RURAL INNOVATION ASSESSMENT TOOL (RIAT)
CONCEPT PAPER SERIES

Review of South African Innovation Policy and Strategy 1994–2012: Innovation for Rural Development

RIAT Concept Paper # 3

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The Department of Science and Technology (DST) contracted the Human Sciences Research Council (HSRC) to develop and pilot the Rural Innovation Assessment Tool (RIAT) in four rural district municipalities. The RIAT aims to enhance the contribution of science and technology interventions to rural development, deepen understanding of the social and institutional dynamics of rural innovations and inform the work of the multi-stakeholder, Rural Innovation Partnership. Based on the outcomes of this project, the team must also explore ways to institutionalise RIAT as a self-discovery diagnostic tool for innovators. This is the third in a series of concepts notes to strengthen the conceptual framework and evidence base for RIAT. The inputs from members of the RIAT Project Reference Team and the other RIAT Project Team members who are not authors of this specific paper are also acknowledged. The views expressed are those of the authors and do not necessarily reflect those of any other party.

EXECUTIVE SUMMARY

At the dawn of liberation in the 1990s a democratic South Africa emerged into a fairly unique political economic context, one in which there was an advanced system of science and technology research and development (R&D) embedded within an extremely poor national innovation system. Since 1994, South African policy makers and the scientific community have attempted to improve on the entire national system of innovation (NSI), starting with the White Paper on Science and Technology of 1996 (DACST 1996) and culminating in the DST Ministerial Review Committee on the science, technology and innovation landscape in South Africa: Final report of 2012. During the same period, strategies were also developed for specific areas of the NSI that were considered to be problematic.

The various papers, plans and assessments of South Africa's system of science and technology and the national system of innovation (NSI) are critiqued as a means of indicating where the NSI could be strengthened. In doing so it considers three primary questions that are important to the RIAT study. Firstly, does the proposed paper, strategy or plan attempt to address the issue of local, regional, sectoral or space-bound sub-national systems? In particular, does it consider the idea of a rural system of innovation to be important? Secondly, how does the proposed paper, strategy or plan attempt to address the primary challenges faced by South Africa by way of enhanced science, technology and innovation systems? These challenges are the continued presence of high levels of poverty, inequality and unemployment/joblessness. Thirdly, does the proposed paper, strategy or plan attempt to consider and explore the concept of social innovation or social technology? Does it do so within the South African context of the three primary challenges?

The paper starts by providing an overview of the situation in 1994 and why restructuring and refocusing was needed. This is followed by briefly looking at how rurality is defined in South Africa and then summarising some ideas about innovation in rural areas, based on global, African and South African research. The purpose is to illustrate some of the evidence that is important in understanding rural innovation and current (mis)perceptions about this. Also, much of the recent research on innovation in rural areas focuses on the informality of its current existence and on ways to strengthen outcomes and practices, when needed.

After looking at some of the characteristics of innovation in developing countries, as South Africa is a middle-income developing country, the four documents we consider to be the crucial documents in designing and refocusing the South African NSI from 1994 until the end of 2012 are reviewed in chronological order, using the three guiding questions above. This section of our review concludes that while much has been done, rural innovation is largely overlooked and, at best, considered to be synonymous with innovation in the agricultural sector (formal rather than informal farming activities). The truly marginalised are still not directly consulted or included in the proposed models

and structures of the NSI. Social innovation was largely ignored between 1996 and 2012. While the Ministerial Review of 2012 considers this an important area of focus, it does not articulate this further. There remains a general attention to the R&D, technology and engineering components of big science and even when the importance of other disciplines, such as the social sciences and humanities, are acknowledged, there is no plausible articulation of how these disciplines would engage equally with the other more entrenched disciplines of medicine, engineering, natural science, physics, etc.

The development of a concerted strategy around how the NSI can achieve a balance in the respective areas in the NSI that will ensure positive changes in the problems of unemployment, poverty and inequality, will require much broader and deeper consultation with stakeholders than initially conducted in the Ministerial Review Committee (Minrec) review. The true dynamics of the NSI and its integration with regional and other sub-national innovation systems has yet to be clearly understood and articulated.

INTRODUCTION

1. BACKGROUND

At the dawn of liberation in the 1990s a democratic South Africa emerged into a fairly unique political economic context; one in which there was an advanced system of science and technology research and development (R&D) embedded within an extremely poor national innovation system (Scerri 2012). This context had been historically determined by South Africa's colonial, Union and apartheid periods. Following the second Anglo-Boer War there was a shift from farming and mining to a period of state-led industrialisation at the beginning of the 20th century. This continued during the period of Union and the first two decades of apartheid, until 1970. During the last two decades of apartheid – the period of the siege economy – the emerging national science and technology R&D system remained state-led, focused on the minerals, energy and the military-industrial complexes and was extremely exclusionary when it came to integrating personnel, research institutes and the private sector. The national system of innovation (NSI) became characterised by its weak state coordination, concentration on South Africa's resource and commodity base, its low-skill economic base and marginal positioning within the global economy (Scerri 2012). Of course, there were some scientific breakthroughs and innovations during the apartheid periods, but these were few and mainly in specific sectors, for example health procedures and military, mining and agricultural technology. The focus of the NSI indicates the insufficient inclusion of small and large private enterprises from many sectors in the NSI and the narrow definition of the NSI. During the various periods of 'brain emigration', namely in the latter half of the apartheid era and again prior to and immediately after 1994, the NSI increasingly lacked a variety of high-end skills beyond commodity orientation and the capacity to measure changing science, technology and innovation (STI) in South Africa, either in terms of its own standards or relative to those of 'developed' and 'developing' economies (Scerri 2012).

Since 1994, South African policy makers and the scientific community have attempted to improve on the entire national system of innovation, starting with the White Paper on Science and Technology (DACST 1996) and culminating in the DST Ministerial Review Committee on the science, technology and innovation landscape in South Africa: Final report of 2012 (DST 2012). During the same period, strategies were also developed for specific areas of the NSI that were considered to be problematic (see for example the Draft strategy for human capital development for research, innovation and scholarship - DST December 2012). Between 2000 and 2012, specific programmes were implemented, such as the Cooperation Framework on Innovation Systems between Finland and South Africa (COFISA) between 2006 and 2009, as well as other more localised initiatives, often implemented with support from the Department of Science and Technology, other line departments or the National Council for Innovation (NACI) in order to improve and strengthen the South African

National System of Innovation (SANSI). Such programmes have had varying degrees of success and these experiences are drawn on in this concept paper. The various papers, plans and assessments of South Africa's system of science and technology and the national system of innovation (NSI) are critiqued as a means of indicating where the NSI should be strengthened. In doing so, it considers three primary questions. Firstly, does the proposed paper, strategy or plan attempt to address the issue of local, regional, sectoral or space-bound sub-national systems? In particular, we are interested in the consideration of a rural system of innovation – which might be incorrectly construed as an agricultural sectoral, local or regional sub-national system. While we believe the linking of rural innovation only to agricultural innovation to be extremely short-sighted in this day and age, we do believe it might offer a partial means of exploring and understanding rural innovation systems.

Secondly, how does the proposed paper, strategy or plan attempt to address the primary challenges faced by South Africa by way of enhanced science, technology and innovation systems? These challenges are the continued presence of high levels of poverty, inequality and unemployment/joblessness[1]. Thirdly, does the proposed paper, strategy or plan attempt to consider and explore the concept of social innovation or social technology? Does it do so within the South African context of the three primary challenges?

The key documents are analysed in chronological order to illustrate changes and gains, as well as lapses, where these are evident, over time. We also reflect on Latin American and Asian examples of how some developing countries have modified their understanding and measurement of their innovation systems so that these more accurately reflect developing society and economy requirements in these countries. Because the focus of RIAT is on rural systems of innovation, we briefly recap on the problem of defining rurality in South Africa and then present some recent trends within local and international studies on rural innovation as a starting point to review South Africa's innovation policies and strategies.

2. A NOTE ON DEFINING RURALITY IN SOUTH AFRICA

A key consideration for any innovation assessment instrument is its relevance to the context in which it is being applied. In the case of RIAT, such an instrument must be suitable for application in rural areas. In the first in this series of concept papers (Jacobs and Hart 2012) a crucial part of the discussion reports that in South Africa there is no formal or accepted definition of rural that clearly distinguishes it from urban areas; in fact, it is implied in some definitions that rural can become more urbanised over time, i.e. a rural area gradually adopts those characteristics often attributed to urban centres or their immediate periphery. The paper by Jacobs and Hart (2012) explores the varied and

[1] Joblessness is a crucial part of South Africa's high level of unemployment as jobs are particularly in short supply. The causes of unemployment have as much to do with the shortage of jobs as they have to do with the shortage of skills.

contested meanings of 'rurality'. The authors concur that rural is a fluid and flexible concept and bound to be continually redefined due to shifts in the sector composition of local economies, location-specific population densities and politico-legal policies bearing on spatial boundaries. There is evidence of the importance of these factors in both pre- and post-1994 definitions of rural areas and in the more recent municipal boundary demarcation 'wars' at the turn of this century. Subdividing rural areas in terms of commercial farming areas and the former homelands or traditional authority areas, a prominent and widespread approach in policy and survey designs, is problematic and confusing, because the former is based on a supposedly value-free economic definition (commercial activities, in which a free market system operates), whereas the latter derives from past politico-legal policies resulting in economic and social inequalities, many of which are still in place and indirectly reinforced by current policies on rural development.

More recent attempts use district and local municipalities as proxies for rural areas, in contrast to the urbanised metros. As Jacobs and Hart (2012) point out, this attempt is far from problem free and results in an unevenness in economic activities, population density, infrastructure and services across Rural District Municipalities (RDMs), which include parts of former homelands, commercial farming areas, large rural towns and very remote areas with poor access roads and often no public or private infrastructure and service provision. Some of the 24 Rural District Municipalities identified for the proposed rolling out of RIAT, and from which the four pilot study sites are drawn, include such unevenness in the characteristics used to distinguish rural from urban. The result is that although these 24 RDMs may well have similar characteristics, in that they are all identified by the Department of Rural Development and Land Reform (DRDLR) as being destitute, in some respects they are far from being homogenous rural enclaves, with some areas comparatively poorer, more remote and less serviced than others. This heterogeneity, also evident across individual RDMs, will need to be reflected in the RIAT design and in the interpretation of the data obtained from the RIAT pilot study and future work or assessments using the tool. Importantly, the 'rurality' of an area will need to be reflected upon, e.g. how does an area's 'rurality' compare with that of previous times when the tool was used. What changes have taken place and how do these changes impact on innovation in these RDMs?

3. CURRENT IDEAS ABOUT INNOVATION IN RURAL AREAS

One of the key questions of RIAT is to identify the existence and nature of the rural innovation system/s. If rural innovation systems exist, then there is a need to understand the nature of the system/s and the actors who comprise this system; including their roles, behaviour and functions. In respect to the existence and nature of such a system, current research indicates that there is an overwhelming focus on the agricultural sector, including forestry and fishing in coastal rural settlements (Chambers, Pacey and Thrupp 1989; Bawden 1995; Scheuermeier, Katz and Heiland 2004; Scoones and Thompson 2004; Waters-Bayer and van Veldhuizen 2005; Reece 2008; Scoones and Adwera 2009; Scoones and Thompson 2009; Hartwich and Scheidegger 2010; Raitzer and

Maredia 2012). While economic sectors, such as crafts and tourism, receive some attention, sectors such as mining and minerals and manufacturing receive very little. Public service organisations receive even less.

In the rural areas of the United Kingdom there has been a general and gradual decline in the agricultural, mining and tourism sectors, but it is uncertain what economic activities will replace these traditional rural industries (NESTA 2007). However, there is an emerging trend towards increasing and more stable skilled and semi-skilled employment in the local public sector (health, education, local authorities) and small enterprises (small-scale manufacturing and retail) (NESTA 2007). Perhaps these are then the future sites for innovation, involving their own separate innovation systems and linking in with the national system of innovation in various ways?

In South Africa, since 1994, we have observed an increasing 'gentrification' of rural areas, especially in parts of the Karoo, West Coast, South Cape and Wild Coast. This practice increases opportunities for livelihoods and innovation in such areas. For example, the use of ICTs (electronic notebooks, tablets and broadband) to facilitate permanent residence in these areas, while retaining continued employment in urban centres, through distance working - thereby getting the best of both worlds, but also providing local opportunities for others. As rural areas become developed (increased investment, income and demand for services), so high-level skills and greater experience are sought and people migrate inwards to rural areas, bringing skills and providing opportunities. Therefore, a crucial question is: are rural innovations those that take place in rural areas or those that benefit rural growth (social, economic, political and cultural)? Perhaps they do both, having application in and outside rural domains and contributing towards local and national growth in a variety of ways, which can be determined by the supportive environment and the extent to which their benefits are facilitated more widely.

Much of the literature on innovation in rural areas internationally, and in South Africa, focuses on two particular issues. The first is that innovation in the agricultural sector is prevalent; when other sectors are indicated, this is usually in terms of their connection to the agricultural sector. For example, a focus might be on how information and communication technologies (ICTs) may assist in agricultural innovations. However, while agriculture may be the prevalent sector in rural areas and other sectors exist, often with a supportive function to the agricultural sector, they do exist independently of agriculture, although the innovation literature explored does not highlight this existence. This evidence was confirmed by at least two recent South African studies (Cartwright et al. 2009; COFISA 2010) conducted in various rural areas of South Africa; notably the Eastern Cape and Limpopo provinces. Examples included the increased uptake in ICT technologies and the expansion of local manufacturing, utilising local natural resources, as well as novel ways to organise people to manage their natural resources and to promote tourism. An earlier and more nationally focused study on rural technology also indicated the diversity of sectors within rural areas that involve innovation activities, notably adoption, adaption and diffusion (Mazibuko et al 2008). Consequently,

RIAT must consider sectors other than agriculture and those having merely a supportive role to the agricultural sector. Rural innovation does not equate to agricultural innovation!

The second issue arising from the literature is that much of the recorded experiences of actors in agricultural innovation (often used synonymously to refer to rural innovation systems) stems from the collaborative research of NGOs, universities and university think tanks. Having realised that many people are excluded from formal agricultural R&D, the focus of these organisations is often on informal systems or arrangements of the disadvantaged or vulnerable that result in innovative processes and products. The intention of this collaborative research is to increase awareness of the intrinsic value of such activities and to get public sector research and extension involved in supporting these local informal innovations as a step towards improving agricultural livelihoods and creating more resilient livelihood opportunities. The starting point of much of this research stems from several arguments by Robert Chambers (1983) for the need to 'put the last first' and to 'challenge the development professions' assumed ideas of reality on the ground and notions of their exclusivity to innovation (1997). Most often, the work of these collaborators is financed by external governments and charitable trusts – the initial studies to identify and record innovations, as well as the facilitation and resources required to get local research and extension involved (see Letty, Shezi and Mudhara 2012). The implication is that informal systems of innovation appear to be largely overlooked by the public and private sector research and extension for various reasons.

Anil Gupta (2012) has evidenced the importance of informal or grassroots innovators and significance of peer to peer networking in developing economies in Asia. Informal systems need to be included in any useful study of rural innovation for, although they may appear to operate in parallel and apart from formal systems, they could operate within such systems or easily integrate these systems into their own practices (see recommendations by Hart and Vorster 2007) thus increasing added value. Some innovation scholars in South Africa (Hart and Vorster 2007; Mazibuko et al 2008; Letty, Shezi and Mudhara 2012) have identified that informal innovation networks are a reality in rural environments, both in marginal areas, where formal networks (sectoral, sub-national, regional and local) are thin or non-apparent and also within various sectors, such as the public service (municipalities) and private sector agriculture. Thus there is a need to include and make visible the heterodox approaches to innovation and the informality of much innovation and outputs in rural areas, including implications of this for protection (IPRs), open source and 'copyleft' ideas, as well as the significance of informal networks in the innovation process.

From most studies two general trends are clear. Firstly, the understanding and prevalence of innovation in rural areas in sectors other than agriculture is under-researched. This is not to say that there is no research on these sectors; however, it is limited and considers existence, rates of diffusion and adoption rather than adaptation and invention in the sense of improvement beyond adaptation only for local application (Mazibuko et al 2008; Hart et al. 2010). Furthermore, there is little focus on social innovation in the sense of organising groups and local people to benefit from

services and democratic governance by innovatively interacting with these services to improve delivery thereof and the design products (goods and services) required. Social innovation or technology is considered in many instances to be a product that improves human well-being, rather than processes of organisation. Secondly, because the focus of a large body of the literature derived from these studies is on informal innovation activities, processes and products developed by farmers and pastoralist or farming communities (Letty, Shezi and Mudhara 2012), it is implicit and also apparent in many instances (see examples from South Africa in Hart et al. 2010) that formal actors, such as public service research and extension, are having little success in reaching and diffusing innovations to smallholder farmers particularly, and rural communities more generally (Hart and Aliber 2010)[2]. Often the lack of success and low adoption rates have to do with poor conceptualisation (most often top-down) of what is needed and what is important, although there are other factors involved, such as political choices and expediency (Hart 2012). Of immediate concern is that this narrow problem-solving focus and lack of success could be a result of having little interest or encouragement in reaching such groups with appropriate and required technology. This state of affairs could result from the 'big science' ideology that underpins the NSI and its main actors, the lack of articulation with regard to a broad understanding of the NSI and the heterogeneity of the actors involved, as well as the failure to recognise the existence and role of informal networks within and outside the formally defined national, sub-national, sectoral, regional and local systems of innovation.

2. METHODOLOGY

This conceptual paper draws on some key literature relevant to grasping recent understandings of innovation policy and strategy in South Africa since 1994. This literature includes key official South African policy documentation, such as the 1996 White Paper on Science and Technology: Preparing for the 21st Century (DACST 1996), the OECD Reviews of innovation policy: South Africa 2007, the 2007 Innovation towards a knowledge based economy: Ten-year plan for South Africa (2008-2018) (DST 2007) and the 2012 Department of Science and Technology Ministerial Review Committee on the science, technology and innovation landscape in South Africa: Final Report (DST 2012).. Recent papers produced by the United Nations University Maastricht Economic and Social Research institute on Innovation and Technology (UNU MERIT) and various academic experts in the broad field of innovation are also reviewed. Practical papers and policy briefs produced by the National Endowment for Science Technology and the Arts (NESTA), the Young Foundation and members of the international multi-stakeholder platform, Promoting Local Innovation in Agriculture and Natural Resource Management (PROLINNOVA), are also incorporated. Literature was obtained at the suggestion of colleagues and various members of the RIAT Reference Group. Some literature sources were drawn from literature recommended by various interviewees during the initiation period of the

[2] In their study of the Comprehensive Rural Development Programme (CRDP) Hart, Aliber, Letty et al. 2010 noted that this situation also applied to other economic sectors and not only to agriculture.

first phase of the study and others obtained from the initial review of literature. Internet searches using the input of key words such as ‘South Africa’, ‘innovation policy’, ‘innovations’, ‘science and technology policy’ and ‘rural innovation’ into some of the online databases described in Jacobs and Hart (2012), were also conducted. A detailed list of the references cited is included at the end of this paper.

REFLECTING ON SOUTH AFRICA'S CORE INNOVATION POLICIES AND STRATEGIES

Studies on innovation in various developing countries, particularly those interested in determining useful indicators of innovation for such countries, note that most of the innovation in these countries is through dissemination mechanisms and incremental change (Polcuch, Lugones and Peirano 2005). The first innovation survey in South Africa reported that 86% of South African industrial innovations are based on incremental change (Polcuch, Lugones and Peirano 2005). This means that any understanding of the innovation system in South Africa must acknowledge and apply greater attention to understanding the systems, networks and actors involved in technology diffusion and incremental change, as these determine the pace of innovation. This review of various policy and strategic documents intends to reflect on if and how these documents can assist the South African science, technology and innovation landscape to address circumstances particular to its development requirements and to ensure that innovation activities focus on these needs, given that the South African NSI exists in a middle-income developing economy.

To do this, we consider answering three primary questions with regard to the various policies, reviews and strategy documents relating to the South African system of innovation since 1994. These questions are:

- Does the proposed policy paper, strategy or plan attempt to address the issue of local or regional sub-national systems, in particular a rural system of innovation?
- How does the proposed paper, strategy or plan attempt to address the primary challenges of continued poverty, inequality and unemployment faced by South Africa, by way of enhanced science, technology and innovation?
- Does the proposed paper, strategy or plan attempt to consider and explore the concept of social innovation or social technology within the South African context of these three primary challenges?

It is perhaps worth stating up front that none of the four policy, strategy or review papers reflect on or appear to attach any significance to the need for understanding rural innovation systems or to make mention of the relevance of such a system, separate to or within, the national system of innovation, policies and strategies. No significance is attached to such a system at present in any of the key documents. This is despite the significant emphasis on rural development and the rural economy in two of the recent government economic and development strategic documents; the New Growth Path of 2011 and the National Development Plan of 2012. A determined policy focus on rural development in general has been implemented in a limited fashion by means of the DRDLR Comprehensive Rural Development Plan (CRDP) since mid-2009. Despite the assumed crucial role of agriculture in rural development, the agricultural sub-system is also not mentioned in any of these policy documents in any significant manner, beyond naming the Agricultural Research Council as the

key player, along with the Ministry of Agriculture and outlining ways of 'farming' natural resources so that sales to pharmaceutical companies may be increased (DST 2007).

1. DACST 1996 WHITE PAPER ON SCIENCE AND TECHNOLOGY

The White Paper on Science and Technology (DACST 1996) has a vision in which all South Africans enjoy an improved and sustained quality of life, integration into the economy by means of satisfactory employment and participation in the democratic political culture. To achieve this vision the following six robust goals are considered critical by the developers of the 1996 White Paper:

1. Establish an efficient, well-coordinated and integrated system of technological and social innovation;
2. Encourage creative and collaborative partnerships for individual and national benefit;
3. Aim at problem solving and involving the multidisciplinary use of engineering, the natural, health, environmental and human and social sciences;
4. Include formerly marginalised stakeholders in science and technology policy-making and resource-allocation activities;
5. Ensure that the advancement of knowledge is valued as important to national development;
6. Improve support to all types of innovation fundamental to sustainable[3] economic growth, employment creation, equity through redress and social development.

To achieve these goals the 1996 White Paper proposes a quadruple helix national innovation system that consists of government, higher education institutions, the private sector and civil society (particularly NGOs, but also media and cultural-based organisations). There also seems to be reference to individuals and engagement with the previously excluded and marginalised, although these individuals and groups are not always clearly defined. This is important because individuals and groups are fundamental to ensuring that innovations become broadly accepted and used by other people beyond the inventors, i.e. innovations must become important to the life of the user and add value to this life if they are to be adopted[4].

Although the ideas of innovation and the NSI cited in the White Paper were largely drawn from a 1994 report of the Canadian Auditor General, these goals appear both laudable and refreshing in light of the pre-1994 narrow and exclusionary practices of science and technology R&D and the weak NIS in South Africa. In Chapter 3 of the White Paper (DACST 1996) it is emphasised that the NSI must achieve an environment composed of:

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[3] The use of sustainable here probably involves reference to both the environment as well as to continued growth – neither of which have been achieved in our view, probably because the term is a buzzword with many interpretations depending on the discipline or sector using it.

[4] Of course this does not mean that the adoption of a technology might not be a result of another factor such as a desire to indicate an improvement in status – especially material status – but even in such cases the innovation must have some usability.

> '… all individuals and organisations involved in creating and using a knowledge base in order to build a better South Africa and would thus constitute a national system of innovation. Such a system, in its broadest conception, is the means through which a country seeks to create, acquire, diffuse and put into practice new knowledge that will help that country and its people achieve their individual and collective goals'.

The bulk of the White Paper describes the functions of the government and the institutional arrangements to achieve the goals outlined above. Key institutional arrangements are the formation of the Department of Science and Technology (DST) as separate from the Department of Arts and Culture (DAC), the establishment of the Ministers Committee on Science and Technology (MCST) and the formation of the National Advisory Council on Innovation (NACI) to formulate policy and ensure the integration of STI into the different sectors of the economy and society. However, while these institutions all exist, most of the goals have not yet been fully realised.

Despite intentions to the contrary, as indicated in the 1996 White Paper on Science and Technology, South Africa's national system of innovation seems to have largely included only recognised formal innovation actors, primarily those in urban areas. If we start tackling each of our core questions in turn, we see that the White Paper makes no mention of rural innovation systems or even local innovation systems, beyond the consideration of national equating to local, in contrast to foreign or external and global innovation systems. While rural is mentioned, the focus is on needs and little distinction is made with regard to differing urban and rural needs – the assumption appears to be a one size fits all solution, one in which only a small proportion will directly benefit. Surprisingly, no mention is made about how indigenous knowledge systems are to be included into the NSI, if at all. Despite an emphasis on the knowledge economy there seems to be little attention, beyond the distribution of journals via SABINET to rural libraries, given to improving basic or tertiary knowledge in rural areas, despite the evidenced need for improved education, knowledge and skill development at all levels, not just tertiary. Although agriculture is noted in the White Paper, this remains confined to formal research and diffusion components, such as the Agricultural Research Council (ARC), the National Department of Agriculture (NDA now DAFF), universities and new funding systems developed after 1996, such as the National Research Foundation (NRF) and the Innovation Fund, which is to be administered by the NRF. While we are aware of a few of the players within the formal NIS, we have no idea of the systems of diffusion of innovation, their nature and also no idea of the informal players in the formal and informal systems that exist.

While mention is made of the challenges facing both South African society and the economy at the dawn of democracy – high levels of poverty, inequality and unemployment – in our opinion, the document fails to realistically address these in any constructive way. It alludes to the need to address these three crucial problems and even to include the use of environmental and social sciences to assist in this process, but practical steps are not proposed, nor are any guidelines suggested. The quintuple helix model of the NSI, cited in innovation studies and policies elsewhere, emphasises that

the natural environments should be conceptualised as drivers for the further advancement of knowledge production and innovation systems. Thus, the quintuple helix model appears to be compatible with the interests of 'social ecology' and 'sustainable development'. While social ecology and sustainable development are important areas, policymakers need to be clear on the role of the natural environment in innovation and subsequently how this proposed role would innovatively contribute to South Africa's three core challenges.

In fact, it seems that the concern of the White Paper is largely with restructuring the existing system so that it becomes broader in the sense of its sectoral focus, more coordinated, more diverse in its employees and largely attempts to improve the education and employment of potential scientists from previously disadvantaged backgrounds. In this way, matters such as poverty, inequality and unemployment will be reduced for a small group of specific individuals – the trickle-down effect is assumed to do the rest! It is further assumed that this restructuring will catalyse the improvement of society and the economy. Because there is no real attempt to address the broader needs of society and emphasise the innovations required to do this, the approach outlined in the White Paper remains narrow and focused on key sectors. It would seem that the focus of the quadruple helix is not on the broader majority of South Africans, most of whom are poor and marginalised, as at no point is it clear where these individuals or groups exist in the helix. There is a need to clearly define their position and role. Perhaps it is only those who now become counted within the quadruple helix structure of the proposed NIS – those who at the dawn of democracy in 1994 could be employed in government, private enterprise, universities, etc., and those who were educated to at least secondary level, so that they could reap the benefits of improved tertiary educational grant-making facilities! For us this is a rather narrow notion of inclusion and results in the continued exclusion of the majority of the previously excluded groups, such as the poor, disabled and those unable to enter the formal components of the quadruple helix, which is mainly through employment, good tertiary education or invitation to advisory positions.

Beyond the mention in the first goal that social innovation is important; nowhere in the White Paper is social innovation or social technology adequately defined! Without any clear definition, how can such technology be developed or innovation take place? While the social sciences and humanities are deemed important because they were historically overlooked, how they will now actually inform social and economic development and innovation in particular is never clarified. It appears that they could advise about social development and the types of innovations and technologies that are socially relevant and appropriate for economic and social development, but what influence they will have and how their research will link in with key concerns is ignored. Simple restructuring of the existing system and renaming of existing structures and their goals, without paying attention to the requisite actions and embedding these with clear purposes within the 'newly designed' NIS, is inadequate. The continued lack of deep integration of the social sciences and humanities with the natural, environmental, health and engineering sciences remains a core problem within the NIS.

Despite what appears at first to be robust and laudable goals, the White Paper seems to have become rather constrained in its implementation beyond restructuring and making limited improvements within the formal components of the previous triple helix NIS, by not paying due attention to what happens outside of this NIS structure and how innovations can be optimised for social and economic development. There is also a lack of focus on constraints to improving not only the formal innovation system, but also the inclusion of grass-roots and bottom-up development of technology and innovation.

2. OECD REVIEWS OF INNOVATION POLICY: SOUTH AFRICA 2007

At the request of the South African Department of Science and Technology (DST), the Organisation for Economic Cooperation and Development (OECD) Directorate for Science, Technology and Industry (DSTI) carried out a review of South Africa's innovation policy in 2007. This review focused on a background report produced by NACI (2006), the results of several interviews with major stakeholders in South Africa's NSI and a peer review meeting with members of the OECD Committee for Scientific and Technological Policy (CSTP). At the time, 2007, South Africa was in the midst of two economic transitions:

- Shifting the structure of its economy away from the pre-1994 dependence on primary resource production and associated commodity-based industries;
- Responding to globalisation by opening its economy to international trade and thus needing to be competitive within the new global markets.

The review was largely a SWOT analysis with the purpose of assessing South Africa's NSI:

> '… both as actor in and contributor to this process [of economic transition] and as a key structural determinant of the country's capacity to create employment while retaining dynamic productivity-driven growth' (OECD 2007: 9).

At the outset, the reviewers pointed out that despite achieving reasonably good growth performance, largely due to gains in productivity, crucial socio-economic problems, primarily poverty, unemployment and exclusion from the formal economy, persisted. These are largely unaddressed by the innovation system as evidenced by the continued entrepreneurial and technological skills shortage in the informal economy

Other specific weaknesses identified within the NSI included the following (OECD 2007, Scerri 2012):

- The continued strong reliance on a resource- and commodity-based economy, despite the intervening period and opportunities of globalisation and trade, meant that the NSI continues to focus on these activities.
- Weak public sector coordination of the planning and implementation of the NSI, which was a key role identified in the White Paper of 1996. This was compounded by the almost exclusive focus on the state as the primary role player within the NSI. Despite intentions to the contrary, one of the results of the poor coordination was the insufficient involvement of the

private sector in the planning and subsequent inclusion in the building of the NSI – evident at the levels of large, medium and small firms – resulting in insufficient funding and skills development in small and medium enterprises (SMEs).

- A lack of understanding and therefore recognition of the broader definition of the NSI that includes the acknowledgement of the interactions and effects of:
    - Geo-political, institutional, macroeconomic, social and cultural contexts;
    - Policy, promotion, financing, representation and the regulation subsystem;
    - Demand on innovation requirements and optimisation.
- Human capital constraints at the higher end of the skills spectrum, especially with regard to the fields of mathematics, science and technology, engineering and design, as well as entrepreneurs and managers across the R&D sector.
- Inadequate capacity for the measurement of science, technology and innovation indicators to allow internal assessment of the contributions of the NSI, as well as comparison with other countries, both developing and developed economies.
- Inconsistencies between the immigration policies and the human resource needs of the NSI.

Subsequent recommendations by the review team, based on local observations and experience of the OECD countries, focused almost exclusively on the following:

- Innovation policy should encourage the private and public sector to creatively respond to social aspirations, such as improving wealth through sustainable job creation, economic growth, health improvement, security and an improved environment.
- Improve knowledge infrastructure to achieve the following:
    - Move away from resource-based industries and commodity focus towards knowledge-intensive production, including services and supplier industries;
    - Reduce the gap between the formal and informal economy by ensuring that the STI provides tangible benefits to the majority of South Africans, enlarge the human resource pool and ensure that the domestic demand for innovation increases.
- The state should not only continue to fund R&D, but also address bottlenecks and impediments to innovation processes within the innovation system to ensure that it performs as a whole. A need to move beyond the simple R&D focus and ensure that innovation occurs across the economy.
- Attain a balance between excellence and equity.
- Incremental growth is unlikely to remain infinitely acceptable to the poor.
- Innovation policy must be open to and consider the needs of all stakeholders, including those outside the STI community, so that there is a good mix of top-down and bottom-up initiatives. In this respect the reviewers noted that foreign individuals, enterprises and knowledge organisations need to participate in the South African NSI, while South Africa needs to participate in foreign research markets if the NSI is to be successful.

- There is a need to reconcile quality, relevance and critical mass to match opportunities within national and global innovation networks, ensure active involvement by research end-users in defining priorities, while rigorously selecting research projects and teams for support.
- Good governance is required to ensure both vertical and horizontal coordination to avoid the dilution of priorities, which may prevent the achievement of critical mass and comparative advantage, while still ensuring effective policy implementation. This final point implies that the NSI should not simply focus on local economic and social needs without ensuring the development of the STI skills base and comparative advantage within the global arena.

A range of strategies were suggested to achieve these recommendations, including the restructuring of the NSI, the changing of responsibilities of various institutions in the NSI, the shifting focus on primary, secondary and tertiary education, human resource development for the workplace, improving immigration policies, university research funding and support to innovation within SMEs. Much of how this is intended by the South African NSI policy makers is evident in the 2007 10-year plan, which we discuss below in detail. However, if we briefly reflect on our four key questions with respect to the OECD review, we note firstly that rural innovation systems are not mentioned at all by the OECD review team. Once again, mention is made of both the rural economy and the role of the agricultural sector by considering ways to optimise the rural economy and increase employment. However, despite indicating that the NSI should take cognisance of the input from rural areas and the agricultural sector, as well as from marginal actors, it is particularly evident that this was not a step highlighted by the OECD review team. While creativity is acknowledged and noted as being important, no attention is paid to how the systems that enhance local and rural creativity can constructively be understood to ensure optimal inclusion in the NSI. However, the review acknowledges the inherent problems in the rural economy, as well as some perceived changes undertaken within the NSI with regard to reorienting the R&D sector towards smallholder farmers and rural SME development. Furthermore, the review team acknowledges the contribution that could be played in the NSI by indigenous knowledge and lists some of the ways in which the NSI has attempted to accommodate this knowledge system.

With respect to acknowledging South Africa's primary challenges of poverty, inequality and unemployment, the review team points out that these are largely unaddressed by the innovation system. They cite as evidence the lack of a creative response to social aspirations, which includes an observed increase in, rather than reduction in, the chasm between the formal and informal economy, while the entrepreneurial and technological skills shortage in the informal economy continues. There is also a lack of evidence that the STI provides tangible benefits to the majority of South Africans by simply enlarging the human resource pool, thereby reducing inequality to some extent and also ensuring the domestic demand for innovation. They report that the National Strategy for Research and Development identified the DST-located Technology and Innovation for Poverty Reduction Directorate as one of the four main technology missions. However, the OECD review team

was not aware of any substantial elaboration of the content of this programme, nor of any integrated approach to action whereby innovation and poverty are the focus. The NACI background report for this OECD review (NACI 2006) briefly noted that this field was a weakness of the national innovation system. The reviewers consequently report that the balance between excellence and equity is not being achieved and that incremental and trickle-down growth are unlikely to remain acceptable to the poor over the medium to long term. Some significant and immediately observable growth is required.

Despite mention in the 1996 White Paper, we see that the OECD reviewers exclude and refrain from commenting on social innovation in any direct sense. The term is not mentioned at all in the report, despite notice of such an institute being based at the University of Limpopo. This is worrisome to say the least, but is perhaps explainable if we consider the ideological underpinnings of the review itself. In what appears to be typical 'northern fashion', the reviewers suggest that the criticisms and shortcomings can be overcome if one largely follows the 'tried and tested' strategies of northern-oriented national systems of innovation. It is noted that NSI and related policy must be open to and consider the needs of all stakeholders, including those outside the STI community. This will ensure a good mix of top-down and bottom-up initiatives. However, the emphasis seems to be on foreign or external inclusiveness, rather than on local requirements. The reviewers note that foreign individuals, enterprises and knowledge organisations must participate in the South African NSI, while South Africa must participate in foreign research markets if the NSI is to be successful. Furthermore, to achieve quality, relevance and critical mass, opportunities must be matched within national and global innovation networks and active involvement by research end-users in defining priorities must be ensured, while rigorously selecting research projects and teams for support.

Here the impression is not so much that the previously excluded and currently marginalised must be heard and represented, but rather that global priorities are an important focus and are paramount. In line with the times and western opinion of developing countries, good governance is required to ensure both vertical and horizontal coordination to avoid the dilution of priorities, which may prevent the achievement of critical mass and comparative advantage while still ensuring effective policy implementation. While good governance is important, this is perhaps not the problem. It is more a problem of integration (especially of those previously excluded) and focus. While we agree that the NSI should not exclusively focus on local economic and social needs, without ensuring the development of the STI skills base and comparative advantage within the global arena, we are against the idea that global concerns are of overriding importance to South Africa and other developing economies. Many of the recommendations of the OECD team appear to be fraught with weaknesses in that the emphasis on foreign and global needs and inputs appears to override local or South African concerns and priorities (and not just of those in power). We do not argue that global considerations are unimportant or must be ignored, but how they can form part of the priorities or focus of the SA NSI needs to be seriously investigated. The OECD review does not do this and no mention is made of informal systems, marginal actors and how we can achieve South Africa's

priorities, while simultaneously improving research capacity by engaging in global research markets and obtaining global research expertise. Northerners such as Gault (2010) seem to reiterate the suggestions of the OECD when they suggest that the Global Grand Challenges (GGC) are the primary focus of all innovation systems, irrespective of their location. Such beliefs are ignorant of the circumstances and conditions within so called 'developing or emerging societies and economies' and which should significantly direct and drive the innovation and development requirements of these countries.

Polcuch, Lugones and Peirano (2005) identify some characteristics of the economies and societies in developing countries that they believe require special attention. These include:

- The size and structure of markets and firms are small. Large companies tend to operate sub-optimally and the scope of all firms is likely to be reduced due to the small size of the local market. Competitiveness is most often based on the exploitation of cheap labour and natural resources, rather than on the desire for efficiency and differentiated products. Informal organisation of innovation is strongly evident while formal R&D projects are fewer.
- Informal practice in the economy is significant, but does not provide a favourable context for innovation, especially when problem solving is not applied systematically.
- State participation can be heavy, reducing competition and discouraging innovation. Many of the large enterprises in the sectors offering increased innovation opportunities at the global level are state owned and have a local monopoly as a result, for example aerospace, energy and telecommunications. Similarly, the ready access to resources also puts such state-owned enterprises at a distinct advantage.
- Innovation decision making is often reduced because of the large presence of multinationals, who innovate for global, rather than local, concerns. Technology diffusion is similarly affected and may well be for the benefit of the multinational, at the expense of locally owned companies.
- Innovation systems are weak in the sense that resources are fewer and government is the main player. Within the NSI, flows of information are fragmented and there may even be no link between the actors. The alternative is to acquire existing technology from outside. Barriers to accumulation of the necessary capabilities are high. Furthermore, infrastructure is weak or non-existent, macroeconomic uncertainty exists, there is institutional fragility, risk-averse behaviour and a lack of social awareness about innovation.

While not all of these characteristics may be applicable to the South African situation, most are. Despite this, the OECD does not consider most of these concerns or look at ways in which they can be improved upon for the benefit of the country. The 2007 ten-year plan (DST 2007), formulated in response to the OECD review and the 2012 Ministerial Review Report on the STI landscape (DST 2012), which addresses some of the constraints overlooked in the ten-year plan and proposes significant restructuring of the NSI, are largely attempts to reconcile the criticisms made in the OECD

review, but do not seemingly consider alternatives and perhaps more 'innovative' strategies that might have greater relevance in a developing economy. Furthermore, they fail to look at how South Africa's challenges of poverty, inequality and continued significant unemployment can be addressed in conjunction with the GGC. There needs to be a meeting of similar and diverse local and global needs, not only within the NSI, but also within south African society as whole. We now turn to these two documents.

3. DST 2007 INNOVATION TOWARDS A KNOWLEDGE-BASED ECONOMY: TEN-YEAR PLAN FOR SOUTH AFRICA (2008-2018)

South Africa's innovation policy after the OECD review is guided by the ten-year innovation plan for South Africa (DST 2007). The plan does not have a specific focus on rural areas, but rather emphasises a knowledge-based economy, one in which innovation and growth are more or less exclusively determined by the level and availability of knowledge.The economy revolves around knowledge and 'western knowledge'-dense societies are assumed to be at the leading edge of innovation and growth. The plan suggests that South African economic growth will be achieved if the NSI focuses on four key elements. These include human capital development, research and development (R&D); associated infrastructure to ensure knowledge exploration and generation and 'enablers' to address the gap between research results and their socio-economic outcomes. Hopefully these 'enablers' will also ensure the understanding of social and economic impacts, as these impacts are often contingent on policy goals and planned intervention outcomes.

The primary focus of the 2008–2018 ten-year plan is to work towards addressing five grand challenge areas (DST 2007):

1. 'Farmer to Pharma' value chain strengthening, which emphasises the desire for South Africa to become a world leader in the biotechnology and pharmaceutical industry by exploiting the country's indigenous and natural resources.
2. Space science and technology development by increasing innovations in the space sciences and the satellite industry, with related improvements in earth observations, communication, engineering and navigation.
3. Ensuring a secure, renewable, clean, affordable and consistent energy supply to reduce reliance on fossil fuels and to access new markets including the 'hydrogen economy'.
4. Contributing towards global climate change through monitoring, scenario development and prediction of changes in Africa and the Southern Ocean.
5. Gaining a greater understanding of human and social dynamics by becoming a social sciences 'knowledge hub' in Africa and contributing to understanding the global shifts in social dynamics.

At first glance it is apparent that this plan is largely top-down in its approach and intentions. No mention is made of rural, local, sub-national or regional innovation systems. Given these five grand challenges, it is clear that there has been no consultation or prioritisation with citizens outside the formal NSI and that any consultation within appears to have been extremely selective. For example, only scientists and industrialists could assume that the 'Farmer to Pharma' approach will actually benefit more than a handful of already well-positioned actors in the economy. Undeniably, there will be some spinoffs for rural areas and residents that can result from the increased economic opportunities afforded by the 'Farmer to Pharma' value chain idea, as well as initiatives such as the Square Kilometre Array. However, the numbers of people reached will be few and contingent outcomes seem to be overlooked. For example, what is the possible effect on natural resource base stemming from concentrated involvement in the agricultural natural resource pharmaceutical industry? What are the economic and trade implications of such involvement – short-terms gains at the cost of long-term losses? We can recall this exclusionary focus was exactly what the White Paper of 1996 wanted to overcome. Yet it still remains, albeit couched in other terms. Rather than attempting to use or understand rural, local, sub-national or regional innovation systems, the ten-year plan in fact ignores the relevance of these in the innovation process and obviously considers them non-existent or unimportant, as no mention is made of them, despite the desire to enhance innovation in South Africa.

Moving on to the idea of South Africa's core challenges, it is plainly evident that the ten-year plan is heavily influenced by the Global Grand Challenges (Gault 2010), which include climate change, health, security and the constraints related to conventional energy resources. Of course, some of these are important concerns to South Africa (renewable energy, internal safety and security, local impacts of climate change) and others have important revenue and knowledge capacity spin-offs (biotechnology, pharmaceutical industry, space science and technology development). However, are these the vital challenges that need to be overcome in order to ensure and increase the social and economic development of South Africa and the majority of its people? Do we perhaps have more pressing challenges that require more of our attention? Why are poverty, inequality and continued unemployment not at the top of a South African NSI list of targets? Human capital development is aimed almost exclusively at graduates, particularly PhDs, who would enter and form part of the NSI cadre. While a need for more qualified South Africans is vital for innovation policy and subsequent activity, policy must also look at ways of increasing employment and the well-being of the less advantaged. The first Concept Paper (Jacobs and Hart 2012) noted the need for education and skills development from foundation phases through to tertiary levels. While this need was highlighted in the OECD review, what appears in the ten-year plan is nothing more than a selective and knee-jerk reaction to OECD criticism and an attempt to align tertiary education with global standards and requirements. Without such alignment the South African NSI cadre could not hope to participate in the GGC. We can conclude then that the ten-year plan overlooks local crucial problems in favour of addressing global concerns in such a manner that social and economic growth will do little more than gradually reach those who need it most, and in minimal amounts. Any benefits will be for a select

few, increasing prevailing inequality and further promoting exclusionary practices within the NSI. These appear to be in contradiction to what the 1996 White Paper intended.

No mention is made of the role of social innovation or social technology. In fact, these concepts are entirely missing from the ten-year plan. It would be valuable to know what and which social innovations and technologies had been considered valuable for inclusive social and economic development in South Africa, based on experiences since 1994. However, this opportunity and learning is missed and instead the plan considers the importance of the social sciences in enabling South Africa to become an exclusive knowledge hub in Africa, with a role that seemingly involves foretelling and the prediction of social trends, dynamics and shifts in the global arena, rather than addressing specific local requirements. Surely a greater understanding of human and social dynamics would be far more important and ultimately more useful if it focused on South African concerns and integrated these coherently with the development of technologies and innovations emerging from other sciences. For example, helping to identify, develop and diffuse relevant and crucial social innovations that improve well-being or to increase the ability of the marginalised to engage with the 'new democracy' or even assisting with the design of technologies in other sectors, for ultimately the success of technology and innovations depend on adoption by potential users.

The ten-year plan was considered to be the key document on South African innovation policy up until early 2012, although it appears to have ignored the rural areas and also the majority of South Africans as beneficiaries and users of innovation. This is surprising, as the generally accepted definition of innovation, in its minimalist interpretation, considers the new use or adoption of technology to be an innovation and neither the complexity of the technology, nor the educational and socio-economic status of the user, are considered necessary determinants of the ability to innovate – of course the more complex the innovations, the greater the specific skills required to use them. However, many innovations are passed on informally (Letty, Shezi and Mudhara 2012) and no attention is given to the role of such informal networks or systems of diffusion and sharing. South Africa's policy on innovation needs to be more inclusive and to consider innovation in rural areas. Since the design of the ten-year plan, a few R&D and technology studies have taken place in rural areas or have included rural areas in their investigations. Most of these have been financed by the Department of Science and Technology, the Department of Rural Development and Land Reform and some provincial government departments of agriculture. Messages from three recent reports compiled by the HSRC on the use of technology and innovation in rural areas (Mazibuko et al. 2008; Hart, Roodt, Jacobs et al. 2010 ; Hart, Aliber, Letty et al. 2010) indicate that there are some serious problems with regard to technology conceptualisation, development, prioritisation and diffusion in South Africa.

Much of the 10-year plan appears to be little more than attempts to attract international support, possible scientific collaboration and skills transfer from more developed countries in the north. Consequently, instead of the plan being innovative it is largely obsolete, in that it is not concerned

with local pressing needs in an effective way and does not attempt to bring broader economic benefits to rural areas. There is ultimately no real rural focus beyond what is perhaps captured indirectly by the focus on the GGC. Furthermore, there is no explicit or implicit attempt to examine and understand the existence of innovation systems in rural areas that facilitate bi-directional diffusion of technology and innovations. Education remains focused on tertiary requirements, despite the need for creating a stronger basic foundation, a fact noted by the OECD report, which strongly cautioned that such a focus was exclusionary and detrimental to greater innovation uptake. Where the OECD review makes valuable recommendations, these are seemingly overlooked in the translation into the ten-year plan, which promotes an exclusionary, rather than an inclusive, NSI.

4. DST 2012 MINISTERIAL REVIEW COMMITTEE ON THE STI LANDSCAPE IN SOUTH AFRICA

In 2010, the then Minister of Science and Technology, Naledi Pandor, set up a committee of scientists to review the science, technology and innovation landscape in South Africa. This was largely a reaction to the OECD report and the ten-year plan, which as we noted above, missed out on addressing many of the weaknesses identified in the OECD review. This Ministerial Review Committee (Minrec) was tasked to consider the state of the SA NSI in light of the following:

- Its readiness to meet the needs of the country in the medium to long term;
- The extent to which SA is making optimal use of its current strengths;
- The degree to which SA is positioned so that it can respond rapidly and significantly to changing global contexts.

Furthermore, the Minrec had to identify what was required from the state and other stakeholders to ensure that increasing investment in innovation would result in a strong and sustainable knowledge-based economy that would be able to effectively advance core national objectives of economic growth, employment and job creation, improved health, quality education and respond to the needs of the most marginalised. Following this process, the Minrec was then expected to make recommendations on the future structure and governance of the NSI, the roles and responsibilities of the various actors, the roles and responsibilities of the DST and its relationship with other government departments, human resource and other capabilities of the NSI and funding and recapitalisation needs. Done in two stages, the final Ministerial Review Report was a 203 page document completed in March 2012.

The final report noted that many of the concerns indicated in the OECD review were ignored in the subsequent ten-year plan of 2007, particularly the more central inclusion of the private sector and SMEs into the NSI, resolving governance issues with regard to vertical and horizontal coordination and the institutional architecture of the NSI. The five grand challenges outlined in the ten-year plan were to be spearheaded by DST as an attempt to shift the resource-based economy towards a knowledge-based economy (focusing on knowledge intensive and value-adding activities). However,

given the spread of departments that would need to be coordinated to achieve this, it was noted that a central authoritative platform would be required[5]. The report went on to note the following existing challenges within the NSI:

- R&D activities, where these still exist, are separately coordinated by line departments and remain highly fragmented, often duplicated and contradictory.
- There needs to be a movement away from formal conventional design and engineering R&D to encourage innovation within public sector service delivery systems, as these systems are equally important and require urgent attention.
- Although noting the problem with primary and secondary education, the emphasis remains on education needs to better equip school leavers and improve tertiary and post-graduate qualifications. Highly skilled individuals remain important.
- Knowledge infrastructure must be maintained and increased to ensure that the various components of the NSI are adequately resourced and capitalised to ensure optimal development, availability and use of knowledge.
- Generally the quantity and nature of the resource flows in the NSI are both inadequate and distorted.
- The NSI must be an internationally open system with in-flows and out-flows of people, skills, resources, etc.
- The capacity of the NSI must improve to ensure that it is a learning organisation that responds to signals both within the system, as well as the wider environment.
- Current exclusionary practices and silo mentality further weaken the system overall and political will is required to ensure improved coordination.
- Improved systems of oversight and analysis are required. In this regard, the report considers improved monitoring and feedback with regard to qualitative and quantitative STI indicators, as well as the need for oversight to ensure correct purposes and modalities are adopted.

To address the identified challenges and gaps within the NSI, the Minrec went on to propose 41 recommendations within the following five core areas:

1. Governance of the NSI, including restructuring and redefining roles and responsibilities; in particular the future role of NACI, is to be changed and a national statutory body, the National Council on Research and Innovation (NCRI) will be established to oversee the NSI and to give it coherence, accountability and the authority to approve research grants and proposals.
2. Ensuring an enabling environment for innovation in the private and social sectors, including the opening up of the innovation system to foreign engagement and employment, as well as the promotion of social innovation;

[5] South Africa's experience with the now largely defunct Integrated Food Security Strategy, led by the DAFF, is a clear indicator that a government line department is just not able to coordinate and obtain buy-in from other departments, many of which have their own separate agendas.

3. The enhancement of human capital and knowledge infrastructure;
4. Monitoring and evaluation of the system as a whole to overcome the limited contributions of simple innovation surveys. Importantly, there is a need to focus on information that can ensure system-mapping, -analysis, -building, -steerage, -evaluation, -learning, and system-foresight.
5. Financing the NSI, including the use of the quadruple helix as a strategic instrument for financing and the financing of social innovation.

Undoubtedly, much can be said for the level of assessment and recommendations made by the Minrec and outlined in the final report. For example, the issue of social innovation has now been put on the radar. However, despite the comprehensiveness of the report, we still have a number of reservations, specifically with regard to some content clarity and as to how various recommendations will be practically implemented.

If we consider the issues of rural or local, sub-national and regional systems of innovation it is extremely surprising, given the detail of the final report, that these systems of innovation are not mentioned. It is clear from various parts of the report and its acknowledgement of earlier policies and strategies that the NSI must be acknowledged as a complex and robust organism, composed of multiple networks, bodies and systems. However, no attention is given to these in any detail and one still gets the impression that the NSI is perceived to be a composition of formally recognised organisations only; while we have a national system, all other sub-national systems are irrelevant, as are networks. Without recognition of sub-national, regional and local systems, geographical or sectoral, how can we consider bi-directional flows of information and innovation? In other words, diffusion must occur within and across the various systems and networks, but ensuring how this can be done smoothly and accessibly is not mentioned at all. Similarly, how do we know what the innovation demands are and how do we expect to achieve participation with the marginalised, so that these demands can be understood and suitable innovations developed? A panel of national level experts is clearly an insufficient means of identifying the necessary innovations, as this is exactly what happens at present and has proved to be both restrictive, top-down and inadequate, in that many technologies and innovations are unsuitable for intended recipients. The simple inclusion of the NGO sector or civil society into the NSI, by means of the quadruple helix model, is also not the final answer. The system is too complex and needs to be better understood. For example, even if we only consider the formal NIS, we need to deeply understand the systems of diffusion, especially bottlenecks to bidirectional exchanges, as well as the socio-political and technical factors that constrain knowledge generation and innovation activities. We have already noted the problems with inter-departmental collaboration, but there will be many similar examples that constrain both knowledge generation and diffusion involving most proposed actors.

The Minrec also noted in its final report that the SA NSI was receiving powerful demand signals to search for innovative answers, particularly to address the crises of continued poverty, inequality and

unemployment/joblessness. Innovation is put at the forefront of all development – economic, environmental and social. The final review report is enlightening in the sense that it strives towards a balance of addressing both local challenges, as well as contributing to global requirements and shifts and also the pooling of expertise. However, we still need to know how this will be done in practice and how the crises of continued poverty, inequality and unemployment will be reduced by means of innovation. This is far from clear. The implementation of policies so often results in a translation which does not always coincide adequately with actual proposed intentions. There is no acknowledgement of this or any suggestion of reducing the effects of contingent outcomes and innovations in controversial areas of science and technology. Some of the problems of current service delivery, including agricultural extension and research, revolve around poorly conceptualised solutions that are deemed to be universal, but that do not address local specifics. So while the core South African problems are acknowledged, it would be enlightening to understand how they will be resolved through a mixture or balance of bottom-up and top-down ideas and plans, including the role of external or global researchers and innovation system collaboration to address such national problems. Surprisingly, while importance of all levels of education, skills and knowledge are noted, nothing is directly said about enskilling the informal sector so that more actors in this sector could become 'formalised' or at the very least avail themselves to available innovations. What are systems through which knowledge and innovations for this sector could be best achieved and enable selection of innovations and even input into future design?

Social innovation has been firmly highlighted in the 2012 review and it is acknowledged that this is under-conceptualised. We do not consider this to be a serious concern, although increasing the understanding of the nature and diversity of social innovation is a desirable area of focus to which we have attempted to contribute in an earlier concept paper (Hart, Jacobs and Mangqalaza 2012). It should be noted that the contributors to the final Ministerial Review Report make no mention of even common understandings of social innovation, such as organisational strategies; instead, the focus is on material technologies that could have social benefits – products that improve sanitation, water quality, health, etc. Of immediate concern is the committee's intention to launch a multi-stakeholder forum, under the auspices of a newly created council to advise government on a limited number of national social innovation priorities 'that should become iconic projects for the NSI and standing items on the agenda' (DST 2012: 28). This is such a flawed recommendation and is in contradiction to earlier statements about acknowledging and encouraging the agency of the marginalised. Furthermore, any limited exposure to, and experience in, development, makes it clear that these flagship-type national projects are disastrous and fraught with complications, from their initial conceptualisation to their implementation and lack of cohesion and integration amongst service providers. The problem of cohesion, integration and coordination is noted in the review, but how this will be ensured when it comes to implementation is ignored. One national social innovation project that has gone pear-shaped is the National Thusong Centre initiative. The lack of departmental integration and provision of key services beyond ITC and local municipal representation have substantially reduced the value of what could have been an important necessary social innovation.

Home Affairs and the SAPS representatives have never arrived at many of these centres, even after years of their existence, despite its top-down conceptualisation and their apparent agreement to participate. This initiative could still be rescued if the services offered were based on the local requirements of each area where a Thusong Centre has been established. In other words, a little more innovation in the form of adaptation is required, but is so far lacking. Perhaps an important role of the NSI, rather than promoting social innovation flagship projects, could be to understand more thoroughly the social dynamics involved in innovation. The NSI needs to acknowledge diversity in demand; until it does so, it will continue to promote universal solutions to diverse situations and heterogeneous populations. The marginalised are not a homogenous group. While there may be similarities in their demands, there will be differences in the ways that these can be met. Furthermore, historical and current social and political dynamics depend on who has the ability to undertake innovation activities.

Our final comment is linked to the three questions we proposed. We agree for the need for better and more effective coherence, integration and coordination, but will a body such as the NCRI realistically and pragmatically achieve the necessary coherence, integration (society as well as formal NSI actors) and coordination? Or will it perhaps be another bottleneck in the system being top heavy and resource intensive, taking needed resources away from the NSI as a whole, while not necessarily having sufficient 'power' to make appropriate decisions? Will it not become another informal network of resource distribution, as we have encountered in so many other statutory bodies? The actual functions, roles and responsibilities of the NCRI need to be more carefully explored. While we might achieve improved coordination in some areas, how will it really ensure participation of the most marginal citizens and the collaborative or participatory development of innovations to address their needs? This crucial development perspective of the NSI seems to remain elusive. Although definitely a step forward, it must be realised that greater clarity is required about the restructuring of the NSI to ensure that innovation leads to social and economic growth for all.

5. CONCLUDING DISCUSSION

While the final Minrec report notes some significant changes from earlier reviews and attempts to promote the initial intentions of the White Paper of 1996, the underpinning ideology still appears to adequately address the need to incorporate the larger share of South African society, who are marginalised. While we have been critical of much of what the various policy, strategic and review documents propose, it is also necessary to provide some alternative that could help shape future innovation policy. While our critique covers a broad range of challenges, here we focus on a possible way of integrating the needs of the marginalised and poor into the innovation system. The developmental needs of so many South Africans have to be seen in the light of continued gross inequality and systems of exclusion, as well as institutions that promote continued exclusion. The fact that much innovation in developing countries is simple and survival oriented is completely ignored in the proposed modalities to improve NSI policy. While high-science innovation activities in

fields such as space and satellite communication, or even biotechnology, may well improve the well-being of many in the future, in the short term they will only benefit a small select group of researchers active in such fields. It is not clear how an emphasis on such areas will immediately benefit and be a catalyst for innovation among the majority who lead a survivalist existence. Utz and Dahlman (2007: 105) argue that it is important, not only to 'reduce the cost and increase the availability of goods and services needed by the poor, but more important, to open up sustainable livelihood and productive income-generating opportunities for the poor'. To shed some light on how the innovation system could be changed, we consider an example from the NSI in India. This needs further investigation, but could prove a useful starting point to consider how best to involve, promote and strengthen informal innovations undertaken by the marginalised members of South African society.

In India, many academics acknowledge that the Indian NSI can be improved to better address the needs of the population (Prahalad and Mashelkar 2010; Salami and Soltanzadeh 2012). Like many other developing countries, India is following the western methodologies of innovation practice and measurement by relying heavily on R&D related activities (Office of Adviser to the Prime Minister 2011). However, unlike many developing countries, India also incorporates some policies and methods that better try to address local challenges of the country, rather than just following the activities of other NSIs. One of the concepts highly used in Indian innovation literature is the concept of Inclusive Innovation (II).

Mashelkar (n.d: 1) defines inclusive innovation as 'any innovation that leads to affordable access of quality goods and services creating livelihood opportunities for the excluded population, primarily at the base of the [socioeconmic] pyramid, and on a long term sustainable basis with a significant outreach'. This type of innovation addresses the needs of poor communities in India and uses innovation to improve their livelihoods. As an illustration of the importance of inclusive innovation, the government of India has established an Inclusive Innovation Fund, which is a private fund where the state is one of the investors. The plan is to achieve $1 billion mark in the fund by 2013 (The Indian Express 2012).

Utz and Dahlman (2007: 106) identify three critical points for promoting inclusive innovation:

- Harnessing formal creation efforts for the poor. It is important to focus on increasing and redirecting formal creation efforts to better meet the needs of poor communities by creating incentives for 'pro-poor early-stage technology development'.
- Promoting and diffusing grassroots innovations. 'Grassroots innovation networks support efforts where traditional knowledge and innovative products emerge at the individual or collective level' (Utz and Dahlman 2007: 106). This type of innovation is mostly bottom up, whereby endogenous knowledge is used to add value to poor communities. Formal scientific and technological knowledge may be incorporated to add value to endogenous knowledge, however, the endogenous knowledge formed at the local level is crucial to grassroots innovation.

- Helping the informal sector better absorb knowledge. The role of government is crucial in assisting better knowledge absorption by the informal sector. Government programmes should also be effective in bridging the gap between the markets and local communities.

Obviously, not all of the characteristics of developing country economies and societies apply to South Africa. Such is also the case with the innovation characteristics. Similarly, endogenous development ability may not be as similar and as extensive as in India. However, reviews of the NSI and also of the tools to measure innovation would benefit, if they considered the local relevance of these developments in other developing countries and remained up to date with possible generic characteristics of innovation across the world's developing countries and considered adapting and testing some of these ideas under local conditions. Such evidence highlights the complexity of understanding innovation; realisation models cannot be universally applied without better understanding. Such cognisance would improve the focus on what is important to innovation in South Africa so that it leads to economic and social growth.

CONCLUSION

This review of four crucial policy documents, strategies and review reports about restructuring the NSI and encouraging innovation in South Africa shows that while a lot has been done to identify constraints within the NSI and to consider ways of restructuring the NSI, these have not really focused on the key areas considered important in the RIAT study. Rural areas are only mentioned in the 1996 White Paper and are subsequently ignored, with only oblique references to the natural environment, natural resources and agriculture (typically large-scale industrial agriculture). Social innovation is also largely sidelined and when mentioned in the Ministerial Review it is largely to highlight its importance; little attempt is made to develop a broad definition. The social dynamics of innovation are therefore overlooked. Of extreme importance is the lack of indication of how the core problems of South Africa – unemployment, poverty and inequality – are to be addressed by way of a restructured NSI. The focus seems to be primarily on innovation within formal enterprises (often R&D units within these or whose core function is R&D). Improving the facilitation of these enterprises and the strengthening of their resources within the NSI seem to be where the emphasis lies. The link between this strategy and the development of South African society and the economy more broadly and equitably is overlooked. While reference is made in many of the documents for the need to balance innovation goals and activities so that they have broader impact and use, related strategies are not forthcoming. Lessons from other developing countries seem to be learned slowly and although COFISA was an attempt to test some ideas in the South African context, this was not done pragmatically, as Finland is significantly different to South Africa in most respects. The relatively good standard of commerce, communication, transport, research and hospitality infrastructure tends to obscure the fact that many people in South Africa are poor, marginalised and do not have access to infrastructure. The rural areas are those which lack sufficient access to this infrastructure and related services. These are compounded by existing social conditions. The poor in these areas are therefore unable to benefit from the good services and infrastructure enjoyed in other areas. Although largely confined to ICTs, valuable lessons have been illustrated in the COFISA work in rural innovation and other fields. These experiences – good and bad - need to contribute to the development of a dynamic innovation system in South Africa.

Tackling poverty, reducing inequality, increasing employment opportunities and addressing the range of social and environmental challenges in South Africa must be done concurrently to ensure long-term and sustainable growth. This will require the recognition of innovations arising from the rural areas, whether they are developed through formal or informal networks, as well as better diffusion and adoption of innovations within these areas and their diffusion to other areas, where they could be valuable. To achieve these ideals, constraints within rural areas, the sub-national innovation systems in these areas and NSI more generally, must be acknowledged and addressed in new and creative ways in order to ensure an enabling environment for the adoption and diffusion of innovations. Many of these innovations could involve making use of new products and this requires skills generation and transfer, to effectively use the machines and implements. However, rather than

anticipating high-technology innovations, we need to remain open to incremental and minor change in low and medium technology innovations that make impressive improvements in specific circumstances. Organisational innovation or change is a valuable innovation process, as it contributes to performance and to the ability to accept and use new innovations. It is crucial in South Africa that more attention is paid to this form of social innovation within the economic and social spheres.

In this regard, some lessons from the European Union can be learned. The 2000 Lisbon Strategy, with its focus on developing the most competitive knowledge-based economy in the world through focusing on innovation stemming largely from R&D, was important in stimulating economic growth and creating jobs across Europe. However, this strategy does not seem to have been able to address the many social and environmental challenges which Europe now faces (YF/SIX 2010). The new European Union strategy, Europe 2020, arose out of the financial and economic crisis of 2008/2009 and an awareness of the need to tackle the numerous social and environmental challenges. The current importance of these challenges is recognised by the creation of a competitive green economy and the realisation of the need to empower people. However, the strategy makes no mention of social innovation in any form and still remains focused on knowledge and innovation driven by R&D, rather than by people.

So even the European models have their flaws! What is required is people-centred innovation (YF/SIX 10), whereby the innovations focus on people for the improvement of their well-being and are directly determined by the inputs of the people or would-be users. South African policies around innovation are mainly focused on scientific and technology knowledge generation and use and push through models of innovation, which are driven by science and technology research and development (R&D). A lot of time is spent in policy documents indicating that qualifications and knowledge must be improved at tertiary levels (DST 2012). South Africa does not appear to be a knowledge society, as knowledge is not strengthened in primary and secondary education. Poor conditions exist in schools and there is little support for those who are different (disabled). Yet there is a sudden overemphasis on formal knowledge and increased skills when people are expected to enter the economy, or those parts of it that require high levels of skills and expertise. Improved education, skills and workplace training across all levels, along with a focus on people-centred innovations – demand and user-led innovations for social and economic well-being – will enable the country to address the obstacles and move towards an innovation society. To develop a concerted strategy around how the NSI can achieve a balance in the respective areas in the NSI will require much broader and deeper consultation with stakeholders than initially conducted in the Minrec review. The true dynamics of the NSI and its integration with regional and other sub-national innovation systems has yet to be clearly understood and needs to be based on empirical evidence drawn from a range of research methods and disciplinary analysis.

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