design process for a proposed next phase of funding for AFSI (2014-2018). In early 2013, a first design mission resulted in draft proposals developed by CSIRO. However, donor critiques of these proposals raised concerns that there was an insufficient shift in emphasis towards development and delivering impacts. Further design development was stalled until after the Australian election in September 2013, from which one consequence was the policy decision by DFAT to concentrate its African programmes post-2014 in Southern and Eastern Africa.

A second design mission and proposal development exercise followed in November 2013. This focused only on Eastern Africa, reflecting the re-alignment of the partnership with the Government's revised geographic priorities for the African region. The drafting of this design was led by an external development consultant at the request of DFAT. The redesign process involved project-level development stakeholder workshops arranged by BecA and CSIRO. These were used to shape the proposed new research and to devise the implementation strategy that actively involved these stakeholders as partners. The overall framing of the proposal was aimed firmly at delivery of impacts through value chain and other policy and institutional developments. The projects themselves are articulated as coalitions for innovation. Learning and innovation are placed centre-stage in each project and are supported by an overarching learning and performance management system, with provision made to recruit new expertise to service this role.

The proposal clearly articulates the understanding of projects contributing to the overall capacity of the agricultural IS in Eastern Africa and the institutional and policy development dimension of this task.

While there were plans to curtail AFSI activities in West Africa post 2015, a redesign process took place for the last 12 months of the partnership which ended in March 2015. This focused on identifying IPs that showed promise for achieving impact and providing additional support with monitoring, evaluation and learning activities. The emphasis in this redesign was to develop a better understanding of the factors associated with using IPs as both a vehicle for project-level impacts as well as stimulus for institutional and policy change within wider R4D systems that constitute the enabling environment for innovation and impact.

Tensions on the Journey to R4D

The above narrative suggests that the findings of the mid-term review seamlessly led to a redesigned AFSI programme that incorporates the recommended elements of an R4D programme. In reality, the redesign terms of reference, the mid-term review recommendations and the role for research in development were contested and reinterpreted through different personal, professional, organizational, bureaucratic and institutional filters during the redesign process. These tensions manifested themselves as different points of view about how R4D should be organized and practised; some were resolved, others remain outstanding. Such differences emerge from both the traditions, norms and policies of different organizational stakeholders (research, development and donor partners), as well as the perspectives and agency of individuals. The main issues include:

1. **The demand for development impacts from research organizations.** An increasingly adamant prerequisite for a redesigned AFSI programme (in addition to research), to take direct responsibility for delivering on-ground impacts, was viewed by some as outside the mandate (and possibly undermining the comparative advantage) of the mostly biophysical research organizations involved in the partnership. Furthermore, the mid-term review recommendations to strengthen emphasis on learning and on researching innovation processes were questioned as competing with both science and impact imperatives. Such negotiations and views are, of course, an issue of balance, complementarities and priorities. However, what it does reveal are challenges to the legitimacy of research organizations leading the impact process and to investment in critically analysing the effectiveness of R4D programmes.
2. **Capacity strengthening as an impact pathway.** The notion of using research projects as a means of strengthening capacity for the delivery of development impacts is discounted relative to the demand for immediate on-ground impacts. A systems capacity strengthening agenda within R4D projects could be used to influence regional and international research practice, with potential for wide-scale impact, albeit at extended timeframes and uncertain pathways to change. At their commencement, both the CORAF/WE CARD and BecA partnerships expressly included a focus on capacity strengthening for these reasons. The AFSI redesign of the final 12 months of the West Africa partnership led to prolonged debates about

whether capacity strengthening should remain a priority in a run-out phase seeking to demonstrate legacy impacts on smallholder farmers.

3. ***Changing programme expectations and framings.*** Over the course of AFSI, views on the programme deliverables changed. At the beginning there was a level of comfort with a programme logic that viewed research, capacity building and other institutional and behavioural outcomes as milestones to the longer-term achievement of impacts. Today, the demands on the AFSI project portfolio are for impacts of the sort associated with straight development projects, transferring resources and services to the poor. The redesign of AFSI aspires to a portfolio of R4D projects that cover a spectrum of deliverables, from quality science, pilot-scale impacts within project timeframes, to impacts at scale delivered through development partners. However, the underlying logic of this portfolio is about delivering at scale, over longer timeframes, stimulated through capacity strengthening and institutional and policy changes.
4. ***R4D or research in development.*** During the redesign phase, differences surfaced about who should lead AFSI projects; development agencies who then draw in research, or research organizations who link their work to development trajectories and processes. There is probably no consensus answer to this debate, it being an empirical question of which arrangements best suit different problem sets. However, these discussions reveal that research organizations and development funders both need to better understand R4D in order to reach an accommodation on how they best work together.
5. ***Capability gaps in R4D for research organizations.*** The review and redesign process highlighted the need for a wider set of expertise to service R4D projects than was widely available in CSIRO, BecA and CORAF/WECARD. Much of this expertise concerns social and economic research and allied expertise – for example in monitoring, evaluation and learning. Not only is this expertise thinly spread and hard to access but a tension remains about whether resources are more effectively spent on this type of expertise rather than bioscience.
6. ***Communicating across disciplines and paradigms.*** Part of the capability challenge undoubtedly arises from the ambiguity in R4D approaches and in the conceptual language preferred by social scientists, which their bioscience colleagues can struggle to comprehend. Within both the social and biophysical sciences there are tensions around modes of research practice, e.g. research on, or with, as well as limited expertise in, systemic action research approaches (Ison, 2008). There are also underlying tensions arising from different points of views about how innovation takes place – as a research-led process of discovery and application or a systemic process that combines technological and institutional adaptation. These oft-argued views are not irreconcilable. However, the R4D community has yet to fully develop a language and accessible narrative that explains the compatibility and promotes synergy between these two views.
7. ***Science and impact tensions.*** An understanding of R4D as an applied research or technology uptake approach creates tension between approaches that deal with short-term

adaptive, impact-orientated tasks and the need to make long-term investments in foundational biophysical science and associated scientific capabilities. Some of this tension arises from the way R4D is commonly interpreted – that it excludes biophysical science when it need not. Regardless, short-term impact agendas (and the approaches these reward) can cause underinvestment in long-term research that will underpin the ability of agricultural systems to respond to the unpredictable challenges and opportunities of the future. This tension does not seem to be adequately addressed in the policy research associated with R4D programmes.

8. **Research-driven or opportunity-driven tensions.** Projects under the AFSI partnership mostly are led by research organizations and CSIRO manages the programme as a whole. This has tended to influence the type of entry points that projects and their IPs have chosen. A desire to identify where existing research procedures, findings and tools can best be put into use has been explicit and caused some degree of path dependence. Technological breakthroughs from research do represent an opportunity and so IPs are an avenue for progressing institutional and policy innovations needed to make effective use of these technologies. An alternative view is that IPs should be opportunity-driven, seeking entry points emerging from value chains, policy changes, new development investments in roads and other infrastructure, or the emergence of new alliances and partnerships. In these cases research would play a supporting role as part of a wider agenda.
9. **Publication tensions.** A continuing requirement to publish is often seen as exacerbating these research and innovation tensions. However, in reality, the tension in R4D is more about achieving a balance between disciplinary science publishing and publishing in the innovation science literature.
10. **Science and innovation broker tensions.** CSIRO is facing a challenge of its changing role from simply a research partner to also being a broker of a wider set of innovation-related activities. This is still new territory for the organization and so it faces the external challenge of persuading those in the development domain that this new role fits alongside its conventional science role. Furthermore, the internal challenge is for those in CSIRO to fully recognize the need to play this role in R4D work and to accept the business case for projects like AFSI that contain brokering and science investments.
11. **Evaluation tensions.** There is still no widely accepted way of evaluating R4D programmes. Differing views remain about what constitutes an appropriate evaluative framework, the nature of metrics of success applied in evaluations, what disciplinary mix should be used in review teams, and what mix of regional and international expertise needs to be enlisted.

Ways Forward: Institutions in the Making

The tensions described above are not unique to the AFSI partners, but are part of a wider pattern of contestation that is observed in discourses around the agricultural R&D interface (Hall, 2011; Sumberg and Thompson, 2012). However, the range of tensions apparent in the case of AFSI highlights the magnitude of the institutional challenges that the journey to R4D entails. Hawkins

et al. (2009) similarly observe that, beyond new tools and protocols, organizational and professional transformation will be required to enable a shift to R4D. Röling (2009) points to the need for institutional change in the agricultural science profession to allow a different modality of using R4D impact to be pursued. An external review (CPWF, 2014) of a 10-year, US\$100 million (€90 million) CGIAR R4D programme, arrived at a similar conclusion.

“The experience of CPWF suggests that successful R4D is contingent on people and their enabling environment in programmes. Give the wrong people the right tools and R4D will fail. Get the right people and the wrong programme enabling environment and R4D will fail. The challenge for implementing R4D is that it requires professional and institutional transformation to make it work and this does not seem to be widely understood as a necessary starting condition. This will require new skills, but also new attitudes.”

Further practical help will certainly be needed in operationalizing the six idealized project characteristics outlined earlier in this chapter. However, the key message from this chapter is that the most help is needed in negotiating into use the practice of R4D in the prevailing institutional setting of R&D practice. The process of institutional change is not one that lends itself to blueprint solutions that can simply be transferred (Biggs and Smith, 2003; Röling, 2009). As Westenholz et al. (2006) explain: institutions (in the sense of new forms of practice and organization) are always ‘in the making’, emerging in particular historical, political and social settings. In other words, institutional change is rarely characterized by seismic shifts in attitudes and practices, but rather by continuous incremental changes. These changes emerge from human interaction and agreement; they cannot be designed, tested and replicated or scaled up as if they were technologies (Biggs and Smith, 2003).

If we accept that this continuous process of incremental institutional change is the key to unlock R4D, how can this be enabled? Foran et al. (2014) observe the need to orchestrate conversations within and between R&D organizations about the changing practice of research in a policy setting where the balance between research and research for innovation and impact is changing. This would seem to point to the critical, but usually underemphasized, learning dimension of R4D and systemic engagement with the innovation and impact process. However, a call for ‘conversations’ about changing research practice needs a much sharper legitimacy and operational focus.

The agricultural systems research literature has for many years been calling for a more reflexive mode of monitoring to upgrade the performance of research activities (Klerkx et al., 2012). However, as the case of AFSI demonstrated, embedding and legitimizing a reflexive learning activity in an R4D programme can face its own institutional challenges (Ison et al., 2014). Nevertheless, other programmes have been able to institute these approaches (CoS-SIS, 2013; CPWF, 2014; Jiggins et al., 2016). It is difficult not to draw the conclusion that the agency of key individuals has been critical in ensuring that the institutional learning change agenda is given adequate attention in R4D programme design and implementation.

Over and above institutional learning and change within programmes, the experience of AFSI suggests that institutional change is also needed at a strategic level. There is a need to orchestrate ‘conversations’ within the research community and between the research community, development organizations and sponsors, as well as with those responsible for setting the policy environment in which R4D practice sits. A useful approach might be to create fora and other dialogue spaces to enable interaction and agreement on new ways of operating around R4D. Clearly, an evidence-base on the effectiveness of new research modalities – what works and what does not – must be accessible. Developing such an evidence base requires not only investigation of development impacts, but also of the processes and institutional arrangements that enable (and disable) these impacts. This could fuel a constructive mode of reflective and collaborative learning about how the power of science and research can be brought to bear on the development challenges of today and the future. Contestation and disagreement won’t disappear, but instead could be better harnessed to support the ‘institutions in the making’ that underpin R4D.

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Chapter 16

INNOVATION SYSTEMS, DOUGLAS, DOUGLASS AND BEYOND: USING CULTURAL THEORY TO UNDERSTAND APPROACHES TO SMALLHOLDER DEVELOPMENT IN SUB-SAHARAN AFRICA

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Abstract

Innovation systems (IS) are taken to be coherent and consistent narratives or discourses. This chapter uses the *Group/Grid* or *Cultural Theory* (CT) to distinguish four competing IS narratives, each with their own theory of change, criterion variables, strategies, pathways of innovation and designs for innovation platforms (IP):

1. The business model of agronomy (BMA), based on the methodological individualism of the diffusion of innovations and ‘agricultural treadmill’ paradigms and focusing on technology development to raise yields.
2. Package and value chain approaches that seek to enable individual entrepreneurship through access to services, inputs, credit and markets and other institutions that reduce transaction costs.
3. Promotion of rules and regulations (hierarchical institutions) to constrain the pursuit of individual interests for some public goods (governance, control of corruption, sustainable use of natural resources).
4. Egalitarian approaches that seek to empower, emancipate, strengthen civil society and enhance social capital.

This framework proves useful for analysing the history of agricultural development in industrial countries and sub-Saharan Africa (SSA) to point to ways forward for inclusive approaches to mobilize the vast productive resources under smallholder management in Africa.

Keywords: Agricultural treadmill, Individualism, Innovation platforms, Inclusive, Institutions, Empower, Social capital

Introduction

This chapter attempts to understand the incompatibility of ideas that agricultural IS practitioners encounter when they ply their trade. Why do such different views of research and innovation continue to persist especially in the context of the agricultural sector in SSA? And why, after decades of effort, is there so little concrete achievement on the ground in terms of mobilizing the vast productive resources under African smallholder management for food security and food sovereignty at levels beyond the extended family or local town? Why is there so little agreement on ways forward given the expected impact of climate change and the growth of its population from 1 billion now to 4 billion by 2100 (Gerland et al., 2014)?

In order to answer such questions and contextualize the contributions to the current volume, let us suppose that agricultural innovation systems (AIS) are narratives or discourses with consequences in the real world in that they inform professional practice, decisions about investment, definitions of criterion variables for assessing success, and intervention strategies. Mytelka (2016) sees IS as conceptual tools and frameworks “that are particularly useful since they do not regard ‘research to the market’ as a linear track, nor do they limit innovations to those at the frontier of knowledge.” Focus is given to the interactions among and behaviour of various actors which are shaped by the policy and institutional context. There have been attempts to define the AIS but in my view there is not one ‘true’ definition of AIS, not one concrete phenomenon that one could call an innovation system. It is more accurate to say that AIS narratives engage on a ‘battlefield of knowledge’ (Long and Long, 1992). Sumberg and Thompson (2012) speak of ‘contested agronomy’ and Struik et al. (2014) write about ‘scientific controversies in intensification and sustainability’ and about trade-offs. AIS narratives are dynamic, contested and never finished. Formulating a definition is a strategic manoeuvre.

Cultural Theory

Contestation, controversy, trade-offs and battlefields suggest that this chapter would benefit from CT formulated by Mary Douglas (2007) and Aaron Wildawsky (Thompson et al., 1990). CT considers human collectivities as pushed and pulled among four competing views on optimal ways of exerting social control and coordinating human affairs (Figure 1). Each ‘cultural bias’ or ‘type of rationality’ reflects preferred kinds of social organization and the values and institutions that uphold them. Each defines itself in contrast to the others. What is rational is defined *a priori* by the premises that uphold each view. This means that the conflicts between them cannot be resolved by argument, and that compromise is at best a temporary and shaky truce based on the relative power of competing views. Societies are healthy to the extent that all four views are given space to express themselves. Domination by any one is detrimental to the health of the collectivity as a whole (Douglas, 2007). The choice for CT in the present chapter is based on the expectation that it can ‘deconstruct irreconcilable differences by identifying the particular type of civilization which the culture (read AIS narrative) upholds’ (Douglas, 2007).

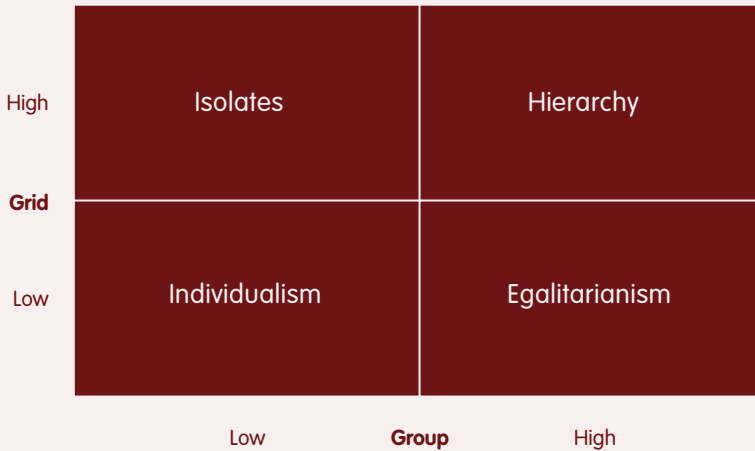


Figure 1. The grid/group diagram used in CT

Source: Based on Douglas (2007)

Four perspectives emerge from two control dimensions: the extent to which people are perceived to be constrained by rules (institutions; formal and informal) (Grid); and the extent to which they are perceived as embedded in stable social networks (Group). Mary Douglas grew up in a Catholic convent school, where she experienced the safety, regularity and predictability of strict *hierarchy*, which stood in sharp contrast to the economy of the England of her time, imbued with neo-liberal values that extolled *individualism*, such as entrepreneurship, freedom, competition, wealth, power and market. The archetype of hierarchical culture is the bureaucrat, for individualism it is the businessman.

Egalitarianism refers to an enclave of people not bound by rules but by strong ties, equality and shared ideals and values. The sect, non-governmental organization (NGO), people's organisation (e.g. a women's cooperative), or sub-political movements (Sherwood et al., 2013) are examples. *Isolates* are more difficult to place. Douglas speaks of prisoners or the Queen as people who are strongly bound by rules but not embedded in groups. We could perhaps think here of unorganized, exploited and alienated peasant communities at the receiving end of globalization, such as those studied by Van Haften and Van de Vijver (1996) in Burkina Faso. In Latin America, one could think of the 'culture of poverty' (Lewis, 1969) with its fatalism, although critics have emphasized that the self-perpetuating nature of poverty is a 'convenient truth' for the dominant classes and that fatalism is the 'best adaptation to impossible circumstances' and does not persist once they change (Niehoff, 1966). On the other hand, Acemoglu and Robinson (2013) and Tabellini (2008) have argued that institutional backwardness can persist over centuries, although they give different reasons. The former emphasizes the role of elites in maintaining such patterns, while the latter focuses on the 'diffusion of adverse cultural traits', which make citizens 'tolerant of ineffective government'.

I will use three of the four perspectives, *individualism*, *hierarchy*, and *egalitarianism*, as most relevant for analysing AIS narratives in SSA and for contextualizing some of the contributions to the current volume.

Individualism

In Douglas' scheme, individualism looks at society as the outcome of individual pursuits that are neither constrained by membership in groups, nor by societal rules and norms. Keywords linked to innovation in this perspective are freedom, entrepreneurship, growth and competition. Its corollary, *methodological individualism*, is the expectation that desirable societal outcomes emerge from individual pursuits to optimize personal/private utility. Societal attributes are seen as aggregated individual actions. This idea is reflected in the expectation that the decisions of thousands of farmers to adopt agricultural technologies leads to agricultural development and lower food prices. It usually ignores collective externalized costs, such as lowering of water tables when farmers adopt pump irrigation. Such costs are themselves an emergent property of individual action (S. Biggs, pers. commun. 2015).

Douglas' individualism raises a theoretical issue where it comes to the role of rules or institutions. She defines individualism in terms of low group and low grid, i.e. in terms of *absence* of control mechanisms, be they group pressure or institutional controls through constitution, regulation, informal norms, policies, governance, or accepted practice (Williamson, 2000). And, as we have seen, methodological individualism looks at society purely as an emergent property of aggregating individual behaviours. In that view, institutions, apart from property rights and their observation, do not feature very strongly. Enter Douglass North (1990).

The contribution of New Institutional Economics (North, 1990) is to have demonstrated that markets, rather than being the autonomous emergent outcome of the aggregation of individual supply and demand, exist only in evolved webs of rule-based institutions that are embedded in a society's political process. Laws protecting private property, agreement to accept an intrinsically worthless piece of paper as money, and companies that insure trade risks are examples of such institutions. Organizations and entrepreneurs initiate and shape the direction of institutional change, which in turn affects the behaviour of the market (R. Haagsma, pers. commun. 2015). Market and institutions mutually influence each other, in line with Giddens' (1984) structuration hypothesis.



Figure 2. Level playing field
Source: McIntyre et al. (2009):66

In North's perspective, institutions play a crucial role by reducing uncertainty in human interaction and thereby the transaction costs of doing business. Institutions *enable* individuals to pursue personal utility. In other words, and contrary to Douglas' condition of 'low grid', the expression of individualism is facilitated by an elaborate supportive institutional context that ensures fair competition ('level playing fields', Figure 2) and upholds other agreements that are of mutual benefit.

Institutions

Institutionalism is a view of society that accepts that the individual actor is governed by collective rules, norms, systems of governance, and shared knowledge that both supports and constrains the actor's agency. Emile Durkheim (Durkheim and Traugott, 1994) defined institutions as 'social facts' that are collective and social in nature and external and constraining to individual choice. Institutions are "supra-individual units of analysis that cannot be reduced to aggregation or direct consequences of individuals' attributes or motives" (Di Maggio and Powell, 1991).

A good example of an institution is the Plimsoll Line marked on the hull of a ship, that indicates the maximum depth to which the ship can be loaded (Figure 3) (Jones, 2006). It is named after Samuel Plimsoll, a British politician who was instrumental in drafting in 1875 a law that enforced the use of the line to stop unscrupulous ship owners from overloading their ships without regard to the safety of their crews. The Board of Trade was charged with enforcing compliance with the new law. The Plimsoll Line has all the hallmarks of an institution, in this case a hierarchical one: it is a negotiated, accepted and enforceable collective rule that constrains individual action within technical limits in conformity with the public good.

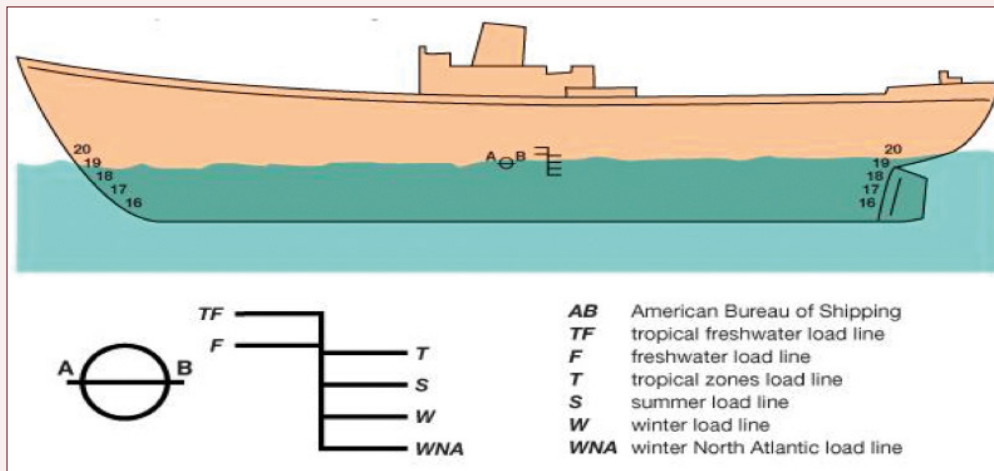


Figure 3. The plimsoll line

Source: <http://www.marine-knowledge.com/plimsoll-lines-significance-meaning/>

The difference between methodological individualism and an institutional perspective is famously exemplified by the contrast between Hardin's (1969) 'tragedy of the commons' and Ostrom's (1992) observation of sustainable 'governance of the commons' by traditional communities. In his classic article, Hardin, from the tenets of neo-classical economics, inferred that each herdsman (on common grazing land) is locked into a system that compels him to increase his herd without limit in a world that is limited. In other words, common grazing land will inevitably be degraded as each individual tries to take as much from the commons as possible before others can do so. Ostrom, on the other hand, documented how traditional communities had preserved common property resources, sometimes for centuries, through rules limiting the number of people having access to the commons as well as the off-take per member, and measures to monitor and sanction compliance. Ostrom opened up a rich vein of research and policymaking by examining how institutions (in this case hierarchical ones) can reconcile collective resource conservation and the pursuit of individual interest. Tabellini (2008) discusses the conditions under which such institutions emerge and observes that in societies in which group membership is not well defined and individuals interact across groups, enforcement is achieved through formal and specialized means such as courts. Ostrom did not reach beyond local informal rules to such generalized rule of law and Biggs (Pers. comun. 2015) warns against romantic enthusiasm about local rules that ensure sustainability of resource use, by pointing out that local rules can easily be used by local elites to serve their own interests.

Institutions play different roles in Douglas' scheme (Figure 1). As we have seen, she defines *individualism* in terms of an absence of institutions, which applies to methodological individualism. North (1990) convincingly showed that by reducing transaction costs institutions enable the individual pursuit of personal utility. In North's perspective, individualism thus requires institutions to function. In *hierarchy*, institutions constrain individual behaviour for the public good. In both cases, institutions define individual behaviours; the difference is the objective. In North's case, the objective is to *create enabling conditions for the expression of individualism*, while hierarchy emphasizes *constraining it for the realization of some public good*. As we shall see, this distinction is crucial for the analysis of AIS, especially given the calls for agricultural intensification and global food security, on the one hand, and for equity and sustainability of finite resources and ecosystem services, on the other.

It is helpful at this stage to summarize the theoretical toolkit I will use for analysing AIS narratives and related vested interests and ideologies by distinguishing four 'cultural biases' or 'types of rationality' (Box 1).

I shall not deal with isolates. The remainder of the chapter uses these four positions to analyse AIS narratives, as well as their manifestation in the IS projects and programmes described in the current volume.

Box 1. Four types of rationality

- The methodological individualism of neo-liberal economics that predicts desirable outcomes from the aggregation of individual behaviours and mostly ignores institutions (except for the assumption of property rights).
- The web of institutions that enable pursuit of individual (or corporate) freedom and utility by reducing transaction costs.
- The hierarchical institutions that constrain individuals in the interest of some public good, such as sustainability of resource use.
- Egalitarian institutions with their focus on social capital, values and equality as dynamic forces for change.

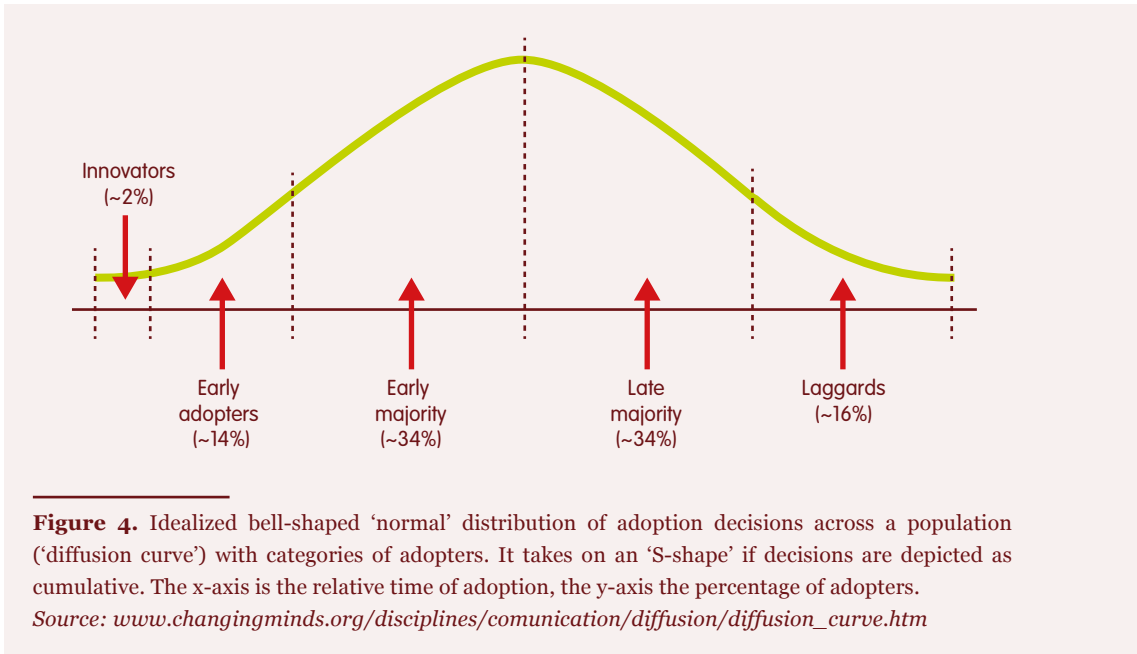
Methodological Individualist Approaches to Innovation

Three research-based paradigms that for some 40 years supported methodological individualist approaches to agricultural innovation came together after the Second World War.

Diffusion of Innovations

Ryan and Gross (1943) studied the spread of hybrid maize among farmers in Iowa and for the first time recorded the autonomous and rapid diffusion of a novel practice among farmers. Diffusion was identified as a magic multiplier of research (e.g. breeding) and extension effort and became recognized as an important component of the transformation of US agriculture during a period of phenomenal productivity growth and of capturing the economies of scale. Rogers' (1962) 'Diffusion of Innovations' became a classic also because the diffusion paradigm proved to have wide application, including such phenomena as the Hula Hoop craze, the spread of HIV/AIDS (which motivated Rogers to move into health education) (Vaughan et al., 2000), and the diffusion of cassava among Nigerian villages in the 1960s.

The diffusion paradigm has become so widely known that there is no need to explain the bell-shaped diffusion curve (Figure 4), adopter categories, the individual's adoption process, and the characteristics of an innovation that facilitate or impede adoption. Methodological individualism underlies this paradigm: diffusion is basically seen as an aggregate phenomenon, without much contextual analysis, say of government support or prices. The decisions of independent individuals be they firms, households or farmers, to adopt a novel practice or product, are sufficient to collectively transform a lifestyle or an industry.



The Agricultural Treadmill

In 1958, Wilbur Cochrane described the economic mechanism that drives diffusion. He called it the 'agricultural treadmill'. It explains diffusion in terms of neo-liberal economics: individual decisions to maximize utility lead to optimal societal outcomes. The treadmill works as follows:

- Farms are seen as small firms (individual decision-makers), which all produce the same commodities;
- Each one is too small to affect the price: they are price takers who produce as much as they want against the going price (rational choice). Individuals' efforts to improve their incomes by producing more leads to a constant downward pressure on overall prices (societal outcome of individual choices);
- Since overall prices are still dictated by the prevailing state of the art, introduction of an innovation allows innovators and early adopters to capture a windfall profit;
- Soon diffusion leads to over-production and further price squeeze. Adoption becomes necessary to stay in the marketplace;
- Farmers who cannot keep up drop out. The survivors absorb their resources and capture economies of scale.

Farmers in such countries as the US and the Netherlands, who have survived years of attrition in farm numbers, have internalized the model: to stay in business you have to surf the waves of innovation and keep growing.

What makes the treadmill particularly attractive for policymakers and corporations are its aggregate outcomes (Box 2). With these perceived advantages, it is little wonder that the treadmill has been widely embraced as the model for agricultural policies, such as the EU's Common Agricultural Policy.

Box 2. Aggregate outcomes of the treadmill: food for policymakers

- Drives intensification and productivity growth;
- Reduces food prices;
- Eliminates uncompetitive farms and releases labour for industry;
- Increases industry efficiency and improves the nation's competitive position;
- Locks farmers into webs of corporate services and sales.

Investment in Agricultural Research and Extension

The influence of the diffusion paradigm and the agricultural treadmill was strongly enhanced by an oft-quoted and still authoritative article in *Science* (Evenson et al., 1979) that, based on studies of the diffusion of hybrid maize and other technological innovations and the multipliers involved, showed that investment in agricultural research and extension has a high internal rate of return (IRR, i.e. a profitable investment). Its second author, Vernon Ruttan, was a highly influential member of 'the profession' (agricultural economics), which at the time claimed the monopoly for translating science into policy.

A Business Model of Agronomy

The apparent success of the Green Revolution in Asia was a final vindication of the model of agricultural development built on diffusion, the treadmill and a high IRR to investment in agricultural research. Its core narrative is that investment in science-based innovation in technology and practice is the driver of productivity growth. I call this the BMA because it justifies a predominant role of agricultural science and technology in agricultural development. Its pathway of innovation is discovery, delivery and use. The linear character of this pathway comes to the fore in such terms as 'upstream' and 'downstream' and the characterization of farmers as 'ultimate users'. The 'system' is the (national) agricultural science, technology and innovation system¹ or national agricultural research system (NARS).

I would not have given so much attention to BMA if it were not that I consider it still to be a dominant AIS narrative in SSA. Other narratives have a hard time in getting their ideas across, for instance in suggesting the need for professionalism beyond the practice of (applied) science for technology development. Agricultural scientists and research play central roles in the organizations that drive African agricultural development. NARS, regional research organizations such as the Council for Agricultural Research and Development in West and Central Africa (CORAF/WECARD) with its 22 member NARS in West and Central Africa, the continent-wide Forum for

¹ Not to be confused with the International Food Policy Research Institute's Agricultural Science and Technology Indicators (e.g. Stads et al., 2014)

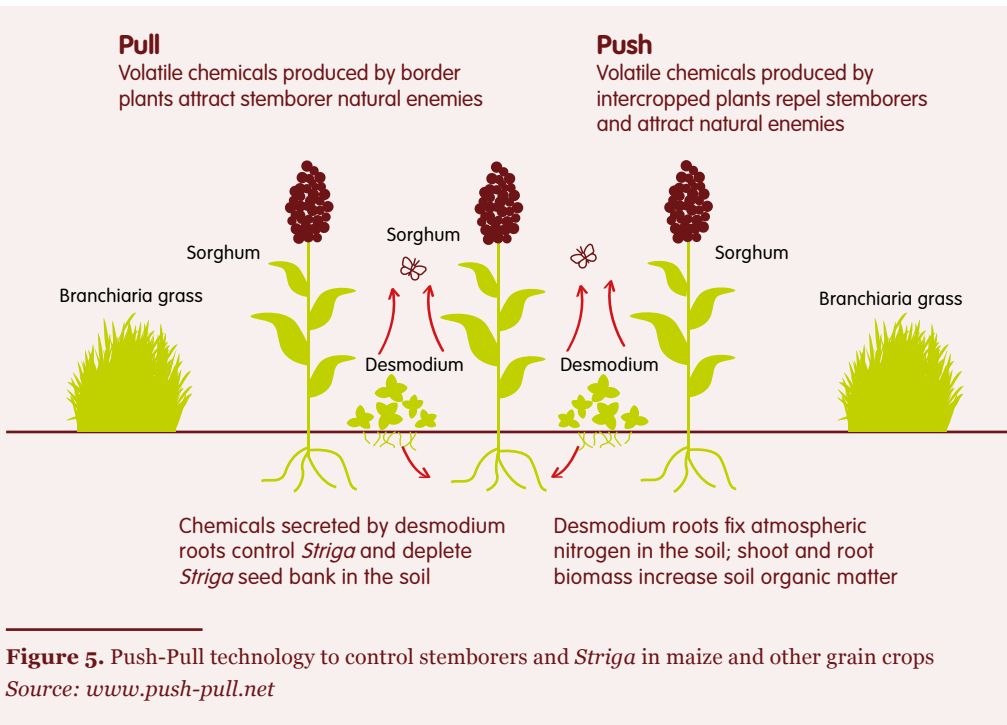
Agricultural Research in Africa (FARA), and the International Centre of Insect Physiology and Ecology (*icipe*) today operate alongside such international research organizations as AfricaRice and the International Institute for Tropical Agriculture. The utilization of the output from these research organizations by farmers has been promoted by schemes, such as the Training and Visit System of Extension (T&V), that once covered all African countries but eventually was found to be ‘fiscally unsustainable’ (Anderson et al., 2006). As we shall see, the dominance of BMA as an AIS narrative also shines through in current innovative efforts such as Integrated Agricultural Research for Development (IAR4D). Investment in agricultural research and development (R&D) is still used as an indicator for the development effort of African nations (Stads et al., 2014).

BMA tends to focus on the individual farm and plot level. Its main criterion variable is yield/ha. An illustration of this thinking is a Wageningen colleague who regards the pursuit of organic agriculture a ‘crime against humanity’ because it is said to have maximum achievable yields/ha some 20% below the potential and will therefore not allow the proverbial population of 9 billion in 2050 to be fed. The limitation of yields/ha as the criterion variable is shown by the work of Tilman et al. (2011) who estimated that moderate intensification in areas with yield gaps could help achieve global food security in 2050 while substantially reducing agriculture’s total environmental impact. In other words, if the criterion is global food security rather than yields/ha, moderate intensification (e.g. based on agro-ecological principles) can be effective. The implicit assumptions of using yields/ha as the criterion for effectiveness is one of the sources of misunderstanding among AIS practitioners.

The Role of Technology

I am aware that the analysis of methodological individualist approaches to agricultural innovation and the characterization of BMA as an AIS narrative can easily lead to defensive reactions on the part of agricultural scientists. This would miss the point. What I have criticized is the dominant AIS narrative. There is no question that agricultural science has a key role to play in the innovation of smallholder farming, and good science is essential in developing technologies that work and can have an impact. Figure 5 gives an example. Where things have gone wrong is that BMA assumes that developing technology is not only a necessary but *sufficient* condition for agricultural development and ignores the role of enabling, constraining and civil society institutions in technology use.

A good example is a current research effort to develop an antiserum that is effective against the bites of all species of snakes in Africa. Given that snakes globally kill an estimated 40,000 people every year, this is a laudable initiative. But developing such a serum is not sufficient if one considers the difficulties of creating timely access to the antiserum for those who have been bitten.



Why BMA has had Disappointing Results

In general, BMA has failed in Africa, especially where food crops are concerned. The Green Revolution never took off (Djurfeldt et al., 2005). Clark (2016) describes the low uptake of outputs from the UK's Department for International Development's major investment in agricultural research and analyses how the follow-up effort to drive Research Into Use also met with only partial success. In several countries, agricultural administrators have begun to realize that NARS are not making the expected contribution to agricultural development. In Mali, for instance, on the 50th anniversary of its independence from France, its highly regarded Institut d'Economie Rural (IER) produced a booklet featuring the major technologies the IER had produced over the years. It made painfully clear to agricultural administrators that only a few of these technologies had been taken up by farmers (M.L. Sidibé², pers. comun. 2011).

The question is why? One issue is that most of the research institutes that make up Africa's NARS focus exclusively on soil fertility, plant protection, genetics, and other disciplinary and technical issues. Very few have a capacity to analyse the actual constraints of smallholders in their own domains of practice or to assess the institutional contexts in which smallholders in a given locality seek to secure their livelihoods. Such issues typically are considered to be outside the purview of science; agriculturalists do not know how to talk about them. Such disciplinarity should, of course, be no problem, were it not that the dominance of research organizations as expected

² In 2011, M.L. Sidibé was the Director General to the Ministry of Agriculture.

drivers of agricultural development turns the commission of technology development into an omission of interventions for helping smallholders become effective entrepreneurs. Agricultural research can be compared to a commercial company without a marketing department.

Another explanation for the disappointing impact of BMA is the Structural Adjustment Programmes (SAP) of the early 1990s. As a condition for receiving further financial assistance, SAPs forced African countries to shut down or reduce funding of public veterinary services, input distribution and produce marketing schemes, credit schemes, integrated commodity marketing boards and parastatals. Contrary to expectation, in most cases the private sector did not step into the void created. As a result, the limited public infrastructure for enabling smallholder development was more or less abolished.

The Forgotten Role of Enabling Institutions in Industrial Countries

A third and key point are the blinkers of the BMA to the history of the societies in which it emerged. Hounkonnou et al. (2012) highlighted this neglected history by exploring agricultural development in the US and the Netherlands, today the two largest exporters of agricultural products by value. The rapid productivity growth in these countries as a result of diffusion and the treadmill mechanism was *preceded* by up to a century by careful and deliberate development by diverse interests (including farm leaders, nobility eager to increase the production of their estates, schoolteachers, priests, politicians and philanthropists) of an enabling institutional context for individual farm development.

The United States. By the 1940s when hybrid maize diffusion took off in Iowa, most US Land Grant Colleges had been established for more than 50 years to provide public agricultural research, extension and education in their State. Farmer Unions had gained strong representation in Federal and State Legislatures. Effective value chains were in place for most commodities. Farmers were embedded in effective networks of service providers, including farm mechanization specialists, and product markets. In 1932, Roosevelt's New Deal, in response to the crisis following the crash of Wall Street in 1929, initiated farmer income support through quotas and direct subsidies and established the Tennessee Valley Authority that covered several states with a far-reaching public mandate to manage the watershed for energy, erosion control, and flood protection.

The Netherlands. The building of the railroads across America in the 19th Century had released huge quantities of cheap grain onto European markets. The ensuing agricultural crisis led to the establishment of a State Commission in 1886 with the explicit task of creating the enabling conditions that would allow farmers to 'pull themselves up by their own bootstraps'. The measures included initiation of agricultural research and education for farmers and (explicitly) farmwomen, and the Land Tenure Act of 1917 that still gives tenants security over their usufruct and therefore makes it rational for them to invest in improving the land. The government also subsidized semi-compulsory land improvement, re-adjudication, consolidation and drainage programmes that transformed the landscape of Rembrandt for 'rational production'. It is said that at least one-third of Dutch productivity growth was due to more effective control of groundwater levels.

The Dutch public extension service is another example of the enabling institutions that were created. It was so well organized and successful that in 1951, i.e. well before the take-off of agricultural productivity growth, Wageningen University and Research (WUR) started an International Course in Rural Extension for mid-career professionals that over the next 40 years attracted thousands of international participants and became a forum for exchange of knowledge and experience in the profession. The public extension service was supported through research and capacity building by a Department of Extension Studies in WUR that spawned textbooks by Van den Ban and Hawkins (1996), translated in ten languages, Röling (1988) and Leeuwis with Van den Ban (2004).

The enabling character of the public extension service became apparent in the 1980s when the government could no longer ignore ground and surface water pollution, saturation of agricultural soils with nitrates and phosphates, and acid rain. These were the externalized costs of the 1 t of liquid slurry per head of the Dutch population that the country's livestock farmers were producing *in surplus* to what the land could absorb³. The government started using extension agents, who so far had served farmers' demands, to implement 'manure laws'. Their new policy-implementing role ('hierarchy') brought the frontline workers into conflict with their historic role of serving farmers' interests. They lost the trust of farmers. After a brief period of tension between the leadership of the service and frontline staff (Wagemans, 1987), the service was privatized. From that time onwards, the Ministry of Agriculture, historically a farmer support organization, with a minister who was usually recruited from the farmers' organizations, became an arm of government responsible for balancing the interests of nature, air and water quality and other environmental issues (public goods), on the one hand, and those of agriculture as a prime export industry, on the other.

Although we have not yet described the distinction between creating enabling conditions for individual entrepreneurship and hierarchical institutions for constraining individual behaviour, the rise and fall of the Dutch public extension service clearly demonstrates that distinction and also shows how enabling individualism can become so dominant that it becomes dysfunctional from a public interest point of view.

The overview of the history of agricultural development in the US and The Netherlands shows that the dominance of BMA is based on an understanding that is scientifically flawed, in that it ignores the deliberate creation in such countries as the US and Holland of the institutional conditions that were necessary for the treadmill to kick into action.

Comparing Asia and Africa

Biggs (2007) demonstrated that the Green Revolution in Asia would have been unthinkable if governments had not created the enabling institutional conditions for its operation. Indonesia, for example, built BAPPENAS (State Ministry for National Development Planning)

³ At first, researchers (employed by the public research institutes) who established these facts were not allowed to publish their results (H. van der Meer, pers. commun. 1980)

as a quasi-military agency that handled seed and input distribution, credit, extension and quality control for millions of rice farmers. This is not the place to discuss the pros and cons of the impact of the Green Revolution in Asia, only to note that the Green Revolution, often claimed as proof for the success of BMA, was in fact as much based on creating enabling institutions, as was the phenomenal increase in agricultural productivity in industrial countries.

A study comparing Asian and African countries' experience of the Green Revolution concluded that SSA is marked by a 'pervasive bias against the smallholder sector on the sub-continent' (Djurfeldt et al., 2005:4). The conclusion is not that African countries do not have institutions. Rather the study indicates that the ones that are there tend to disable farm development. Obligations in extended families, corruption, rent seeking, lack of interest in and understanding of small farmer' issues among urban elites, under-investment, and catering to urban votes by importing cheap agricultural products that pre-empt local farm development have been cited as co-related causes. This has been explained in greater detail in Hounkonnou et al. (2012). Many African institutions can be seen as dysfunctional individualism in the absence of the effective rule of law, checks and balances, and a strong civil society. These issues are further discussed later.

Creating Enabling Conditions for African Smallholders

What Enabling Conditions?

I now turn to concrete efforts to create African institutions that enable smallholder farmers to innovate beyond indigenous innovation of subsistence agriculture through trial and error and through adopting novelties such as cassava, maize and all the other Latin American crops that now provide the staple food for most Africans. Box 3 provides a list of such enabling institutions.

Box 3. Some enabling institutional conditions for individual farm development

- Research and extension
- Supportive farm journals and other media (e.g. marketing information)
- Training courses for farm men and women
- Farmer organizations that represent (including small) farmers' interests (strong lobbies)
- Effective collection and use of statistics on agriculture
- Credit system
- Seed system
- Input distribution
- Mechanization support
- Bookkeeping support
- Integrated value chains and marketing mechanisms
- Land tenure laws
- Regulatory frameworks to create level playing fields
- Policies, including fiscal policies that support, protect and subsidize farming where necessary
- Infrastructure

The increasing consensus about the disappointing impact of technology development among African agricultural research administrators, policymakers and donors has inspired programmes that aim to create enabling conditions for African smallholders. The IAR4D philosophy that the Comprehensive Africa Agriculture Development Programme, FARA (Hawkins et al., 2009; Adekunle et al., 2016) and CORAF/WECARD (Sanyang et al., 2016) are implementing explicitly recognizes the role of enabling institutions, and focus on multi-stakeholder approaches that allow innovation to emerge from interaction on ‘platforms’. I come back to platforms later. These efforts represent a major change compared to ‘pure’ BMA.

AGRA’s Initiative as an Illustrative Example

An additional example is the 5-year, US\$180 million (€162 million) flagship initiative – first in Ghana, Malawi and Tanzania and now in 18 countries – of the Alliance for a Green Revolution in Africa (AGRA), funded by the Bill and Melinda Gates and Rockefeller Foundations (Coghlan, 2014) (Box 4).

Box 4. Key ingredients of the AGRA programmes

AGRA programmes have recruited thousands of farmers whose yields, on average, have doubled. By 2015 AGRA hoped to have reached 20 million smallholders. A central objective is to redress the continuing loss of nutrients in Africa’s soils: “Alleviating soil fertility constraints in Africa is the biggest obstacle to global food security” (Lobell, 2014). AGRA’s Soil Health Programme has set up 9,000 dealers within 5 km of AGRA farmers to sell them the supplies they need. As a result, AGRA farmers each now use 10 to 50 kg/ha of fertilizers. AGRA has appointed 2,800 inspectors to monitor soil health and advise the farmers. The dealers supply seeds, especially of nitrogen-fixing legumes such as soybeans and pigeon peas, and the inoculums to make them grow effectively. To solve the lack of service infrastructure, AGRA also offers micro-credit and links farmers to produce buying agents, thus linking farmers to the entire business chain. Groups of 15 to 20 farmers are encouraged to form collectives to develop bargaining power and collective assets. One major customer for AGRA farmers is the UN World Food Programme. It has apparently already bought 450,000 t of food from AGRA farmers, worth US\$177 million (€159 million), and the scheme is set to continue.

AGRA by these means claims to have been able to move considerable numbers of farmers into commercial agriculture. It has created the enabling conditions to ‘get agriculture moving’. AGRA’s work brings to mind my own experience with co-implementing a small hybrid maize package scheme explicitly aimed at ‘laggards’ in Tetu Division of Central Province, that was part of Kenya’s Special Rural Development Programme in the early 1970s (Ascroft et al., 1973; Röling, 1988: esp. chapter 6). Such programmes invariably experience that if one creates realistic opportunities for male and female farmers, however small and poor, they will grasp them with alacrity.

Concerns about Current Efforts to Create Enabling Conditions

Although they do focus on enabling institutions, programmes such as AGRA’s tend to focus on disseminating science-based technologies available on the shelf rather than on creating opportunities based on diagnosis of farmers’ constraints in a particular context (Clark, 2016).

The programmes introduce technology packages, e.g. high yielding varieties (HYV) of seeds, fertilizers and pesticides that smallholder farmers typically cannot afford and therefore require seasonal credit or subsidy. My involvement in the ‘Tetu programme’ taught me that such package programmes are successful within tenuous margins set by:

- Farm size and hence the amount of surplus and cash that can be generated for loan repayment.
- The ability of farmers to make a sizeable gain in yields as a result of the programme.
- Sufficient and timely rainfall in conditions where every planting season is a gamble that the rains start in time, persist, and are adequate.

The higher the costs of the inputs and the smaller the farm size, the smaller the margins within which success is possible. The removal by the then Kenyan Government of a subsidy on fertilizers raised the price to a point where, for loan repayment to be feasible, a plot of half an acre required a yield/ha that was realized only by a minority of the farmers. Failure of the rains can wipe out the success of the programme as farmers lose their investment and default on their loans. Such risky conditions do not encourage commercial companies to take over the functions and services previously provided by the publicly-funded programmes, especially where the logistics of providing the small loans and quantities of inputs that each farmer requires are expensive.

This raises a third concern. As in the Tetu programme, the creation of enabling conditions by external agencies such as AGRA and others is artificial in the sense that it is not necessarily embedded in government policy and agencies with capable and transparent management, trained staff, and a legitimate budget that is based on an ability to raise taxes. The current programmes seem as ‘fiscally unsustainable’ as the T&V system. The 2006 pledge by African governments to inject 10% of their incomes in agriculture has so far been honoured by only 8 of the 54 (Coghlan, 2014). African agriculture can develop only if governments, as a matter of routine, develop and fund the enabling institutions that would make this possible.

An Alternative Attempt to Create Enabling Conditions

The Convergence of Sciences-Strengthening Innovation Systems (CoS-SIS) action research programme (Hounkonnou et al., 2016; Jiggins et al., 2016) also explicitly sets out to create enabling institutions for smallholder intensification (CoS-SIS, 2014). Its forerunner, CoS, initially focused on participatory technology development but was confronted with institutional issues to a point where it started to experiment with them (van Huis et al., 2007). CoS-SIS built on this experience. The interventions undertaken by its platforms took entry points that, inspired by authors such as Grindle (2011), were based on scoping and diagnostic studies (Jiggins, 2012; Adjei-Nsiah et al., 2013) to identify the institutional constraints and opportunities for smallholders in a given agricultural domain (e.g. cocoa, oil palm, irrigated rice) that could be changed. The big difference with the programmes discussed so far is, therefore, that the institutional innovations that the programme promoted in each domain were not in support of adoption of a *a priori* chosen science-based HYV, but emerged in the platforms on the basis of information about smallholder conditions and deliberation about what would be effective entry points for intervention by the platform.

The investment in 'knowing that we don't know' what the priorities are in smallholder development, and accepting that smallholders themselves are the experts on the issue, is a hard paradigm shift for people who have been weaned on the notion that science is the source of truth. This shift is a key point of contestation between BMA and adepts of participatory approaches (Chambers, 1994), and the PRA toolkit developed for them (Pretty et al., 1995). Again, this is not to bash scientists or belittle the essential contributions of technology development, but to highlight the myopia of the BMA.

Key Characterizations of Enabling Individualism

The AIS narrative that supports the creation of enabling institutional conditions features terms such as access to input and output markets, and thresholds for entry. The system typically is the integrated value chain. Criterion variables include kilos of fertilizer per hectare used by farmers, the proportion of their product that is marketed, credit repayment and opportunity. Pathways of innovation that are promoted differ according to the objective. When the focus is on the adoption of HYVs, a great deal of emphasis has been given to creating networks of input dealers, seed systems and credit systems. In the case of CoS-SIS, the pathway includes scoping and diagnostic studies and participatory selection of entry points for intervention in a given domain.

Limitations of Enabling Individual Entrepreneurship and the Hierarchical Responses to them

Externalities of the Treadmill

Enabling individual farmers to pursue their self-interest eventually mobilizes the self-propelled treadmill mechanism. Although this seems not to have happened to any significant degree in SSA, it seems a good idea to summarize the experience of industrial countries as a prelude to discussing the relevance of AIS narratives based on hierarchy.

The treadmill stimulates the *externalization of costs* by individuals who seek to maximize their own utility. I already gave the example of the pollution of Dutch surface and ground water by nitrates and phosphates, and the acid rain caused by the fact that the Netherlands imports masses of feed for its intensive livestock industry, but keeps all the slurry. Such externalized costs more generally include the loss of ecosystem services, such as biodiversity, soil restoration, pollination, climate stability and resilience under extreme events. These are not luxury concerns of industrial countries; they increasingly affect Africa and other developing regions. Sherwood et al. (2004) describe how the intensification of potato production in Carchi, Ecuador, based on the treadmill, eventually led to the destruction of the land, the industry and the communities involved.

The treadmill represents a *race to the bottom* through a downward spiral of prices. Intensification involves scale enlargement that ends with a handful of farmers and farm companies. The question is how far the process should continue. In industrial countries, the expenditure on food by the average citizen is now only a few cents of every dollar or euro earned and the gap between actual yields and maximum possible yields (yield gap) has virtually closed (Slingerland, 2014). One can consider these as positive outcomes of the treadmill. Yet the race continues. For example,

the European dairy sector, that used to be protected against the consequences of the race to the bottom by production quotas, was re-liberalized in 2015 and political parties are debating measures to prevent the worst consequences. Internationally, the EU promotes free trade and the uninhibited operation of the treadmill which favours its exports, while at the same time protecting its own farmers from the race to the bottom by income supports, subsidies, production quota and other measures. International pressure to liberalize markets is resisted. For example, at the time of writing, there is increasing resistance in Europe to the Trans-Atlantic Trade and Investment Partnership (TTIP) between Canada, the EU, Mexico and the US.

The treadmill produces a great many *dropouts*. One can look at this positively as a way of getting rid of inefficient and small farmers and making labour available for industry. That no doubt has salience in certain historical periods of rapid industrialization or when other opportunities for alternative employment and emigration are plentiful. However, many developing countries retain huge numbers of smallholders with few opportunities for alternative employment. When these are suddenly exposed to competition from agriculture in industrial countries that have experienced decades of scale enlargement, the subsequent expulsion of large proportions of smallholders from land-based livelihoods has destabilizing effects. The exposure of Mexico's millions of small-scale maize producers to competition from large-scale North American farmers under the North American Free Trade Agreement is a case in point. The same mechanism operates when African countries import cheap food to satisfy their urban populations.

It is, however, not just the resultant destabilization that needs consideration. The import of cheap food pre-empts local agricultural development and prevents the productive agricultural resources under smallholder management from being mobilized for global food security. Free trade and Ricardo's principle of relative advantage, when based on short-term monetary criteria, can jeopardize our ability to feed the world's future population by preventing the mobilization of productive resources.

A final reason for pressure to introduce regulation is the *role of corporations*. An effective treadmill offers opportunities for agribusiness to sell seeds, pesticides, fertilizers and services to farmers and to market their produce. In the end, agribusiness employs more people than primary production. The intensification of farming in industrial countries has been accompanied by a concentration of life science, food and input companies. The egg-timer model features a mass of producers at one end and a mass of producers at the other linked through an ever-smaller number of corporations. Corporate investment in agricultural research is now many times that of the public sector. Extension agents have been replaced by corporate services and salesmen, who are now farmers' main source of advice on chemical use, investment, choice of varieties, mechanization and other issues.

In industrial countries, the private sector's dominance over the food system is increasingly seen to conflict with the public good when it comes to health (e.g. obesity), food safety (e.g. use of antibiotics), greenhouse gas (GHG) emissions, waste, unclosed cycles (e.g. carbon, nitrogen), loss of biodiversity, and further intensification (e.g. Struik et al., 2014).

The Relevance of Hierarchy for Africa

Most of the people involved in African smallholder development are pre-occupied with the question ‘how do we get agriculture moving?’ Few ask ‘moving where?’ Given the fact that most African governments consider agricultural development a priority, and that the relevant organizations have limited capacity and access to funding to make much difference on the ground, the issue is perhaps premature. But this should not blind us to the relevance of hierarchy for helping establish a decent society, for redressing injustice and for creating equal opportunity and other public goods. Often such interventions are not only a question of national government but can be realized at the township, district, provincial or regional levels.

In most African countries, agribusiness generally is in its infancy. Numerous projects and programmes seek to develop agribusiness as part of the enabling conditions required for farm development (as we have seen in the case of the AGRA programme). Nevertheless, regulations (i.e. hierarchical institutions) are also needed and this dimension has not been sufficiently addressed. Corporations regard their bottom line and not necessarily the public good. The commercial food system provides examples. Micronutrient deficiency and obesity have become severe and growing problems that have overtaken problems of undernourishment; stunting and wasting in many African countries. The pesticide industry, in the absence of regulations, actively promotes the use of chemicals that have been found to be toxic to humans and the environment although more benign and cheaper alternatives and practices are available, and the life science industry unwittingly ‘hooks’ farmers on its seeds without due regard to the rich agro-biodiversity that has made African farmers resilient. Many African countries have started to protect farmers’ intellectual property rights in the agro-biodiversity they have developed over the centuries.

Corporations prefer regulatory frameworks that are transparent and enforceable. However, regulatory frameworks also are vulnerable to corruption. Sherwood and Paredes (2014) describe the role of pesticide companies in the politics of keeping highly toxic pesticides on the market in Ecuador and the strategic use of social mechanisms that were involved. Creation of the institutions that control individual greed cannot be left solely to the private sector. Agricultural development requires a strong, well-informed and accountable public sector that can establish and enforce the rule of law. Agricultural science has a role in carrying out research on such regulatory frameworks and in advising governments and electorates. I give some examples of recent African studies that highlight the need for effective regulatory frameworks.

Conflicts between timber companies and cocoa farmers (Ayenor et al., 2004), pastoralists and arable farmers (Dangbegnon, 1998), top and tail enders along irrigation canals (Bolding, 2004), fishermen competing for the last fish in the lake (Dangbegnon, 1998), and villagers in over-populated rural communities who suffer high stress and alienation as land and vegetation cover deteriorate (Van Haaften and Van de Vijver, 1996) are destructive and require submission to arbitration and jurisdiction, negotiation and acceptance of binding rules, and agreed ways of monitoring and sanctioning trespass. Hierarchy is the preferred type of rationality for such situations.

Both the CoS and the CoS-SIS programmes took entry points for intervention that emerged from scoping and diagnostic studies of smallholder communities. This gave rise to identification of priorities of local people themselves. Box 5 shows that many of these priorities require hierarchical institutions. CoS' impact was evaluated 5 years after it ended (Sterk et al., 2013) but for CoS-SIS it is as yet impossible to say whether and why the institutions that did emerge were sustainable.

Box 5. Examples of priorities for intervention raised by smallholder farmers that required hierarchical institutions

- Doctoring of cocoa weighing scales by Licensed Buying Agents (LBA) in Ghana cheated farmers by as much 10-15%. An agreement between the district administration, farmers and LBAs that effectively stopped the practice, however, did not survive the termination of CoS (Dormon et al., 2007).
- Local landowners in Benin resumed control of land leased to immigrant tenants from Attacora when the tenants invested in land improvement. This tenure insecurity resulted in the tenants exhausting the land even though they were well aware of the principles of soil fertility management. A locally negotiated tenancy agreement supported by CoS did not survive the end of the programme (Saïdu et al., 2007).
- In Benin, CoS-SIS fieldwork coincided with a disastrous period in the country's cotton industry that historically had provided most export earnings. The enforced privatization of the industry as a result of a SAP had allowed a powerful businessman to gain control of input distribution, ginning and the transport of cotton. His company made it impossible for farmers to buy the pesticides required for implementing a cheaper and more benign integrated pest management (IPM) strategy that relied less on pesticide use (Togbe et al., 2014). The CoS-SIS IP opted for a bypass of the formal system and supported local women to produce neem seed oil as an alternative pesticide. The bypass required formal admittance of neem as a permitted pesticide in cotton. At the time of writing the outcome is uncertain.
- The use of old truck tyres as fuel for boiling palm fruits in artisanal crude palm oil (CPO) production in Ghana was identified by the CoS-SIS IP as a practice that harmed the health of the women processors, the environment and the quality of the CPO. The platform's intervention led to a seemingly lasting ban on the use of tyres as fuel throughout the district concerned, with explicit support from traditional rulers (Osei-Amponsah et al., 2014).
- In Benin, the introduction of a high yielding and fast fruiting hybrid oil palm variety led to demand for improved seedlings. That demand was not met by the official source of certified seed, the public NARS. As a result, nurserymen started selling 'unofficial' hybrids of low quality at premium prices. A diagnostic study found that this had resulted in small farmers' oil palm plantations containing more low yielding and sterile trees, the more recent their planting date was (Akpo et al., 2014). Innovation at the farm level thus depended on first creating a transparent and dependable seed system. The CoS-SIS platform took up this

challenge and worked with nurserymen, two municipalities, the Ministry of Agriculture and the research organization to create such a seed system. This work has led to incorporating necessary action in the national development plan (Vissoh et al., in press).

- In northern Benin, multi-purpose dams provide water for washing, drinking, fishing, drenching cattle, swimming, and irrigation for vegetables. They have become infested by (protected) Nile crocodiles. These diverse interests are now agreed that solving the resultant conflicts among users and uses requires multi-stakeholder negotiations at various aggregation levels, and the development of regulatory measures, as well as monitoring and enforcement capability. At the time of writing, the outcome is uncertain (Kpéra et al., 2014).
- In Ghana, the COCOBOD, the apex parastatal for the cocoa industry, has remained in charge of all matters concerning the production and marketing of cocoa. One of its programmes, CODAPEC, featured mass spraying of cocoa plantations by spraying gangs hired by COCOBOD, with pesticides synthesized by COCOBOD, and paid for by COCOBOD from the proceeds of its monopoly on cocoa bean export. The costs limited the funds available to raise the price paid to farmers for the beans. The spraying service was presented as 'free of charge'. The CoS-SIS cocoa platform that took price formation and farmer reward as its entry points identified CODAPEC as technically ineffective and as a bottleneck to paying farmers a better price. Lobbying by the platform's influential members contributed to current plans to abolish CODAPEC (Adu-Acheampong et al., 2014; Adu-Acheampong et al., 2016). This is an example of the need to challenge the regulatory power of public agencies.

Increasing Pressure for (Global) Regulation of Rampant Individualism

The report of the International Assessment of Agricultural Knowledge, Science and Technology for Development (McIntyre et al., 2009) authored by over 400 scientists, and signed by 57 governments, concluded that 'business as usual is not an option'. Pursuit of self-interest in competitive markets fails when it comes to ecological sustainability, poverty reduction, and optimal use of the world's productive resources for global food security, sovereignty and resilience in the face of climate change. In view of scientific evidence that human activity increasingly determines biosphere outcomes (our geological era is now called the 'anthropocene'), one can perhaps say that we are living during epochal transitions (Mytelka, 2016) that highlight societal capacity to self-regulate in the interest of common survival.

The self-propelled treadmill and profit seeking eventually lead to public outrage against externalized costs. This, in turn, elicits political activity in favour of regulatory frameworks and other constraining institutions that operate under principles of hierarchy. In the end, most agricultural politics becomes characterized by a right wing and a left wing, in which the former emphasizes entrepreneurship, less regulation, freedom to grow, profit, the reduction of transaction costs and the benefits of competition, and the latter equity, land care, livelihoods, reduction of GHG emissions, sustainability, and rights. Agricultural development requires an institutional context that not only enables individual farm households and agribusiness to follow entrepreneurial

strategies, but also one that constrains individual behaviour where necessary to ensure the sustainability of ecosystem services and resource use, as well as to level playing fields and equalize market opportunity.

Institutional analysis supports the observation of Conway (1994) and Kuyper and Struik (2014) that, instead of expecting AIS to deliver win-win solutions, it is more realistic to consider agricultural innovation as a contested *trade-off* among different criterion variables and interests, and between ‘free’ entrepreneurship and rules to regulate its undesirable consequences for the public good.

Characteristics of AIS Narratives Based on Hierarchy

The hierarchy-related AIS narratives look at *systems* in terms of ecosystems and their services, and of circular systems that recycle resources. Systems can also refer to entire polities with emphasis on the destabilizing effects of income inequality. From an automatic focus on the nation as the implicit unit of analysis and management (methodological nationalism [Beck and Grande, 2010; Sherwood et al., 2013]), the system shifts to the global Earth as the appropriate unit of analysis and management of the flimsy and vulnerable biosphere, political stability and food security (e.g. Stiglitz, 2006). *Criterion variables* used in this type of AIS narrative emphasize sustainability, equity, resilience, stability, transparency and human rights. Issues raised include climate change, biodiversity, and poverty. The *pathways of innovation* of this AIS narrative typically include integrated natural resource management (e.g. water catchment management), adaptive management (Holling et al., 2002), creating jurisprudence, bringing court cases, and lobbying for rights and sustainability issues. Visionary leaders, such as Samuel Plimsoll, have a key role to play.

Egalitarian AIS Narratives

The Role of Egalitarianism in Agricultural Innovation

In most rural areas in Africa, both the public and private sectors are generally described as weak, not transparent, or altogether absent on the ground. Consequently, many AIS narratives focus on people’s organizations, farmer unions, cooperatives, sub-political movements (Sherwood et al., 2013), self-organization, NGOs and other expressions of civil society to fill the void and counter such dysfunctional institutional arrangements as monopolies by pesticide companies, corruption, and human rights violations, and provide access to markets and basic health and productive services. These AIS narratives are based on a very different rationality from the three types of rationality discussed so far.

Civil society organizations might have goals that focus on the adoption of HYVs, the provision of enabling services, or the rule of law and human rights, but the actual egalitarian innovation mechanisms are entirely different. They involve empowerment, emancipation, solidarity, equality, bottom-up processes, shared causes, stakeholder dynamics, facilitation of interaction, devolution, countervailing power, counter-movement, participation, networks, social capital, and other social dynamics that recur in the egalitarian narrative.

For example, in hierarchy, effectiveness is served by building the capacity of extension services to deliver the goods; in egalitarianism effectiveness only emerges when clients have claim making capacity or countervailing power to make extension workers serve their needs. The example makes clear that it is not so much a question of either or, but of both at the same time. Egalitarianism has a crucial role to play in agricultural innovation.

Egalitarianism in Africa

In the 1960s, I used to visit a small rural town, Umuabi, just north of Enugu, then the capital of the Eastern Region of Nigeria. This town had a strong social organization, which included its 'sons abroad' associations, also called 'progressive unions', which were made up of villagers who had found work in the larger world but would come home around Christmas to help improve the town, not just by constructing stone houses for themselves, but especially by supporting the building of amenities, such as schools, sports fields, and churches, and by paying scholarships for villagers to attend law or medical school to help the town in legal (land) battles and disease outbreaks. The town exerted strong control in that people who did not contribute would be ostracized and barred from visiting the town. Another sanction was public ridicule and whipping of the legs by the youths of the town. In all, it effectively levied taxes to pay for public goods. Box 6 gives an example of the dynamics that were operative in the town. It is illustrative of the strong checks and balances that were/are built into local society.

Box 6. The Chief of Umuabi

Although the Igbo are a famous example of an acephalous society, one person was generally referred to as 'the Chief' because he used the experience he had gained as a bookkeeper in the coal mines near Enugu to help townspeople find their way in the larger world, and make educational choices, etc. He also represented the town in the County Council. Every year a secondary school scholarship was distributed among the towns belonging to the County. When Umuabi's turn came, the Chief decided to keep the scholarship for his own daughter. However, the clerk of the County, also from Umuabi, reported this to the town's people. They instituted a public examination to determine who should get the scholarship. The daughter of a poor widow won; the Chief's daughter came second. When I asked why the Chief was still there enjoying his special status, I was told: "we would all have done the same thing". In other words, individual pursuit of gain even by devious means is acceptable, but civil society provides the checks and balances to constrain it.

Today, such dynamics continue to operate. In his book *'Listening to the Cradle: Building on Local Dynamics for African Renaissance'*, Hounkonnou (2001) describes several interesting and successful cases of rural communities that have self-organized to stop theft, build water and health systems, provide credit, train youths, etc. He identifies the origins of these performances in early experiences of young village people in successfully organizing dances, competitive games, and other ways of building local social capital.

The void created by the end of colonialism and the later SAPs was filled by political power that was, on the whole, not constrained by the rule of law. Networks built on ethnicity or other forms of identity as well as on personal relationship, and patronage in many of the new countries, became the fabric of society. They are only slowly being replaced by more formal and impersonal institutions. In the meantime, ‘politics’ captured many ‘progressive unions’, ‘harambee’ activities and other local social capital. Early cooperatives, such as those formed around cocoa production in Ghana, were more or less destroyed in the process. In some countries, such as Mozambique and Tanzania, efforts were made to build on the coherence and solidarity of village society, but these were not successful.

Given the weakness of formal institutions, including legal pluralism (Von Benda-Beckmann, 2002), the tax system, the civil service, and the ability to implement regulation, and given the limited financial resources of the public sector, it is little wonder that egalitarianism, be it through personal networks, sub-political movements, NGOs, people’s organizations, cooperatives, or women’s groups, is relied upon for achieving many societal goals, such as providing health, housing, water, development services and education. In most African countries, a plethora of NGOs, many of them run by elites, vie for development funds to achieve public goods in the local areas on which they focus. What is of interest is that such initiatives are beginning to lead to effective institutions at the higher than village level. An example is the Forum for Ouémé Valley in Benin that provides collective management and development planning of the vulnerable water catchment (D. Hounkonnou, pers. commun. 2015). It becomes clear that contrary to common belief, it is not money that is the central ingredient in such development, but the ability of people to trust each other, and engage in binding agreements and concerted action.

In the current volume, only the chapter by Triomphe et al. (2016) truly reflects egalitarianism in its focus on local innovation. As we shall see, however, many of the IPs that have been used by the various programmes in this volume rely for their success on egalitarian dynamics and emergence from interaction.

Attributes of AIS Narratives Based on Egalitarianism

The *system* in these narratives typically refers to a group, the multiple stakeholders in an issue or resource, facilitator-clients dyads, or civil society. The *criterion variables* include solidarity, participation, empowerment, self-organization, equality, trust, and the extent of sharing a common cause. Preferred *pathways of innovation* are convening stakeholders, facilitation of their interaction (Nederlof and Pyburn, 2012), pushing ‘the cause’, proselytizing, devolution, and, importantly, investing in interaction. A good example is the IPM farmer field school. *Drivers* are trust, a common cause, negotiated agreement, concerted action, leadership, brokers (Klerkx et al., 2009), facilitation and ‘agency’. Van der Ploeg (1994) has shown that farmers are not swept up in one-dimensional historical determinism; they choose their own criterion variables and develop different ‘farming styles’ as they pursue their interests.

Innovation Platforms (IPs)

Generally Accepted Features of IPs

As a concept, the IP (e.g. Röling, 1994) appeals to many people and organizations. It has rapidly become an iconic feature of AIS, to which the contributions to this volume bear witness. The concept is attractive because it can be understood in any way that fits its proponents' pre-analytic position in the CT spectrum. My task here is to disentangle the various ways in which an IP is used.

The different perspectives have some things in common. Not one of the contributions to this volume expects agriculture to take off as a result of developing high yielding technologies on an experiment station that conforms with the BMA. Some have embraced IAR4D that calls for 'broad-based approaches' that expect innovation to emerge from the interaction among multiple stakeholders in an agricultural domain. This interaction takes place in an IP.

Interaction is seen to create mutual understanding and trust, convergence among the interests represented on the platform, and the emergence of a common identity, as well as agreement on the diagnosis of the situation, the entry points for action, collective goals, and concerted action. The IP represents the idea of synergy: the whole is more than the sum of the parts. Involvement in IPs is expected to generate commitment. The decisions that emerge from a platform process ('ownership') are expected to be better embedded in the society concerned than those that are externally imposed. In all, the common focus on platforms reflects a shift to what I have called egalitarian narratives.

However, the commonalities still leave considerable differences among the IPs reported upon in this volume. I distinguish IPs made up of package actors, value chain actors, empowered farmers and stakeholders in a domain.

Package Actors

Some of the programmes described in the current volume focus on delivering packages of inputs, such as seeds, and access to credit and markets to enable adoption of HYVs. The concomitant platform is composed of the actors that can deliver the ingredients of the package. The programme goals are determined by scientists, based on entry points that arise from a largely technical diagnosis (soils, genetics, etc.) and by promising technologies already available 'on-the-shelf'. In a way, this type of platform represents the smallest deviation from the BMA (Clark, 2016). However, even if the intention was simply to disseminate HYVs, in these programmes much has happened beyond what was foreseen or planned for (e.g. Sanyang et al., 2016). The IP concept is taking off as a result of the synergies achieved on the platforms and because policy-makers have been included as platform actors.

Value Chain Actors

A related form of IPs seeks to integrate the actors along a value chain that links producers and consumers. The actors in a given industry – e.g. cut flowers in Kenya (Bolo, 2016), or the wine industry in Argentina (Farinelli, 2016) – set up an institutional framework that allows the industry concerned to thrive. This form of IP can make an industry blossom for the benefit of its

smallholders/out-growers, especially if a monopoly over processing and sales allows for recovery of supervised credit. Such IPs create access to markets, enable smallholders to engage in value-adding activities, and remove obstacles in the value chain that inhibit participation of smallholders in it. Entry points for such platforms emerge from an analysis of the value chain in terms of flows of goods and money, and the constituent actors.

The CoS-SIS programme found the value chain to be a good concept to explain institutions and IS to scientists: everybody understands it, and the systemic and institutional nature of agricultural development, including issues such as the misuse of power, emerge from the experiences in the room. An example of this type of IP is the effort to develop artisanal CPO production in Ghana. Improving the quality of the CPO that the village women produce allowed them to access lucrative urban and export markets (Adjei-Nsiah et al., 2012; Osei-Amponsah, 2016). The phenomenal development of small-scale rural mechanization in Bangladesh (Biggs and Justice, 2016) is based on an integrated value chain.

Empowered Producers

In Benin, where experience of the crisis in the cotton industry meant there was little trust in public and private agencies to deliver anything that benefitted smallholders, the CoS-SIS National Programme Coordinator placed his faith in IPs that built on the empowered farmer groups that had emerged from previous participatory technology development experiments. NGOs similarly work with empowered groups of farmers to develop a product of uniform and consistent quality and quantity to access urban markets. For example, the CoS-SIS IP in the shea nut domain in Mali (Sidibé et al., in press) worked with a women's cooperative to produce high quality shea butter.

Domain Actors

The BMA operates on the basis of 'recommendation domains', i.e. populations that are similar in terms of agro-ecological conditions, farming system and market context, so that they can function as target groups for 'rolling out' the technology that is developed. CoS-SIS (Jiggins et al., 2016) used a different notion of 'agricultural domain': a potential system of interest (Ison, 2016) among actors who have a stake in the domain. In this approach, IPs became temporary arenas for selected domain stakeholders to negotiate concerted action to realize the changes prioritized for the domain (Röling et al., 2014). The selection of platform members and the priorities for action was based on scoping studies by post-docs seconded from national organizations (Adjei-Nsiah et al., 2012) and diagnostic studies by Ph.D. students (Jiggins, 2012). The platforms did not receive funds to finance projects but were supported to meet, interact and operate. 'Scaling' was pursued by institutionalization, i.e. by embedding the changes achieved, and the platforms themselves, or both, in the existing institutional regimes at local, district and/or national levels. The aim was not to roll out change across individuals, but system change. This type of platform, though themselves based on principles of egalitarianism, were expected to generate various forms of change in institutions, be it to enable entrepreneurship, to help develop regulatory frameworks (hierarchy) or for mobilizing self-organization. The results are reported in a special issue of *Cahiers Agricultures* (Jiggins and Jamin, in press). Here I briefly report on an IP that deliberately sought to improve the rule of law (Box 7).

Box 7. A platform that improved the rule of law in an irrigation scheme in Mali

The large irrigation scheme in Mali, the Office du Niger, has been deregulated in recent years, leading to a breakdown in compliance with tenancy and irrigation rules, and conflict and litigation among rice farmers, cattle keepers and trans-migrant herders. This, in turn, had an increasingly debilitating effect on the effective running of the scheme. The CoS-SIS platform engaged in translation of the official rules from French into local languages, meetings to discuss the texts with villagers, negotiation of acceptable rules for co-management, large billboards to make these public, and changes to the ‘*Contrat Plan*’ (the formal agreement between tenants and scheme authorities). These actions vastly reduced the number of conflicts and all but stopped litigation (Ouologuem et al., in press).

Conclusion

Perhaps my exploration of AIS narratives as types of rationality within CT runs ‘the danger of writing up’ (Matsaert et al., 2007). The analysis, summarized in Table 1, does, however, seem helpful in a number of points.

Table 1. Summary of main features of AIS narratives

| Rationality type in CT | Methodological individualism (BMA) | Enabling individualism | Hierarchy | Egalitarianism |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Key actor | <ul style="list-style-type: none"> • Technocrat • Neo-liberal economist • Scientist | <ul style="list-style-type: none"> • Businessman • Institutional economist | <ul style="list-style-type: none"> • Bureaucrat | <ul style="list-style-type: none"> • Activist citizen |
| Driver of farm innovation | <ul style="list-style-type: none"> • Discovery, delivery and diffusion of technology | <ul style="list-style-type: none"> • Pursuit of individual utility • Opportunity • Treadmill | <ul style="list-style-type: none"> • Rule of law • Justice • Rights | <ul style="list-style-type: none"> • Empowerment • Solidarity |
| Investment in | <ul style="list-style-type: none"> • Research and extension | <ul style="list-style-type: none"> • Value chain components and integration | <ul style="list-style-type: none"> • Regulatory frameworks and enforcement | <ul style="list-style-type: none"> • Interaction |
| System | <ul style="list-style-type: none"> • NARS | <ul style="list-style-type: none"> • Market | <ul style="list-style-type: none"> • Polity • Governance | <ul style="list-style-type: none"> • Civil society |
| Criterion variable | <ul style="list-style-type: none"> • Yields/ha • Adoption | <ul style="list-style-type: none"> • Access to services, credit and markets | <ul style="list-style-type: none"> • Checks and balances | <ul style="list-style-type: none"> • Equality • Trust • Emancipation |
| Pathway of innovation | <ul style="list-style-type: none"> • Technology development | <ul style="list-style-type: none"> • Create dealerships • Assemble chain actors | <ul style="list-style-type: none"> • Rule making • Surveillance • Conflict resolution | <ul style="list-style-type: none"> • Convene and facilitate stakeholders • Participation |

1. The narratives ('cultures', or theories of change [J. Brouwers, pers. comun. 2015]) are seen as internally coherent, i.e. an expressed preference for, say, a certain type of driver or investment flags the entire complex of thought. One could say that the narratives appear to satisfy the need for cognitive consistency.
2. The narratives are engaged in a 'battle of knowledge' in which the scientist, businessman, bureaucrat and activist slug it out. Sometimes, they act in mutual isolation from each other, each celebrating victories the others do not recognize. In some contexts, one of the narratives has become so dominant that the others hardly get a look in (as in the case of the BMA). Yet, as Douglas (2007) suggests, healthy agricultural development requires that all of the narratives exert their influence, be it to different degrees, i.e. that they form a dynamic equilibrium and so mutually curtail the excesses that each of them, in isolation, can give rise to. AIS narratives are like political party programmes. In a healthy democracy, the dominance of one mobilizes the others. However, so far agricultural innovation lacks the required democratic mechanisms, which allows the dominance of an AIS narrative to translate into vested interests and entrenched positions that are hard to change. The CT analysis of AIS narratives provides arguments to support change.
3. One can consider the dynamic equilibrium as a 'system' in the sense of a desirable potential outcome in which some trade-off is attained. In this sense, the CT analysis seems to present a window for conceptual advance. In their review of the evolution of system approaches to agricultural innovation, Klerkx et al. (2012) say:

"The agricultural innovation systems perspective provides a comprehensive view on actors and factors that co-determine innovation, and in this sense allows understanding the complexity of agricultural innovation. However, its holism is also a pitfall as it allows for many interpretations, which complicates a clear focus of this research field and the building of cumulative evidence. Hence, more work needs to be done conceptually and empirically."

The CT analysis looks at each AIS narrative as a coherent and consistent type of rationality. Considering their dynamic equilibrium as a system adds a layer that does justice to the socially constructed nature of systems by clearly identifying the different narratives that contribute to the outcome. Such a perspective on a 'second order' IS could be a guiding concept for policy, a basis for training agriculturalists, and a framework for evaluation and research. The mechanisms by which certain narratives gain dominance and the nature of the entrenchment that props them up still require a great deal of further research.

4. Every IS practitioner has experienced how their ideas clash with other perspectives, 'fall on deaf ears', or are assimilated into other frames of reference by colleagues, donors, government officers, and businessmen. The thoughtful contribution of Hall et al. (2016) bears witness to this experience. The CT analysis allows "irreconcilable differences to be deconstructed by identifying the civilization which the narrative upholds" (Douglas, 2007). An example is a statement of the CEO of WUR in an interview in 2014:

“With respect to genetic modification, scientists and policy makers have made huge communication mistakes. As a consequence, Europe has closed its doors. The discussion has reached a stalemate. Therefore, the continent runs behind and we miss the chance to transfer our knowledge about it to farmers.”

It is not difficult to recognize the treadmill and the BMA narrative. That recognition allows one to move beyond the pros and cons of biotechnology to a discussion of the institutional issues involved.

5. The narratives clarify the nature of innovation. Most people use innovation to refer to changes in technology (productivity, efficiency), or in business practice or organization (competitive advantage). As we have seen, innovation can also occur in regulatory frameworks (public goods) or social capital (civil society). Leeuwis and Aarts (2011) have pointed out that innovation can also refer to new forms of exchange and self-organization among social actors, facilitated or not by professional ‘change makers’. Innovation happens when new platforms allow representatives of different AIS narratives to negotiate dynamic equilibriums. Perhaps this is the kind of innovation that the world is most in need of, e.g. in resolving such core issues as accommodating growth and sustainability, wealth creation and equity, and agricultural intensification and maintaining the biosphere. Platforms support resolutions based on diversity, which trumps expertise any time (Hong and Page, 2004).
6. In SSA, the BMA based on the methodological individualism of neo-liberal economics, has dominated agricultural development for a long time. The narrative draws its justification from a misguided analysis of the history of agricultural development in industrial countries. One can hardly imagine a less appropriate AIS for SSA. Yet agricultural innovation in SSA still largely is the responsibility of agricultural research organizations. At the time of writing, one sees them engage in foreign-funded value chain development that seems (fiscally) unsustainable. The helicopter view provided by CT analysis seems helpful in recognizing such situations and in providing words for making their institutional nature discussable.
7. In industrial countries, the persistence of the unmitigated belief in technological innovation driven by the free market and the treadmill and pressing for further agricultural intensification gives rise to strong counter-movements that emphasize the undesirability of the current food system, the flimsiness of the biosphere, and the need to leave most of the remaining fossil fuels in the ground, etc. Most of this discussion focuses on technical issues (e.g. diets in the case of obesity). The CT analysis adds an institutional dimension to this epochal contradiction.

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Chapter 17

INNOVATION SYSTEMS, AGRICULTURAL DEVELOPMENT AND ECONOMIC EMPOWERMENT: LESSONS FROM CTA'S AGRICULTURAL SCIENCE TECHNOLOGY AND INNOVATION SYSTEM CAPACITY BUILDING PROGRAMME – IMPLICATIONS FOR POLICY

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Abstract

In 2003-2004, the Technical Centre for Agricultural and Rural Cooperation (CTA) began a process of competence building to enhance science, technology and innovation (STI) policy processes in support of agricultural and rural development in the 79 member countries that make up the African, Caribbean and Pacific (ACP) Group of States. Senior officials and mid-career professionals attached to universities, national research organizations and policy think tanks were the main target group. The assumptions were that: little innovation was occurring in the agricultural sector; a disconnect existed between the agriculture research and development (R&D) community and science and technology (S&T) policymaking; and the national innovation system (IS) concept was relevant to ACP agricultural transformation. A structured approach was adopted for building capacity on innovation and innovation processes and for applying the innovation systems approach (ISA) to understanding the agricultural science, technology and innovation (ASTI) system. The main aspects of the programme were: sensitization and training to increase understanding and gain buy-in; reinforcement of new knowledge and skills through the conduct of country case studies on analyzing the ASTI system, using a standardized methodological framework and policy advocacy. This chapter profiles the evolution of the CTA-ASTI system capacity building programme and presents a synthesis of the key findings and lessons learned. It concludes that the ISA is useful for guiding policies and programmes and there is a need to develop competencies to enhance innovation for agricultural development and economic empowerment.

Keywords: Disconnect, Evolution, Case study, Relevant, Competence building

Introduction

Agriculture is the mainstay of the economies of the majority of the 79 member states of the ACP Group of States that fall under the mandate of CTA; a joint ACP and European Union organization. A diverse range of agricultural commodities are produced for domestic consumption and export but performance over four decades (1962-2002) has been weak (Skoet et al., 2004; Koroma and Deep Ford, 2006). Over all, there was a decline in the sector's contribution to: gross domestic product (GDP) from 70% to 60%; employment from about 21% to 18%; and trade from about 18% to 15%, for the periods 1978-81 and 1991-2001, respectively (Koroma and Deep Ford, 2006). There have been no significant improvements since 2001 and the majority of ACP countries have become net food importers to meet the needs of a total combined population of approximately 730 million people.

Trade reforms have negatively impacted the sector, as governments pursued trade liberalization policies. In addition, the inability to modernize agricultural production systems, add value to locally produced foods, respond to changing consumer demands, upgrade infrastructure including laboratory facilities, or innovate, mean that many ACP countries are limited in their responsiveness to challenges in the local and international environment. The dwindling natural resource base, under-investment in tertiary education, research, training and extension, changing eating patterns and a growing preference for imported foods, susceptibility to natural disasters and climate change, unpredictable commodity prices, limited financial resources and political unrest (in some countries), all create additional problems and hinder recovery, diversification and growth in the agricultural sector.

In 2003-2004, acknowledging the growing emphasis on STI for development (UN Millennium Project Task Force on Science, Technology and Innovation, 2005) and the increasing relevance of the national IS concept and the ISA to enhancing economic performance, CTA began collaborating with ACP and international partners, to build capacity to understand, analyze and strengthen ASTI systems. The focus was on mobilizing the ACP scientific community to engage more in policy processes and with society to improve agricultural and economic transformation. Determining the best strategy to build capacity on innovation, IS and the ISA, and their relevance to agriculture, was a challenge. Consensus by the ACP scientific community was needed and a collaborative and integrated approach was adopted to: (i) raise awareness and gain buy-in; (ii) design and conduct tailor-made training programmes; and (iii) develop and pilot standardized methodologies for analyzing and strengthening the ASTI systems using a case study approach. At the forefront was the question: how can ACP countries systematically leverage STI in the agricultural sector to contribute to socio-economic development?

This chapter presents an overview of the evolution of the CTA-ASTI system training programme, the methodological framework for analyzing the ASTI systems, a synthesis of the case study results, the lessons learned, and implications for policy. Analyzing the entire ASTI system was not attempted (and should not be attempted) given the high costs, time and human resource constraints and the need to provide policy relevant information within a very short timeframe. The international team and ACP experts with whom CTA collaborated, learned valuable lessons on implementing ISA in developing countries.

Conceptual Issues on Innovation and the Innovation Systems Approach

Conceptual issues had to be addressed very early in the process as clarity of key terms was needed to gain buy-in from directors of research and S&T policy organizations, deans of faculties of agriculture and science, and lead experts. The broader definition of innovation was adopted so as to move beyond the tendency to focus on technological innovation and consider social, political and organizational innovations as well. Innovation was defined as the application of all types of knowledge – whether codified or tacit, indigenous or scientific or other epistemologies – to bring new and/or improved products, processes and services into social and economic use. Nelson and Nelson (2002) assert that new technologies and new institutions evolve and this co-evolutionary process is the driving force behind economic growth. Innovation was emphasized as an interactive, evolutionary, cumulative process that is embedded in an institutional context.

Another important distinction that had to be made was between ‘organizations’ and ‘institutions’ to be in line with predominant IS thinking. As such, ‘organizations’ were promoted as formal structures operating within an institutional context (Edquist and Johnson, 1997; Coriat and Weinstein, 2002) and ‘institutions’ – both formal (laws, rules and regulations, e.g. intellectual property rights) and informal (e.g. cultural norms) – as the mechanisms that facilitate, stimulate or constrain innovation. Institutional change was seen as a complex task, requiring a lot of time to mature before the full impact could be felt. Knowledge, learning, individuals, organizations and institutions were therefore core to the innovation process.

Since the entry point was the S&T community, the definition of S&T capacity – the personnel, infrastructure, investment, institutional and regulatory framework available to generate and acquire scientific knowledge and technological capabilities for creatively and competently addressing societal needs – was also important (IAC, 2004). ACP countries were, and still are, challenged to translate their limited S&T capacity into well-resourced and efficiently executed policies and programmes that can lead to improvements. The S&T community was inimical to this change as they are among the network actors who constitute the IS.

CTA's decision to focus on the ASTI system as a subset of the wider national IS approach was essential as the initial reference point. The national IS concept had been used for comparing the economic performance of developed and ‘catching up’ countries (OECD, 1997; Freeman, 2002) and was considered relevant for developing countries (Lundvall et al., 2002; Feinson, 2003; Spielman, 2006). Analysis of sectoral and regional IS were also considered legitimate (Cooke et al., 1997; Malerba, 2002). Despite the boundary, spatial and temporal differences, and conflicting schools of thought – on whether an IS: (i) can or cannot be designed; (ii) is static or dynamic; and (iii) exists in the context of developing countries – the views of Edquist (1997), who posited that some system components could be designed while others evolve spontaneously, prevailed.

CTA, in consultation with ACP and international partners, discussed all these contentious issues and determined that ASTI systems existed in ACP countries and where they did not, could be created or stimulated, once the necessary policy instruments, knowledge infrastructure and institutional mechanisms were in place. Dynamism in the system was contingent on interactions

among the system actors, a continuous injection of new ideas and knowledge, an inherent capacity to create or take advantage of opportunities and respond to challenges and shocks, as well as proactive and visionary leadership. In a static IS, output would stagnate or decline with negative impacts on sectoral and economic performance, as was the case of the agricultural sector in ACP countries.

Broadening and deepening knowledge on the national IS concept was necessary and adapting the ISA to ACP country contexts was considered relevant for policy learning and in line with IS practice (Johnson and Lundvall, 2003; Sharif, 2006). Developing and piloting a methodological framework for studying the ASTI system was also necessary, although there were limitations to providing empirical evidence (Spielman, 2006). In studying sectoral systems, focus should be on the specific knowledge base, demand, technologies, inputs, recommended levels of analysis, and flexibility in the choice of the unit of analysis (Malerba, 2002). CTA's ASTI system capacity building programme corresponded to an identified need to improve the understanding of the agricultural IS, communicate its potential, develop tools for studying and analyzing impact, and establish a community of practice (Rajalathi et al., 2008). The competencies needed for innovation cannot simply be acquired or imitated by rote as all actors must be able to continuously learn, upgrade knowledge and skills, and innovate (Mytelka, 2003) and this was important for the ACP Group of States.

Evolution of the Capacity Building Programme

The ASTI system capacity building programme comprised three main components: sensitization and formal training workshops; conduct of country case studies to reinforce knowledge and skills; and convening of policy advocacy platforms to share lessons learned. In November 2003, CTA held the first meeting of high-level ACP decision-makers to introduce the key IS concepts. They determined the utility of ISA and consensus was achieved on its importance and relevance to ACP agricultural and rural development. This paved the way for launching the training programme in 2004 which targeted six ACP experts and was followed by the commissioning of the first series of case studies using a draft methodological framework for analyzing the ASTI system. In 2005, feedback from ACP experts and lessons learned were presented to senior decision-makers. It was agreed that the training programme should be modified to de-emphasize some trade aspects and include emerging S&T issues (e.g. biotechnology, remote sensing and intellectual property rights [IPR]) before being rolled out across the ACP region.

Two complementary 5-day training modules were subsequently developed and piloted for strengthening ASTI systems. These were 'Demand-Led Research/Priority Setting' led by CABI Africa and 'Farmer Experimentation and Innovation' led by Vrije University, The Netherlands. These training modules responded to the gaps identified in the ASTI system case studies. In 2006, all three 1-week training programmes – 'Understanding and Analyzing the ASTI System', 'Farmer Experimentation and Innovation' and 'Demand-Led Research/Priority Setting' – were condensed into one intensive week-long 'training of trainers' (TOT) programme. Emphasis was placed on interactive learning, learning-by-doing, abstract conceptualization and reflection to simulate an innovation cluster environment, and create an interactive platform for facilitating

knowledge sharing and learning. The main objective of the TOT programme was to develop the capacity of ACP professionals to train others and do so cost-effectively. From 2007 onwards, ACP experts who had been trained and had led country case studies were co-opted as facilitators; thereby transferring ownership to ACP experts to further embed IS thinking and practice in national systems.

Over the period 2004-2008, more than 600 ACP senior level experts from ministries, national and regional research and extension organizations, universities, colleges, and farmers' organizations were trained. The final workshop evaluation reports confirmed that knowledge had been gained, skills improved and that the 1-week workshop, though very intense, had introduced them to new thinking and exceeded expectations. The most important topics were national IS, applying the ISA to agriculture and analyzing the ASTI system. However, a need for additional training, so that scientists and researchers could better influence policy, was expressed.

Analyzing the ASTI System – The Methodological Framework

The ASTI system methodological framework case study approach had a dual purpose; as an epistemological approach to research and a method for collecting and analyzing data. It was commodity based but with a national level of analysis. The framework was also developed as a toolkit to allow expert teams to choose and apply elements based on the context (CTA, 2005).

The standardized approach included: (i) desk research to reveal the historical performance of the agricultural sector, the commodity targeted, the policy framework and key actors; (ii) a stakeholder sensitization workshop to introduce the key innovation, national IS and ISA concepts to key actors, gain buy-in and identify any missing actors and policies; (iii) semi-structured interviews, surveys using pre-tested structured questionnaires (at least 50 actors based on the agreed sampling plan) and focus group sessions; (iv) grouping and mapping of actor linkages; (v) assessment of habits, practices, competencies and key functions; and (vi) a final stakeholder workshop to discuss and refine the results and recommendations and bring them to the attention of policymakers (CTA, 2005).

ACP experts who led the ASTI system case studies underwent formal IS training, and were attached to a partner organization. This ensured that they had a basic understanding of the key concepts, support for undertaking the study and that IS thinking would be embedded in the organization, going forward (beyond the research system), thereby ensuring sustainability (World Bank, 2007).

Selection of agricultural commodities was done in consultation with stakeholders. These had to be important for food security or export diversification, or be under threat from loss of traditional preferential markets. The first case studies focused on diverse commodities: cassava (*Manihot esculenta*) and cocoa (*Theobroma cacao*) in Cameroon; ginger (*Zingiber officinale* Roscoe) and mangoes (*Mangifera indica*) in Jamaica; the floriculture industry in Kenya; and rice (*Oryza sativa*) in Papua New Guinea (PNG) and Senegal. In 2005, experts conducted case studies on NERICA rice in The Gambia, nutmeg (*Myristica fragans*) in Grenada, the sugar cane (*Saccharum officinarum*) industry in Jamaica, maize (*Zea mays*) in Malawi and noni (*Morinda citrifolia*) in

Samoa and Tuvalu. Between 2006 and 2008, the focus was on bananas (*Musa spp*) in PNG, St. Vincent and the Grenadines, Tanzania and Uganda, and plantains (*Musa paradisiaca*) and fisheries in Ghana. Two key questions had to be answered.

1. What is the nature of the ASTI system? Is innovation taking place? If yes – under what conditions and if not, why not?
2. What recommendations can be made for improving the STI policy framework to enhance the performance of ACP agriculture?

Summary of key findings

The summary of the main findings is presented as follows:

1. Performance of the agricultural sector and the commodities studied.
2. The policy and domestic environment for innovation.
3. Key actors and the linkages in the ASTI system.
4. Competencies, habits and practices of key actors.
5. Key functions and innovation performance.

Performance of the agricultural sector and the commodities studied

In all case study reports, agricultural contribution to GDP had decreased or remained almost constant for more than 5 years. Omot (2005) reported that real agricultural GDP in PNG declined by 0.4% over a 20-year period (1980-2002) and 7.5% over the 3-5 years prior to 2002. In St. Vincent and the Grenadines, between 1990 and 2006, agriculture as a percentage of real GDP declined from 21.2% to 9.3% (CARDI, 2006). Most of the traditional export commodities (e.g. bananas, cocoa, nutmeg, sugar) showed little or no growth in export value. Cameroon, Grenada, Jamaica and St. Vincent and the Grenadines lost international markets when they could not respond to changes in international trading regimes, natural disasters and disease (Ngou Ngoupayou et al., 2004; NCST, 2005; CARDI, 2006; CARDI, 2007). For commodities considered critical to food security, performance was mixed: for example per person production of plantains in Ghana increased between 1990-2000 (Owusu-Bennoah et al., 2007; Egyir et al., 2010) but cassava production in Cameroon declined from 1.4 to 1.1 MT during the same period, and land under cultivation dropped from 95,235 to 77,515 ha (Ngou Ngoupayou et al., 2004). Growth in production and export earnings, however, was reported for the floriculture and noni industries in Kenya and Samoa.

The policy and domestic environment for innovation

Most case studies showed that ACP countries had relevant agricultural support, S&T, information and communication technology (ICT), and trade and investment policies in place, but IPR policies were either non-existent or under development. For example, Ghana's S&T policy had the stated goal of supporting national socio-economic development and its ICT policy aimed to facilitate improvement in the efficiency and productivity of the agricultural sector (Owusu-Bennoah et al., 2007). The Millennium Challenge Corporation in Ghana had signed a 5-year agreement to make US\$547 million available to support irrigation development, post-harvest and value chain investment, increased access to credit, and farmer and enterprise training. PNG had policies to

support R&D, infrastructure, trade and enterprise development of the rice sub-sector (Omot, 2005). In Kenya, several government policies had contributed to innovation, growth and high economic performance in the floriculture industry (Bolo, 2005). These included the Seeds and Plant Varieties Act (cap 326) which was revised in 1991 to confer Plant Breeders Rights on persons breeding or discovering new varieties. Sessional Paper no.1 of 1994 encouraged the industry to develop mutually beneficial contractual links with research institutes and to access patented varieties (Bolo, 2005). However, while large flower enterprises were able to take advantage of the suite of policy instruments, smallholder Kenyan flower farmers did not reap similar rewards. They did not have the organizational infrastructure nor the technical support from public agencies.

The general finding was that relevant policies and legislation were not implemented, and in some cases were non-existent. Lack of financing and incentives, insufficient human resources and inadequate physical infrastructure were major limitations. Structural adjustment and trade liberalization programmes had resulted in under-investment in R&D and erosion of extension services in several countries (Ngou Ngoupayou et al., 2004; NCST, 2005). Food security commodities – such as banana and plantain which ranked as the fourth most important food in Ghana, a staple for 4 million Tanzanians and third among the seven staple food crops consumed in PNG – were not emphasized in government policy (Kambuou and Gwabu, 2007; Maerere et al., 2007; Owusu-Bennoah et al., 2007). Changing policies, failure to optimize existing policies and a lack of communication between public organizations and the private sector contributed to system failures.

The perceptions of key informants, summarized from selected case studies, were that the domestic environment for agricultural innovation was inadequate (Table 1). Key informants rated IPR and venture capital, as 'weak to very weak'. Government incentives, the quality of scientific and skilled manpower, and competencies of local universities for technical collaboration and R&D were also poorly rated. ICT services and water and electricity supply received mixed results ranging from weak, to average and strong (only in the Caribbean). This worrying state of play emerged across all pilot country case studies with little regional differences, and recommendations were made for improving the enabling environment for innovation (Egyir et al., 2010; Maerere et al., 2010).

Table 1: Domestic environment to support agricultural innovation

| Infrastructure | PNG – rice | Jamaica – ginger | Grenada – nutmeg | Tanzania – banana | Malawi – maize |
|-------------------------------------------------------------------|---------------|---------------------|---------------------|----------------------|-------------------|
| Government incentives for innovation | Weak | Weak | Weak | Weak | Average |
| Scientific/skilled manpower | Weak | Average | Weak | Average | Average |
| Local universities competence for technical collaboration and R&D | Weak | Weak | Weak | Weak | Average |
| R&D institutions for technical collaboration | Average | Average | Weak | Very weak | Weak |
| Intellectual property protection | Weak | Weak | Weak | Very weak | Weak |
| Availability of venture capital | Very weak | Weak | n/a | Very weak | Weak |
| Quality of ICT services | Weak | Strong | Average | Weak | Weak |
| State of power supply | Average | Strong | Average to strong | Weak | Weak |
| State of water supply | Average | Average | Average | Weak | Weak |

1-1.4 (very weak); 1.5-2.4 (weak); 2.5-3.4 (average); 3.5-4.4 (strong); >4.5 (very strong)

Source: Author's summary

Key actor linkages in the ASTI system

The actors were clustered based on their main functions: (i) demand (e.g. consumers, traders, wholesalers); (ii) enterprise (e.g. farmers, agro-processors and input suppliers); (iii) diffusion (e.g. extension); (iv) research and training (e.g. research organizations, universities); and (v) infrastructure (e.g. policy, finance). Some actors performed multiple roles. Key informants from the surveys and semi-structured interviews were collated and validated during stakeholder workshops. A pattern emerged across all the case studies, that the linkages between universities and enterprises were generally weak or non-existent and those between enterprises (for example farmer-to-farmer) were strong (Table 2). In rare cases the collaboration between actors was found to be strong and this was observed in cases where donors stipulated collaborative research as a requirement for accessing international funding.

Table 2: Intensity of linkages between key actor groups for selected case studies

| Actor-actor linkage | Jamaica – ginger and mango | Cameroon – cassava and cocoa | Senegal – rice | PNG – rice |
|---------------------------------|-----------------------------------|-------------------------------------|-----------------------|-------------------|
| Public research-enterprise | Weak | Average | Average to strong | Very weak |
| Public research-diffusion | Average | Average | Average to strong | Weak |
| Universities-enterprise | Weak | Weak to average | None to weak | None |
| National-international research | Weak to average | Strong | Strong | n/a |
| Extension-enterprise | Average | Average | Average to strong | Very weak |
| Enterprise-enterprise | Strong | Strong | Very strong | None |

1-1.4 (very weak); 1.5-2.4 (weak); 2.5-3.4 (average); 3.5-4.4 (strong); >4.5 (very strong)

Source: Author's summary (2009)

Competencies, habits and practices of key actors

The case studies captured information on the competencies of the main actors and their habits and practices with respect to learning, linkages and investments. From the reports, the level of education and training of researchers and other professionals was adequate (BSc, MSc and PhD levels), but their knowledge on the production, processing and marketing of the specific commodities under study was limited. Most smallholder farmers had very little education, having attained only primary level schooling. Training was offered to farmers mainly to improve agronomic practices and pests and disease management. Training opportunities and expertise in post-harvest handling and food processing did not feature highly, although small-scale processing of several commodities, including banana, cassava, plantain and rice, was reported. Omot (2005) noted that the National Agricultural Research Institute in PNG was restricted to undertaking rice varietal selection and environmental sustainability studies as they did not have the capacity to address post-harvest handling, processing and packaging of rice. The majority of researchers were agronomists and entomologists; there was only one post-harvest specialist and no agricultural engineers.

Learning was taking place at the level of the enterprises. Banana farmers in Ghana adopted new techniques for rapid multiplication of planting material, improving soil fertility and weed control (Owusu-Bennoah et al., 2007). In St. Vincent and the Grenadines, farmers introduced new banana varieties and tissue culture plantlets, but did not adopt irrigation and improved fertilization techniques, and failed to achieve the projected yields (CARDI, 2007). Under-investment in training and public research impacted on the ability of all actors to generate and access new knowledge and learn.

Key functions and innovation performance

The key functions of the IS are to: create new knowledge and markets or facilitate market access and development, direct research, supply resources (capital and competence), facilitate information and knowledge flows, and enhance networking. Although, individually, actors were executing their core functions as prescribed in their mandates, this had little impact on the overall performance of the ASTI systems, in terms of innovativeness, contribution to agricultural GDP (except for floriculture in Kenya), food and nutrition security or market competitiveness. Research organizations and universities were conducting research but there was little linkage between the research that was being done and the challenges faced by the sectors. Bananas and nutmeg, although important export commodities for St. Vincent and the Grenadines and Grenada respectively, were not research priorities for the University of the West Indies, the Caribbean Agricultural Research and Development Institute or government researchers. Maerere et al. (2007) noted that although the banana sector faced several challenges (e.g. pests and disease, low soil fertility and low yielding varieties), little research and extension services were directed at the sector, either from government or other organizations.

The universities were fulfilling their roles as locally trained scientists were seen as being as capable as those trained overseas, yet there was a competency gap for addressing the challenges the sectors faced or for taking advantage of new opportunities. For example, growth of the Kenyan floriculture industry was dependent on accessing external knowledge (Bolo, 2005).

Budgetary constraints were cited several times as the reason for non-implementation of several activities, lack of public research outputs, or failure by various actors to adopt new technologies. International funding was available to support research projects in some sub-sectors, however, this sometimes created tensions as the level of financing for international research actors was higher. In the case of PNG, regional and international research collaboration existed on banana fusarium wilt disease. International research organizations were involved in research on priority commodities (e.g. roots and tubers and cocoa), but it was not found to necessarily address local concerns (Ngou Ngoupayou et al., 2004).

While smallholder farmers and agro-processors were able to identify new market opportunities for fresh and processed foods, there were no coordinated initiatives to develop domestic and regional markets or provide services to improve product quality to take advantage of market opportunities. The problems faced by the noni industry in Samoa and smallholder farmers in Kenya, in meeting international market standards, serve as good examples of endemic system failures. The weak linkages between and among the actor groups, in the majority of cases, inhibited knowledge flow and innovation. Little attention was paid to the strong farmer-to-farmer networks for improving collaboration or for identifying new areas of research to address the specific needs of the sectors.

Conclusion

The IS approach is relevant for understanding and evaluating innovation processes in the ACP agricultural sector. Little innovation is taking place and ACP countries are unable to respond effectively to the multiple complex challenges facing the sector. Several national policies exist to support innovation activities but implementation is weak or ineffective. Small farmers and agro-processors are innovating within their existing knowledge base; however they are reluctant or constrained to adopt new knowledge and technologies because of lack of markets and limited financial and technical support. The limited research being carried out by the scientific community is not linked to the challenges faced by the farmers and other agro-entrepreneurs. Existing resources are also not being optimized due to the inadequate linkages among key actors, and the scientific community is disconnected from other key actors, including policymakers. ASTI systems are weak and the knowledge infrastructure (universities, R&D organizations, extension services) is not sufficiently aligned, integrated and responsive to challenges and opportunities for revitalizing the agriculture sector. Government investments in science, technology and innovation in support of agricultural and rural development are not sufficient.

Innovation is needed to enhance ACP agricultural performance and competitiveness but there is no clear consensus on the way forward. Some may argue that increasing investments in S&T is neither the most important factor nor the most urgent for enhancing innovation, but the results from the case studies show that ACP agricultural sectors are struggling and scientific and technical capacity needs to be strengthened. Failure to increase investments in knowledge infrastructure means that ACP countries will continue to fall behind in agricultural production, processing and marketing. They will not have the necessary competencies available for undertaking either fundamental or adaptive research or ground-breaking science to generate new knowledge or evaluate and adapt existing knowledge, including technologies that can contribute to enhancing innovation performance within the diverse and complex agricultural and food systems that exist. However, ACP scientists need to be more connected to other actors in the system to understand what is happening at local, national and international levels and provide visionary leadership and support for transforming the ACP agricultural sector.

In the complex interconnected world of the 21st Century, innovation must be promoted and supported for economic development in ACP countries, and this should be extended to the agricultural sector, which forms the backbone of national economies. Endogenous knowledge systems, that have the requisite S&T capability, are linked to local knowledge, and are complemented by increased access to global knowledge, are essential. Strengthening knowledge networks and learning competencies, achieving policy coherence, improving the institutional framework and making resources available to spur and sustain agricultural innovation, for achieving food security and economic development, therefore remain national imperatives for ACP countries.

Some may argue that more scientific rigour and empirical data are needed for improving the methodological framework piloted and tested by CTA to analyze the ASTI systems, however, the ACP scientists who used the tool found it useful and may disagree. The structured approach that CTA embarked on starting in 2003-2004, to build the capacity of ACP scientists to

understand innovation processes and analyze and strengthen IS including engaging in policy processes, has contributed to mobilizing the necessary resources needed for strengthening the knowledge infrastructure and enhancing innovation for the economic empowerment of smallholder farmers, agriculture-led economic development and achieving food and nutrition security. Several ACP organizations have mainstreamed the IS approach into their research and academic programmes, however, much more still needs to be done. Success can only be measured by overall improvement in agricultural performance; improved production, processing, marketing and trade and an ability to anticipate as well as respond to challenges such that societies and economies benefit.

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About WUR/CoS-SIS

Wageningen University and Research (WUR)/Convergence of Sciences-Strengthening Innovation Systems (CoS-SIS) was a programme of comparative action research, which aimed to gain a better understanding of the conditions that enable smallholders to innovate and improve their farming systems. It featured diagnostic studies, innovation system analyses and participatory field and institutional experiments, working with multi-stakeholder innovation platforms at local, district and national levels. It was a partnership involving: the Université d'Abomey-Calavi, Benin; the University of Ghana at Legon; the Institut Polytechnique Rural de Formation et Recherche Appliquée at Katibougou, Mali; and, in the Netherlands, WUR and the Royal Tropical Institute (KIT). Funding of €4.5 million was provided by the Directorate-General for International Cooperation (DGIS) of the Netherlands Ministry of Foreign Affairs.



About CTA

The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food security, resilience and inclusive economic growth in Africa, the Caribbean and the Pacific through innovations in sustainable agriculture. CTA operates under the framework of the Cotonou Agreement and is funded by the EU. <http://www.cta.int>

