Rethinking the benchmarking of agricultural and rural innovation

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Abstract

The purpose of this paper is to re-examine the role that benchmarking can play in rural and agricultural innovations. Although generally known as 'traditional sectors', rural activities are far from static but rather driven by old and new challenges pleading for innovative responses. Despite the broad range of insights from the burgeoning literature on innovation systems during the last decade, most benchmarking thinking and practice still remains highly science-based and centred in promoting public R&D, especially in developing countries. This paper argues that a transition from simplistic to more dynamic forms of benchmarking needs to bring it closer to the contemporary understanding of processes of innovation and technological change, as a participatory process.

This paper explores the advantages and challenges of re-defining benchmarking in an innovation systems framework. It particularly stresses the need to bring benchmarking closer to the contemporary understanding of processes of innovation and technological change. Efforts to creatively improve benchmarking in rural innovation would involve (1) expanding the set of current indicators to track underlying capacities; and (2) exploring new avenues and roles for benchmarking as a tool for dynamic comparison and as a learning mechanism.

Keywords: benchmarking, agricultural innovation systems, rural innovation.

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1. Introduction

Innovation is agreed to be a strategic variable in any development process. However, innovation becomes even more imperative in poor rural communities where creative solutions can be critical to fulfil some of the most basic needs such as food security and health. Rural economies still represent an important sector in developing countries, where land-based activities predominate (rural population accounted for an average of 72% of the total population in low income and least developed countries in 2010[2]). The rural sector is the heart of most developing country economies, but it is also a sector increasingly challenged by globalisation, poverty, climate change and pandemics such as HIV/AIDS. Although generally referred to as 'traditional sectors', rural activities are not static. Old and new challenges drive creative responses and innovation processes in rural economies, such as adaptation to climate change, changing demands in global agricultural production, increasing competition and economic risks. Innovative responses may include growing new food products and energy crops, exploring innovative conservation strategies, and diversifying into new forms of economic activity.

The distinction is not always made explicit; however, agricultural activities in advanced economies and developing countries are essentially different. In developed countries farms are much larger than in developing countries, they tend to be more technologically advanced and reliant on mechanisation; and benefit more regularly from technology transfer from foreign sources, universities and research institutes. In developing countries, agriculture is typically characterised by large numbers of small-scale producers and highly decentralized production; overall disconnection from technology research and universities as sources of technology, and mostly populated by informal farmers cultivating at the subsistence level (World Bank, 2007; Hall et al, 2005). These differences do not necessarily imply that small farmers in developing countries do not innovate. However, they indicate that agricultural innovations are not homogenous, and that they require to be looked at with a different lens in developing countries.

Researchers and policy-makers still struggle to identify what 'good innovation practices' are and even more to recognise how these innovation activities can and should be effectively fostered. Traditional views have measured innovation using indicators of inputs and outputs. The most commonly used measures of inputs include R&D expenditures – public and private – as well as technical and scientific manpower. Output measures are generally patents and scientific publications (e.g. Tassey, 1997; Furman et al., 2002); and also the economic impact of innovations (for instance reflected in profitability or market shares). Implicit in this view is the consideration that the supply of R&D resources and other technical inputs mechanically translates into 'better' innovations as the result of a

[2] World Development Indicators (2011)

linear process. However, recent thinking has realised that innovations are rarely originated in a linear manner, but rather, they emerge from complex and multiple interactions among a variety of actors and their environment, known as the 'innovation system' (Freeman, 1987; Lundvall 1992; Nelson, 1993; etc). The innovation systems perspective highlights the importance of networking, interactive learning and collaboration. It provides an analytical framework inclusive of the diversity of agents that generate, assimilate and exchange the knowledge conducive to successful innovations, understanding 'good innovation practices' as highly context-specific phenomena.

The important contributions of the innovation systems literature can no longer be deemed as a temporary fad or an intellectual fashion. The understanding of innovation as a systemic process has been widely accepted in the academic spheres, and adopted as a policy formulating framework by many governments, international donors and organisations[3]. In the agricultural sector, this transition has reflected in a move from the early predominant perspective of national agricultural research systems (NARS) to agricultural knowledge, and information system (AKIS); and more recently to agricultural innovation system (AIS)[4]. The concept of agricultural innovation system not only broadens the concept of innovation itself (beyond technical and science-based to other types of innovations – e.g. organisational and non-technical innovations) but also emphasises the wide set of actors that can play a role in the development of such innovations (beyond the traditional agricultural research, extension, and education agencies). Despite the rapid recognition of innovation as an interactive process of learning, the tools to compare, revise and improve innovation practices are still designed on the basis of traditional linear models of innovation. This paper proposes the urgent need to expand and revisit the current methods and indicators to benchmark innovation in rural sectors, in line with the latest advances on innovation theories.

One overall conclusion from the literature on innovation systems is that there is no sole, unique indicator that depicts the process of innovation. Innovation is a multi-dimensional and dynamic process of learning and interaction. However, capturing it remains a challenge, and current indicators still tend to depict a one-dimensional/static image of innovation. To account for multidimensionality, two solutions have been suggested: (1) Improving the measures of innovation by expanding the set of indicators – this has contributed to a broader consideration of innovation, including not only measures of inputs and outputs, but also processes, linkages and institutions (e.g. Spielman and Binner, 2008). However, these attempts have tended to pay less attention to other underlying dynamic processes of

[3] For instance, South Africa put the concept of 'innovation systems' at the core of its vision for the development of a new socio-economic structure in the mid 1990s, which culminated in the White Paper on Science and Technology: 'Preparing for the 21st Century' (DACST, 1996).

[4] Agwu et al (2008) argues that these three perspectives are somewhat interlinked and cumulative: "NARS focuses on the generation of knowledge, AKIS on the generation and diffusion of knowledge, and AIS on the generation, diffusion, and application of knowledge" (p.1607)

learning and accumulation of capabilities, which are fundamental for innovation[5]. The second solution to multidimensionality has been (2) combining existing measures into composite indicators. Composite indicators allow cross-national comparisons of country performance, are easier to interpret by policy makers, and also make convenient analytical tools, although they leave unresolved the dynamic nature of innovation. The use of composite indicators remains subject of controversy – some notable critiques are mentioned below.

In this paper a two-way solution to this dual problem is proposed. This solution implies on the one hand, expanding the taxonomy of indicators, by developing indicators for networking, learning and accumulation of capabilities suitable for the rural/agricultural sector, and adding them to the existing set of indicators – of inputs and outputs. On the other hand, we proposed to also look at possible avenues of revisiting the role of benchmarking. This exercise would observe the possibilities of moving benchmarking away from measuring the relative distance to static indicators of 'best practice', towards becoming a dynamic comparative mechanism for reflection, social interaction and learning. This paper suggests that in order to bring benchmarking closer to the innovation systems framework, these two avenues require further exploration.

For this purpose, this paper first provides an overview of the overall purpose of benchmarking exercises in section 2. This section provides a comparison of the traditional understanding of innovation capacity and the suggested benchmarking within an innovation systems context. Also, the differences between the rural sector and the industrial/services sectors are summarised. Section 3 describes the evaluation of innovation thinking and the key features of the innovation systems literature that are relevant for the reformulation of benchmarking. Section 4 then discuss some of the shortages and limitation of current benchmarking methods and suggest the contributions from other branches of literature. Finally, in section 5 we put forward a new rationale for innovation benchmarking —based on its original role in comparing and learning from experience, in a systemic context— before arriving at a number of conclusions.

[5] In many occasions the indicators of inputs and outputs have been directly identified with "learning" or "capabilities" presuming that for instance conducting R&D (input indicator) directly reflects a certain level of capability (Kraemer-Mbula, 2009)

1. What is the purpose of benchmarking exercises?

The term 'benchmarking' has become increasingly used over the last decade at many different levels for various purposes. Analysts have utilised benchmarking studies to identify 'best practice' across organisations; lobbying groups to make international comparisons and push for the allocation of funds on specific sectors or activities; and governments to set up priorities and policy responses. Benchmarking broadly refers to comparing and assessing performance. Comparing the performance of organisations, sectors and economies has received considerable attention and resources in recent years, particularly with growing internationalisation of production, increasing trade across regions and subsequent intensification of global interactions. Competitive forces rule existing global economic relationships, and agents have a keen interest in knowing how well or bad they are performing in relation to their international competitors. It has been argued that at the level of the organisation, the use of benchmarking can foster innovation, identify gaps and trajectories, and enhance the quality of products and services (Ogden and Wilson, 2000; Dattakumar and Jagadeesh, 2003). Additionally, at the level of the government, benchmarking is commonly used to formulate policies intended to affect performance at various levels, in order to achieve a specific target (e.g. achieve certain goals on GDP growth, R&D investment, FDI or exports).

In the field of science, technology and innovation (STI) there are well-known published rankings (such as the OECD S&T indicators, World Bank Development Indicators, UNIDO Industrial Development Indicators, etc) as well as many unpublished ones prepared by governments, consultants and research institutions, which are used as baselines to assess and design innovation strategies. For the agricultural sector, the collection of this type of information is largely in the hands of agricultural research centres, most of which are members of the Consultative Group on International Agricultural Research (CGIAR)[6]. These organisations fully rely on quantitative information on innovation activities as the foundation of measuring, monitoring, and benchmarking the performance, inputs and outcomes of agricultural S&T systems (Spielman and Kelemework, 2009).

Substantial (and growing) efforts are devoted to the collection of this kind of data, and although their results are widely cited and published, many sceptics have pointed out the limited value of comparing absolute figures in different socio-political contexts, where history, habits, institutions and actors are fundamentally different (e.g. Kraemer-Mbula and Wamae, 2010). In fact, according to the innovation systems literature, these latter factors (context, institutions, habits, etc) precisely determine the nature and direction of innovation, which in turns shapes the development trajectory of a specific region.

[6] See www.cgiar.org.

Conventional approaches benchmarking have implicit the idea that regions and countries follow similar patterns of development. Early economic theories, understood development as a race along a fixed track where developing countries would be able to catch up with advanced countries by adopting 'best practices', which would in turn shorten their productivity and technological gap. As noted by Perez and Soete (1988: 476) this perception of development implies that technology and innovation are also a cumulative unidirectional process and emulating the best performer in a particular aspect will automatically lead to superior performance standards. Strongly influenced by these dominant theoretical approaches at the time, benchmarking exercises have been focused on what is happening elsewhere (outside the organisation, sector, or economy) as a frame of reference. In order to answer the question of '*how good is my performance and how can it be improved*?' benchmarking exercises have focused on what takes place externally to the unit subject to assessment rather than on introspective evaluation of the organisation, sector or country. The conventional approach typifies a paradigm where scientists and researchers are the main holders of the knowledge that triggers successful agricultural innovations. Therefore, orchestration of catching-up at the national level has been largely placed in the hands of the state, who on the basis of international comparisons, sets up the goals and priorities, and designs policies and strategies to meet these goals. As the result, benchmarking has traditionally been considered a top-down exercise, with the objective of setting up best performance and effectively distributing resources to promote innovative activities.

However, scholars advocating for the 'agricultural innovation system' approach have argued that the drivers of innovation are broader than government or public sector institutions, going well beyond a focus on the funding and performance of publicly funded R&D (Klerkx et al, 2010; Janssen et al, 2010; Hall et al, 2008). Innovation systems places greater emphasis on the interconnections at various levels: between smallholders, education and research institutions, extension services, business enterprises, informal actors, foreign MNCs, NGOs, etc. It focuses on the *quality* of these connections (i.e. their nature, strength, etc). This broader perspective on innovation systems underpins the need to benchmark at various different levels, improving innovative performance through dialogue, joint problem solving and objective setting at multiple levels, in order to close performance gaps. Table 1 summarises the dominant characteristics of benchmarking compared to those proposed in this paper.

Table 1: Conventional benchmarking versus proposed benchmarking in innovation systems

Key features	**Traditional benchmarking**	**Proposed benchmarking in IS**
Understanding of development	Development as catching-up	Development as upgrading
Objective	Setting up best-performance: Catching-up tool	Improving performance: Institutional learning tool
Locus of knowledge	Scientists and Researchers	Farmers, researchers, civil society, government, NGOs, etc
Focus	Focus on measurable impact	Focus on improving dialogue and linkages across the IS
Direction	Top-down exercise: implemented at the policy level; distribution of public resources	Multilayered exercise: implemented at various levels; encourage improvement performance across the IS
Reference for benchmarking	External to the IS	Combination of external comparison and introspective exercises.
Underlying culture	Reflects a culture of achieving pre-determined goals	Reflect a culture of change and improvement

Source: author

In this paper it is argued that expanding the role of benchmarking requires bringing conventional benchmarking and new views on benchmarking much closer. Benchmarking should reflect a type of culture where change is central, rather than merely achieving pre-determined goals at higher level of policy (i.e. catching-up, or imitating 'best practice'). Benchmarking should constitute a tool for regularly improving and revising the goals and practices of innovation internal to the system. Although innovation systems are internationally open (i.e. collaboration among international value chains, emigration and immigration of skilled people, collaboration with foreign partners in technological development and innovation, etc), the assessment of the innovation system needs to combine comparisons to external actors, but also introspective exercises of self-comparison.

Moreover, it is here argued that the traditional approach to benchmarking runs the risk of creating inflated expectations on the outcomes of heavy public investments in innovation inputs (i.e. public investments on R&D, or training scientists and technicians). The application of this type of approaches in the context of developing countries is likely to lead to different outcomes to the foreign contexts in which they originated. Additionally, in developing regions where public resources are particularly scarce, the socioeconomic cost of misusing public funds can be very high, delaying development.

This paper argues that by focusing on innovation systems and the structures that promote learning within and across organisations, it is possible to develop meaningful benchmarking assessment in such a way that they promote dialogue and learning across systems. It suggests that not only learning needs to acquire a central role in innovation systems in which benchmarking needs to be a dynamic tool, as well as being implemented at all stages of the innovation process. The proposed benchmarking in this paper is an integral component of institutional learning, as a tool for dialogue and problem-solving across agents: benchmarking as a tool for institutional learning.

However, the commitment to such a view of benchmarking requires other commitments for its implementation, including making sure that provisions are done for planning, capabilities, resources, and long-term focus. The last section of this paper suggests directions for an alternative type of benchmarking, bringing these aspects into consideration. Section 3 thus begins with a brief overview of the definitions of innovation and innovation capacity, highlighting those that are closer to the type of benchmarking proposed in this paper. Next, some key features of innovation system concept are introduced to illustrate the natural shift that benchmarking exercises ought to take in order to match the intellectual advances.

3. Evolution of innovation thinking: summary of key changes

The first issue we face is that the definitions and understanding of the innovation process has substantially changed over the last decade and continues to be updated in light of incoming research findings. Innovation and innovation capacity have been defined in many different ways. Some authors have identified innovation with research while others have adopted a broader definition of innovation, focusing on the dynamic aspects of innovation, interactive learning – as multidimensional. This section summarises some of the key features that have changed from the traditional model of innovation to the innovation systems approach, that are relevant for the adaption of benchmarking.

3.1. From research-based innovation to learning and capability-based innovation

The long-held belief that innovations are generated from scientific research in a linear progression has been very influential over a long period of time. The acceptance of the so-called ‘linear approach’ has led many developing countries to prioritise support to scientific research institutions, and training scientists and engineers. It has also constituted a regular tool for academics to lobby for more research funding, and for policy advisers to recommend higher public funding for R&D. As a result,

innovation policies affecting agricultural sectors (and industrial sectors) in developing countries have been traditionally shaped by a linear conceptualisation of innovation. Nowadays, very few academics would defend such a model of innovation[7]. Nevertheless, in the absence of an alternative 'easily' implementable policy formula, the limitation of support to scientific research as a means for innovation still remains a mainstream practice in both developed and developing countries.

Scientific research can be relevant for certain types of innovations, even in the agricultural and rural sectors. For instance, basic scientific research in biology, chemistry and chemical engineering has been found to be relevant for product innovation in drugs, fertilizers and new seed varieties [add references]. However, most innovations, particularly in poorer rural societies are the result of improvements, adaptations and small incremental changes, and relate to the ability of agents to solve problems and overcome existing structural, infrastructural, institutional and financial constraints. These incremental changes tend to be introduced by farmers who devise new forms of organising production, storage and distribution rather (or at least as well as) scientist and engineers These innovations are often the result of a different type of knowledge and set of capabilities (organisational, managerial, etc) rather than the direct application of scientific or technical expertise. Perspectives on agricultural innovation systems pay attention to gradual, incremental and interactive generation of innovations based on a wider set of capabilities.

[add here Box 1] – Box.

The growing literature on agricultural innovation systems suggests that people in firms (and farms) build technological capabilities as a result of accumulating different types of knowledge, which combine scientific, design, engineering and operational knowledge from multiple sources (Hall, 2005, etc). The focus on technological capabilities emphasises the importance of learning in markets prone to imperfections. The literature on technological capabilities in developing countries has led to numerous classifications and types of capabilities (from more basic routine production capabilities to more complex technological capabilities), that are often acquired sequentially[8]. In this line, capabilities have been identified with the ability to adopt, adapt, upgrade and develop new products, processes and technologies on the basis of acquired knowledge. This accumulation of knowledge takes places through the interaction of actors across the system (for instance, between farmers, firms, NGOs, government departments, financial institutions, etc). Therefore, the quality and the strength of interactions among agents of the innovation system are critical. Research on innovation systems has

[7] Rosenberg (1994: 139) claimed that the 'linear model of innovation is dead'.

[8] For a summary of their main features see Kraemer-Mbula, 2009.

gradually evolved to illustrate how the exchange and use of knowledge across actors within the system constitutes the basis of capabilities and ultimately, innovation.

3.2. From supply-led to demand-led knowledge

Early linear approaches implied that innovation was essentially a 'science-pushed' process, where the supply of scientific and technological advances would determine the rate and speed of innovations. The idea of national agricultural research systems (NARS) emphasised the linear movement of knowledge generated in formal research institutions to the end users (farmers), and the role of the state in fostering technical change through the provision of agriculture research as a public good. However, overall weak demand for research products in agricultural societies has gradually exposed the inadequacy of existing research outputs, which tend to have little use in the context of rural economies (Byerlee et al 2002; Hall et al, 2006). Contemporary thinking on agricultural innovation systems views innovation as a process that cannot be understood purely in terms of independent decision-making or driven by one single source of knowledge (i.e. scientific research institutions). Instead innovation is seen as the result of a cumulative and co-operative phenomenon in which interactive learning and collective participation are fundamental. Learning is thus considered as a social process, particularly in terms of transfer and accumulation of tacit knowledge – in this case mainly accumulated by poor farmers through experience and experimentation.

Participatory approaches and demand-driven research agendas have been at the centre of international support, as means to empower poor famers and allow them shape the direction of public funds invested in agricultural research. In these approaches, participation of stakeholders was expected to lead to better designed research agendas, better targeted and distributed benefits, and ultimately more effective innovations. Current interpretations of innovation systems also emphasise the importance of the participation of stakeholders in prioritising research agendas in such a way that attend their demands and needs. Paying attention to the demand for knowledge is now considered an essential characteristic of an effective innovation system. However, the implementation of demand-led knowledge schemes brings up several challenges that do not have easy solutions.

For famers to articulate their demands effectively, they need to be well-informed – i.e. quality of the demand matters. Demand-led promotion must also be coordinated with activities aimed at long-term improvement of its quality (e.g. education and training). The higher the capabilities of the demand, the closer the generation of knowledge would be to the needs of final users. Also, coordinating the different demands for knowledge from multiple actors within the system is also a major challenge. Different actors might have different (and perhaps conflicting) demands for knowledge. The

articulation of the demand is therefore of outmost importance, particularly from those actors that are marginalised or isolated and therefore, have limited social and economic leverage and negotiating power.

A demand-led system involving users and producers of knowledge requires a fluid communication system between the multiple stakeholders in an agricultural innovation system. This can only be achieved by developing instruments that facilitate active participation of all stakeholders in an exercise of dynamic dialogue. This paper suggests that benchmarking can constitute a tool that encourages demand-led knowledge by encouraging participation, making the benefits of participation clearer, facilitating learning and dialogue; and ultimately leading to changes in the habits and behaviour of existing institutions in the way innovation is measured and promoted. This latter aspect is examined below.

3.3. From "institutional rules" to institutional learning

There is little disagreement amongst innovation scholars on the important role that institutions play in shaping the process of technological change. The innovation systems approach has particularly emphasised the role of formal institutions in innovation processes (such as private firms, public and private research organizations, NGOs, financial institutions, government and other organisations), as well as informal rules (i.e. norms of behaviour, habits, routines, codes of conduct) that individuals use to interact and reach collective goals (Edquist, 1997).

However, there is less agreement on what is it that institutions can and should operate to promote or influence innovations. Mechanistic interpretations of the innovation system have seen institutions as something that can be constructed, governed and manipulated by policy-makers (Lundvall, 2007). These ideas have translated into a tendency to emphasise institutional reform, institutional development linked to institutional leaderships. Particularly in less developed countries, characterised often by fragmented societies, civil unrest and weak states, the establishment of effective institutions that set up and guard the 'rules of the game' was considered the most adequate starting point for an innovation strategy [add refs]. However, this approach has often led to an institutional networks composed by single purpose organisations, applying a top-down approach of policy implementation and ignoring the importance of social participation.

On the contrary, broader interpretations of the innovation systems framework reject the idea that once a policy decision has been made, successful implementation and effective innovations will follow. In particular, AIS perspective argues that institutions must learn and constantly adapt to the changing

needs of the actors within the system [add refs]. Previous studies have found that learning organisational cultures and dynamic structures are the most important factors influencing institutional change and innovative capabilities [add refs]. Despite their importance, the challenge of how to design 'learning institutions' remains a great challenge.

Institutional learning can be hampered by: (a) lack of systematic and formal mechanisms to promote and facilitate communication among actors, (b) lack of methods to guide the exploration of systematic issues and (c) lack of incentives for participation. In the context of institutional learning, benchmarking can be a vital tool for communication, but also to establish a pool of innovative ideas and 'good practices' for the collective identification of problems and solutions.

3.4. From static to dynamic systems

Based on evolutionary views, innovation systems are not deemed as static or permanent structures, but constantly transformed through a process of 'creative destruction' (Metcalfe, 1995, 2006)[9]. Similarly, the AIS approach considers that changes in components of the system (organisation and/or institutions) lead to the emergence of new interactions and innovation processes. Systems are continuously adapting to new opportunities, new challenges, new arising technologies, new incoming actors and stakeholders, etc. Within this transformation, innovation systems must develop mechanisms to revise and adjust their own priorities and objectives.

4. Debates and practices on innovation benchmarking

Numerous benchmarking models have been proposed and used in the field of business management, each aiming at different purposes and stressing different aspects. Some of the most typical benchmarking models at the level of the individual organisation and individual project include: internal, external, competitive, functional and generic benchmarking[10,11]. However, benchmarking innovation at the systemic level has been somewhat more problematic and less varied. Acknowledging and embracing complexity inevitably raise multiple questions such as (i) '*what are we measuring*? – the inputs, the outputs, the quality of the institutions, the relationships between different actors, the innovation performance, the impact of innovations and/or innovation policies?';

[9] The concept of 'creative destruction' was developed by Schumpeter (1947) to describe the constant process of change in an economy, driven by the accumulation of knowledge and its application to new circumstances in search of profit opportunity.

[10] For comprehensive reviews see Kozak and Nield (2001), [and add a few more]

[11] [add brackets with explanation]

(ii) '*what is the ultimate purpose of benchmarking*? – informing policy-makers, facilitating innovation and at what level, identify innovation performance gaps?'; and (iii) '*what specific actions can be taken on the basis of the results* obtained from benchmarking exercises?'. This section does not aim to provide exhaustive answers to these questions but to encourage discussion in an innovation systems perspective

4.1. Quantitative approaches

Many of these questions have been answered in a simplistic fashion, and to some extent answers have remained unchallenged. As a result, existing benchmarking tools still tend to rely on quantitative indicators that measure innovation performance in more or less straightforward styles. Measuring and benchmarking innovation is almost exclusively done through the use of input and output indicators, which intend to reflect different aspects and stages of the innovation process.

In the field of science, technology and innovation (STI) there are well-known published rankings. The OECD Science and Technology indicators collect detailed data on R&D expenditures and number of researchers. The World Bank's World Development Indicators collect international data on and patents, researchers in R&D and R&D expenditures. UNIDO Industrial Development Indicators collect international data on high-tech exports, overseas royalties and technical fees, and R&D expenditures for manufacturing sectors. The European Innovation Scoreboard (EIS) attempts to benchmark, on a yearly basis, the innovation performance of European manufacturing and services firms by drawing on statistics from the Community Innovation Survey (CIS). Following the Oslo Manual, the CIS collects data on various aspects including human resources, product and process innovations, innovation finance, co-operation and knowledge exchange. The indicators collected are combined into a single composite indicator, the Summary Innovation Index (SII), which is used as basis to compare national innovative performance across countries. Other non-EU countries have also followed the implementation of similar surveys, such as Canada, Australia, New Zealand and South Africa[12]. Most of these surveys have been designed to address firms in industrial and services sectors in advanced economies. Their direct application to the context of developing countries (where rural activities are the backbone of the economy) has been not only limited but also largely questioned.

Measuring innovation activities in the rural sector requires a different lens, to that applied in industrial and service sectors. Some of the reasons are summarised in table 2 below. Productive activities in the manufacturing/industrial sector tend to be centralised in formal profit-driven enterprises, while the rural productive landscape is characterised by scattered smallholder farmers driven by subsistence.

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Technologies [add comment]. In the industrial formal sector, R&D activities tend to be embedded in firms, while in the rural sector R&D takes place separately from farmers in public research institutions.

Table 2: Benchmarking in industrial/service sectors versus rural/agricultural sectors

	Industry/services sectors	**Rural/agricultural sectors**
Nature of firms	Formal	Informal
Actors	Centralised in firms	Diffused farmers
Nature of activities	Profit generation	Subsistence
Technologies	Tend to be global	Tend to be local
	Largely generic	Largely context-specific (e.g. seed variety)
Nature of R&D	R&D embedded in firms	R&D separated in public research institutes
Innovations	Radical and incremental	Incremental

For the agricultural sector, the collection of this type of information is largely in the hands of agricultural research centres, most of which are members of the Consultative Group on International Agricultural Research (CGIAR). These organisations fully rely on quantitative information on innovation activities as the foundation of measuring, monitoring, and benchmarking the performance, inputs and outcomes of agricultural S&T systems (IFPRI, 2008). Inevitably, the choice of indicators is a result of a linear (input-output) view of the innovation cycle. In the agricultural sector, the CGIAR has been almost the exclusive source of internationally comparable data and policy analyses on agricultural research systems for nearly two decades. In particular, the Agricultural Science and Technology Indicators initiative (ASTI)[13] coordinates the compilation of international data on agricultural R&D. The set of indicators collected are focused on R&D spending (private, public, etc), R&D staff and technical personnel. These indicators have constituted a central piece in assessing gaps, needs and priorities, as well as guiding decisions of policy-makers, S&T managers and donors.

The predominance of this type of benchmarking model has raised multiple concerns related to its observed limitations and disadvantages (Hall, etc, add references, Katz, 2006). Recent contestations to the input-output approach have pointed the need for wider tools with which to benchmark innovativeness in the agricultural sector. Even within the workspace of the CGIAR, Spielman and Kelemework (2009) have recently recognised the importance to broaden the scope of innovation and pay attention to not only inputs and outputs but also the 'process' of innovation by incorporating systemic considerations related to learning, institutions and capabilities. These authors recognise the need for a benchmarking model more coherent with the concept of innovation systems. This valuable

[13] See http://www.asti.cgiar.org/

call for a reformulation of benchmarking exercises is however tackled lightly, by widening the range of quantitative indicators, and developing a complex composite indicator, the Agriculture, Development, and Innovation Index (ADII) — following some of the mainstream methodologies mentioned above. Composite indicators have also been subject of extensive revision and critique (Lall, 2001; Grupp and Mogee, 2004; etc).

Over the last two decades, comparative rankings have become a common tool in policy formulation, especially in short-medium term science and technology policies [refs], but also for longer-term policy issues. The direct application of these benchmarking exercises into policy-making by drawing a single desirable goal (i.e. higher R&D) has justified the allocation of huge amounts of funds to the collection of this type of data, although in many cases the information collected has not lead to rigorous academic testing [refs]. In other words, despite the spread of benchmarking across both the developed and developing world, there has not so far been a systematic attempt to evaluate its usefulness as an instrument of science and innovation policy. The entrenchment of the traditional reliance on ranking tables based on single indicators has lead to limited changes in the degree of participation, or the audience and the purpose addressed with benchmarking.

4.2. Qualitative approaches

The term 'benchmarking' originally refers to measuring performance against a standard or 'benchmark'. However, effective comparison involves more than looking at one's position within a league table. Benchmarking has the intention of comparing performance (not only against external actors, but also introspectively over time), in a structured manner with the intention of identifying a desirable future, alternative pathways and adapting practices and processes to achieve a better performance (Auluck, 2002; Papaioannou et al, 2006). Implicit in the idea of benchmarking is the process of dynamic learning and constant adaption to changing and revised targets within a complex context.

To date, the innovation systems literature has not provided a solid direction or guidelines towards benchmarking practices that would achieve this goal. However, other branches of literature, such as the literature on business management and public policy, have come up with alternatives to the use of simplistic quantitative indicators, when faced with complexity and uncertainty. Although these contributions have not been explicitly developed to provide an alternative to the current benchmarking exercises, they can feed into the methodological challenges that lay ahead of the need to reformulate benchmarking. Some contributions from the literature on scenario and adaptive planning, foresight, and participatory action research, are summarised below.

- ***Scenario planning***. Scenarios are generally defined in the literature as descriptions hypothetical future conditions and events (Porter, 1985). There are many methods for scenario building, but little consensus on which methods works best. Nevertheless, common to most approaches is the recognition that to obtain plausible and coherent likely descriptions of the future, there is a need to combine the projections of different actors. Contributions from many authors (such as Georgantzas and Acar, 1995; Shoemaker, 1995; Van der Heijjden, 1997) have suggested some general steps for scenario planning. These steps include the identification of different types of uncertainties, selection of stakeholder group of experts, brainstorming and dialogue. Rather than forecasting the future, scenario planning aims to collecting views from multiple actors and jointly develop narratives of the future. This exercise allows listing patterns, mapping relationships and ranking driving forces. By widening participation to multiple stakeholders, scenario planning attempts to identify new possibilities, challenge long-held assumptions, and share knowledge, which often becomes the basis for strategic decision-making. Despite being successfully used at the corporate level, scenario analysis has rarely been applied at the level of the sector or industry, including the rural sectors, with some exceptions (Hall et al 2006).

- ***Adaptive planning***. Similar to scenario planning, adaptive planning is also a strand of strategic planning at the corporate level. The adaptive planning approach stresses the limitations of controlling future developments, and proposes a sequential process of decision-making during which several options remain open to allow flexible responses to changing circumstances. Its main difference from the scenario planning methodology is that in adaptive planning, the scenario, stakeholders and circumstances under which decisions are made and strategies are shaped, are not fixed but open to change. Adaptive planning emphasises the processes of learning-by-doing and learning-by-interacting as the bases of constant adaptation of actors to constant change. [add references]

- ***Technology foresight***. Technology foresight exercises have attracted great attention since 1990s, as a tool for governments, academics and practitioners to identify priorities and make strategic choices in relation to science, technology and innovation. By aiming to predict and react to future scenarios, technology foresight implicitly involves a better understanding of the forces (technological and non-technological, i.e. social) that are likely to shape the long-term future. In this line, foresight has been defined as a 'systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building process' (Gavigan et al, 2001, p.3). The modalities of foresight differ strongly in terms of timeline (from immediate future to long-term horizons), goals pursued (from providing policy advice to providing social forums), and range of actors involved (from exclusive S&T expert opinion to wide social participation). Conventional

technology forecasting approaches have tended to foresee the future on the basis of a linear understanding of processes of technological change. However, foresight experts are recently reacting to growing pressures to support strategic analysis and policy-making, and are converging with scenario and adapting planning methodologies as a response to increasing complexity (Eriksson and Weber, 2008). Adaptive foresight models, therefore, have raised the aspirations of this type of exercise and intend to 'collectively shape the future' through coordination and mobilisation of actors. In this sense, effective foresight exercises are measured in terms of their impact on the strategic decision-making and behaviour of economic actors and policy-makers (Georghiou and Keenan, 2006).

- ***Participatory action research***. Action research is a method for exploring and solving issues. The concept emerged in the 1940s as a call to generate action-oriented knowledge in order to understand and change complex systems. Although many varieties and dimensions have developed since, action research still emphasises the role of collective enquiry and participation of multiple agents to better understand their practices and improve their actions (Kemmis and McTagggart, 1988; add more). The application of action research to other fields has been largely discussed (….), given mainly to its generic features based on: (1) self-reflection – improving practices through critical self-reflection of agents, as active partners, (2) process orientation – aiming at making learning a cyclical and iterative process, (3) collaborative relationships – co-management and co-generation of solutions and new knowledge (4) governance – enhancing the balance of power in knowledge production and decision-making, (5) change orientation – securing group commitment to transformation; and (6) development of expertise and resource – facilitating the process of knowledge dissemination and develop local expertise.

Long traditions of benchmarking have resulted in the confinement of comparative analyses to a collection of 'best-practice' indicators. However, the real use of benchmarking is to serve as a process of learning from the experiences of others. Learning in a complex system implies having the capacity of multiple agents to revise current innovation practices (system's self-assessment) as well as outline a desired future. It may therefore be useful to revise the perspectives of parallel techniques, such as those outlined above, to put the real purpose of benchmarking into a structured framework.

4. Revisiting benchmarking

This section build up from the recent theoretical advances presented in section3, and the discussion on current indicators, as well as the contribution from other strands of literature presented in section 4. Despite the conceptual advances, the implementation of the innovation systems approach is still

riddled with many challenges. In practical terms, it has been difficult to beat the simplicity of traditional benchmarking in advising innovation policies based on achieving certain levels of R&D targets or technically trained personnel. Greater need for participation, often clashes with the ability of policy makers to manage the complexity of innovation and the actions and/or responses that it entails.

This section attempts to propose tentative solutions to some of these challenges. The solutions are not simple and require action in two dimensions. On one hand, it requires expanding the current set of indicators, to account for underlying processes of learning and accumulation of capabilities. On the other hand it requires exploring new alternative roles for benchmarking. This exercise would involve looking at the possibilities of moving benchmarking away from measuring the relative distance to static indicators of 'best practice', towards becoming a dynamic tool for reflection, social interaction and learning.

5.2. Benchmarking as a dynamic tool

Despite the conceptual advances, the implementation of the innovation systems approach is still riddled with many challenges. In practical terms, it has been difficult to beat the simplicity of traditional benchmarking in advising innovation policies based on achieving certain levels of R&D targets or technically trained personnel. Greater need for participation, often clashes with the ability of policy makers to manage the complexity of innovation and the actions and/or responses that it entails. Despite these barriers, an alternative type of policy making can be observed, where complexity, participation, learning and growing capabilities can be addressed and guided by a new process of benchmarking. The previous section showed that participatory approaches to deal with complex scenarios have been already developed in other disciplines. The purpose of this section is to propose the main features of a new approach to benchmarking and outline the substantial methodological challenges ahead.

The new benchmarking approach proposed in this paper would take close consideration of various critical factors:

1- Focus on *processes* before results. Benchmarking as a tool for dialogue offers the opportunity for actors in the innovation system to question about their practices as well as their performance. The focus on processes, rather than results, constitutes a central element to ensure that short-term results are achieved as well as long-term improvement of the system.

2- Focus on *dialogue*. Participatory approach in a structured dialogue enhances the pool of knowledge and clarifies the available options, based on the demands of relevant actors in the

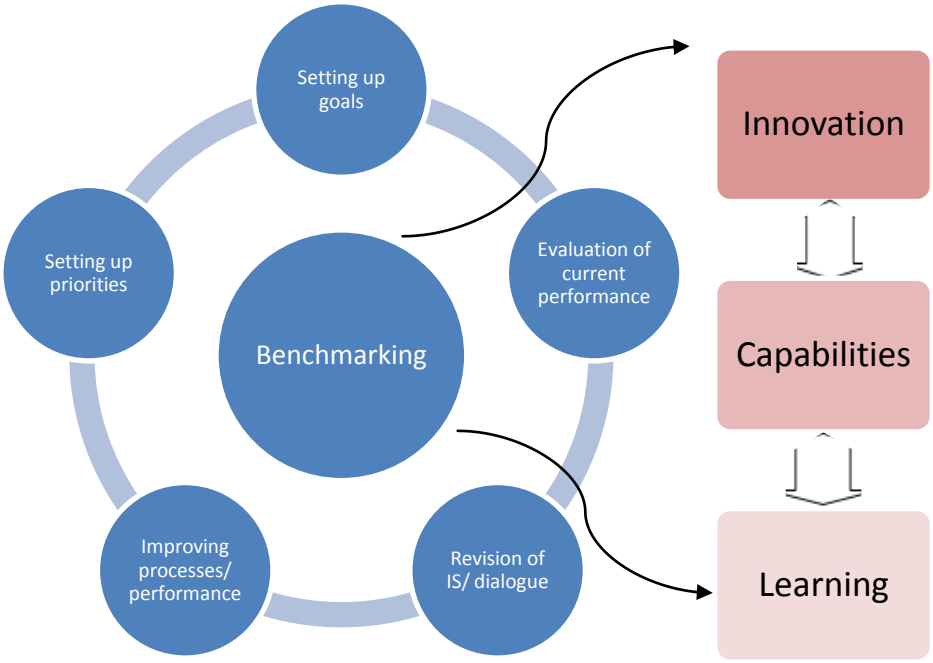
system. This type of benchmarking moves away from the idea of best practice towards an evolutionary culture where ideas from multiple actors are constantly revised.

3- Contribution to improving performance. Benchmarking is a strategic tool and as such it has to be used for raising innovation performance. Improving performance is a consequence of the improvement of capabilities of actors in decision making [explain better].

4- *Fine-tuning* tool: benchmarking must constantly foster the revision and reformulation of priorities and goals of the system. Benchmarking in this sense, can constitute a decisive tool for transformation and adaptation of innovation systems to changing circumstances.

5- Feeding into the *innovation cycles*. Many authors have described innovation and technological advancement as a continuous process of absorption and creation of technical knowledge [add references]. That is, as a process of learning. Learning processes, shaped by internal and external stimuli, translate into the accumulation of capabilities to generate changes or innovation at many levels (organisational and institutional). The type of benchmarking proposed feeds into this innovation cycle, increasing the capabilities of actors, and shaping their decision-making processes, on the basis of revised perceptions and expectations for the future.

Figure 1: Benchmarking as a tool for learning and innovation



Concluding remarks

The understanding of innovation has radically changed. It has moved away from being the realm of advanced economies. Especially in recent years, studies on innovating sectors, regions and nations have proliferated in the developing world, setting up examples of how innovation can and does take place in developing countries. Innovation – initially deemed as a research-based, radical technological change – is now understood as a multilayered complex process of interactive learning. The need to stretch up the understanding of innovations, especially in those countries and communities marked by poverty, has manifested in the innovation systems literature applied to the agricultural and rural sectors [add references].

The understanding of innovation has changed in its form and shape, and we need to renovate the way we think about it and the environment in which it takes place. Concluding that the public sector in Sweden invests 10 times in agricultural R&D more than Botswana seems a futile exercise for the improving and upgrading innovation. First, this type of benchmarking does not tell us whether agricultural R&D is a priority in Botswana, if it is, by whom, or what is the optimal rate for that country. Secondly, this benchmarking implies that Botswana requires a similar amount and type of innovation effort than a country with a completely different set of socio-economic needs, industrial structure, history and pattern of development.

This paper argues that perhaps we can start by understanding what is happening in Botswana, which actors in the economy are in most need, how are certain actors already developing creative solutions to their existing problems. How can we help those actors expand their innovations, innovate more effectively. To get this level of understanding quantitative and qualitative information are most required for a substantial participatory dialogue that leads to the improvement and transformation of the innovation system.

It is interesting that up until now, developing countries have tried to catch up not only in terms of GPD, FDI, R&D investments, contributions of economic sectors to the economy, etc; but also in terms of the formulae followed to achieve these goals. In this moment of economic recession, where the terms of trade are changing, natural resources are diminishing, and climate change affecting the agricultural sector, the generation of original and flexible innovative responses in contexts of scarcity becomes crucial. Some have claimed the end of the era of the simple formulas that reduce innovation policy advice to "increase expenditure on R&D, or FDI or buy more high tech". New solutions require facing and accepting complexity and diversity as the norm, as the reality, in this case for developing countries. Joint effort from academics, policy practitioners, analysts, industry and wider society are needed to effectively advance our understanding of a "new understanding" of innovation

strategies, and alternatives for implementation. However these efforts require designing tools that guide this process and capabilities to implement them.

Decision-making in relation to innovation and new technology, be it from a company's or from a public policy perspective, is confronted with the need to deal with complexity in ever-changing landscapes. This complexity is due to the increasingly interactive and multi-actor character of innovation processes, a development that – in conjunction with the new possibilities offered by information and communication technologies – has given rise to an internationalisation of research and innovation. This obviously makes the anticipation of future developments and their consequences more difficult than ever before.

To achieve these ambitious yet necessary goals, benchmarking exercises need to converge with other techniques that aim to the same purpose, such as foresight exercises, scenario planning and action research. The combination of self-assessment with forward-looking exercises must enable decision-makers to better understand and cope with the interactive, complex and inherently uncertain character of innovation.

Advances in rural and agricultural sectors have proved to be essential not only for the survival of farmers and rural businesses, but also offering attractive opportunities for the socio-economic progress of developing regions {add references]. However, rural sectors in developing countries are often characterised by disjointed actors and poor institutional networks [explain better]. Especially rural economies in developing countries pay a high price when limited resources are allocated in low-impact exercises.

Benchmarking as it is practiced today, shows a number of shortcomings with respect to its impact on learning, innovation and decision-making. This paper suggests that an urgent re-assessment of benchmarking methodologies could benefit from contributions from the wider fields of foresight and strategic planning. This paper attempts to raise this point, and although broad suggestions are outlined, it does not attempt to suggest detailed viable alternatives. In order to fruitfully integrate these methodologies into a new approach to benchmarking that links with the current innovation systems literature, this paper calls for practical experimentation of a variety of approaches in a number of developing regions.

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