



Working Paper Series

#2012-023

**An exploration of agricultural grassroots innovation in South Africa and
implications for innovation indicator development**

Brigid Letty, Zanele Shezi and Maxwell Mudhara

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: <http://www.merit.unu.edu>

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: <http://mgsog.merit.unu.edu>

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

UNU-MERIT Working Papers

ISSN 1871-9872

**Maastricht Economic and social Research Institute on Innovation and Technology,
UNU-MERIT**

**Maastricht Graduate School of Governance
MGSOG**

*UNU-MERIT Working Papers intend to disseminate preliminary results of research
carried out at UNU-MERIT and MGSOG to stimulate discussion on the issues raised.*

An exploration of agricultural grassroots innovation in South Africa and implications for innovation indicator development

Brigid Letty

bletty@inr.org.za

Institute of Natural Resources
PO Box 100 396, Scottsville, 3209
South Africa

and

Zanele Shezi and Maxwell Mudhara

Farmer Support Group
University of KwaZulu-Natal
P/Bag X01, Scottsville, 3209
South Africa

Abstract

The core of this paper consists of two case studies of ‘grassroots’ innovation led by innovative smallholder farmers in a village in South Africa – one about developing an alternative production practice for growing potatoes, and the other about introducing a new cash crop (cherry peppers) and the establishment of a new marketing relationship. One of the purposes of the study was to explore questions about the development of innovation indicators that might support policy and management concerned with this kind of innovation. The case studies are therefore located in the context of a review of existing science, technology and innovation indicators and their limitations with respect to this area of agricultural innovation. Another purpose was to identify and clarify the position of ‘grassroots’ innovation within other perspectives on different kinds of innovation system (or mode of innovation) in agriculture in developing countries. The case studies are also therefore set in the context of a review of literature about these other system perspectives, focusing in particular in ‘formal’ and ‘informal’ systems, and on ‘grassroots’ and ‘participatory’ modes of innovation involving interactions between formal and informal systems. The combination of case studies and broader reviews leads to two main conclusions: (1) grassroots and other participatory modes of agricultural innovation merit much greater policy attention than they have received; but (2) the base of available analysis and indicators about these approaches to innovation and their effectiveness is still inadequate to inform and support policy and management in this area. The paper therefore concludes with a discussion of steps that might be taken to improve the available information, understanding and indicators about these modes of innovation.

JEL Codes: O13, O17, O33.

Key words: Agriculture, innovation, grassroots innovation, informal economy

The work reported in this paper was undertaken as part of a UNU-MERIT Project on *Research and Training Support to Build African Capacity in Science, Technology, and Innovation Indicators*, funded by Canada’s International Development Research Centre (IDRC) Grant 104753.

March 2012

TABLE OF CONTENTS

1	INTRODUCTION	1
2	INNOVATION INDICATORS: AN OVERVIEW OF SCOPE AND ORIGINS	6
2.1	Aspects of innovation illuminated by innovation indicators	6
2.2	Innovation indicators: data sources and paths of development	8
2.3	The development of agricultural innovation indicators	13
3	GRASSROOTS AND PARTICIPATORY INNOVATION: PREVIOUS ANALYSIS AND INDICATOR DEVELOPMENT	17
3.1	Early perspectives on alternative modes of innovation: Emerging system concepts	18
3.2	Promoting and reporting on 25 years of innovation: An indicator-free approach	23
3.3	Steps towards typological, evaluative and comparative analysis	30
4	THE CONTEXT OF THE CASE-STUDIES	45
4.1	Smallholder agriculture in South Africa	45
4.2	The Village Context: Potshini	49
4.3	The organizational context: PROLINNOVA and FAIR	51
4.4	The approach to the case-study research	53
5	THE CASE STUDIES: MAIN FINDINGS	54
5.1	The demand for innovation support	54
5.2	Case 1: Innovation in potato production	55
5.3	Case 2: Introducing a new cash crop and a new marketing arrangement	58
6	DISCUSSION: FROM CASE STUDIES TOWARDS POLICY ANALYSIS	60
6.1	Summary: The case-study observations	60
6.2	The Case Studies: Some more detailed implications	62
7	CONCLUSIONS AND NEXT STEPS	68
	ACKNOWLEDGMENTS	74
	REFERENCES	74

1 INTRODUCTION¹

This paper explores a set of issues at the intersection of three areas of debate about innovation in agriculture in developing countries in general and in South Africa more specifically. The first of these, our primary focus, is about ‘grassroots’ agricultural innovation: one of several modes of agricultural innovation that, in contrast to more conventional modes, involves significant roles being played by farmers in initiating and exercising control over the innovation process, and often also in executing significant parts of it themselves. The second area is about disadvantaged ‘smallholder’ production: the segment of agriculture where, it is argued, the potential benefits of more widespread and intensive grassroots innovation seem to be especially large. The third is about the further development and greater use of ‘innovation indicators’ in policy-oriented analysis of agricultural innovation – focusing here on policy analysis concerned with the allocation of resources to support grassroots modes of innovation in smallholder agriculture – and also other participatory modes (see below).

Although significant involvement of farmers in the process of innovation is a key characteristic of grassroots innovation, this does not mean that this mode of innovation is exclusively ‘internal’ to the innovating farm or rural community. ‘Grassroots’ is not another term to describe forms of innovation based only on highly localized ‘informal’ or ‘traditional’ knowledge systems. While those forms of knowledge may be involved, grassroots innovation also often draws extensively on ‘external’ sources of knowledge – not only existing knowledge but also new knowledge recently created on experiment stations or in agricultural research centres. Indeed, an important aim of those who foster this approach to innovation is to strengthen such links to external knowledge sources – but via mechanisms that are substantially demand-pulled rather than simply supply-pushed.

With this emphasis on significant elements of initiation, control and execution by farmers and their organizations, grassroots innovation is one among a wider spectrum of closely related approaches being explored to develop new ways of achieving agricultural innovation in developing countries. These depart from the broad approach most commonly used, and they have attracted increasing attention in policy debate over the last decade. Some of this debate has focused on developing new ways of organising the provision of agricultural services – for example in the form of ‘demand-driven’, ‘demand-led’ or ‘community-based’ services (e.g. Chipeta 2006, Anderson 2007, World Bank, 2007: 172-176, Feder et al. 2010). Most of the discussion in these studies has concentrated on extension-centred services, only part of the whole bundle of services involved in innovation (see, for example, Figure 1 in Feder et al. 2010). In contrast, the demand-driven characteristics of grassroots innovation encompass a wider range of innovation-related services, including knowledge-creating and technology-developing research services that lie behind what are normally considered to be extension activities.

Thus grassroots innovation overlaps with what have been described as ‘participatory’ modes of agricultural research or technology development. These involve strengthened demand and influence by farmers on centralized agricultural research, as well as their greater direct involvement in actually undertaking experimentation and research – either via participation in these activities organized by formal research organizations or independently in their own

¹ Sections 1-3 and 4.1 draw substantially upon unpublished work by Martin Bell.

‘informal R&D’ (Biggs and Clay 1981). As with demand-led extension services, these participatory and informal modes of innovation have been the subject of recently increasing debate about how to organize and manage agricultural innovation (e.g. Ceccarelli et al. 2009, Sanginga et al. 2009a, Scoones and Thompson 2009).

Grassroots and participatory modes of innovation are therefore seen as being closely related ways of achieving innovative change in agriculture. Although the paper later highlights differences between them, the stress here is on their common features. Both of them constitute ways of organising innovation activities that are substantially different from the dominant modes that have been used for the last fifty years or more in developing countries. They not only blur the common sharp distinction between research and extension activities, but also, with significant involvement of the technology-users (farmers) in the innovation process, they are also more decentralized than conventional modes in which innovative activities are much more centralized in formally organized research institutes. In summary, they both involve patterns of specialization, division and coordination of innovative labour that differ significantly from conventional patterns of high specialization and sharp differentiation between (i) research and technology development, (ii) technology extension, and (iii) technology use.

Consequently the bundle of closely related ‘grassroots-participatory’ modes of innovation is broadly contrasted with the bundle of ‘conventional’ modes in this paper. It is examined in two ways: first by reviewing some of the existing literature covering the whole spectrum, and then by reporting on two case studies specifically focused on grassroots innovation in South Africa.

Variations on these grassroots-participatory forms of farmer-driven innovation can and do occur in many types of agricultural production. Indeed it is important to recognize that the core features of these modes of innovation are not even confined to agriculture. In particular, key characteristics of the role of technology-users in the division of labour between different innovation actors, as well as features of the interaction and coordination between these actors, have many similarities with what has been described as ‘user innovation’ in many industries in the advanced economies. The numerous studies of such user innovation in the advanced economies, have covered for instance: not only agriculture (as in the Netherlands - Klerkx and Leeuwis 2008), but also residential construction, scientific instruments, security software and banking services in the US (Slaughter 1993, von Hippel 1976, Franke and von Hippel 2003; Oliveira and von Hippel 2011); and sports-related consumer products in Canada and the US (Franke and Shah 2003, Lüthje et al. 2005, Baldwin et al., 2006).²

In other words, the types of innovation process that are bundled together here as ‘grassroots-participatory’ modes of innovation, are not radically novel or revolutionary approaches to innovation. But, nor are they ‘second rate’ and ‘inferior’ approaches. They simply incorporate ways of achieving innovative change in production that are different in several respects from other ways, while many of their core characteristics have long been embedded in innovation processes occurring across a wide range of circumstances.

² Aspects of the similarity of user-intensive forms of innovation across agricultural/non-agriculture and developing/developed country contexts have been explored in Douthwaite et al. (2001) and Douthwaite (2002).

The focus in this paper is on their occurrence in one rather broad set of circumstances: which is commonly described as ‘smallholder’ agriculture. This is usually distinguished from other kinds of agriculture in developing countries that are described as ‘commercial’ or ‘large-scale’. This distinction is unduly simple, and the focus on farm size and commercialization as the key distinguishing features is misleading because: substantial parts of ‘smallholder’ agriculture involve commercial production for markets.

Nevertheless the distinction is widely used as shorthand to refer to a dual structure of the agricultural sector that has other equally important distinguishing characteristics. In particular, in contrast to the large-scale/commercial segment of agriculture, smallholder production has most of the following characteristics: (i) it is poorly supported by capital, with limited or no access to irrigation or other means of water control, paved roads, agricultural machinery and so forth; (ii) it involves high levels of agro-ecological heterogeneity, with correspondingly complex farming systems; (iii) it is typically based not only on rain-fed agriculture, but also on relatively marginal agricultural land, being consequently vulnerable to multiple forms and high levels of stress and wide output variation; and (iv) it is weakly integrated with supporting knowledge institutions, credit systems and markets for inputs and outputs. Such differences are, of course, matters of degree, and in most developing countries the total number of farms is spread across these differences in continuous, albeit highly skewed, distributions. But as we elaborate later, the distribution in South Africa, the immediate context for the innovation case studies in this paper, is particularly sharply differentiated in an extreme form of agricultural dualism.

The focus of this paper on smallholder agriculture seems timely because the last few years have seen a renewed interest in its developmental roles, along with a growing recognition of the importance of innovation in sustaining those roles. The renewed interest has been prompted partly by a greater recognition since the 1990s of the persisting co-location of smallholder agriculture and a large proportion of the world’s most extreme forms of poverty. As summarized by Hazell et al. (2010), more than two-thirds of the world’s three billion rural people live on small farms of less than two hectares: “These people include half of the world’s undernourished people, three-quarters of Africa’s malnourished children, and the majority of people living in absolute poverty” (p.1349). Interest in the potential roles of smallholder agriculture has been further stimulated by perceptions of the threats from climate change and by rising world food prices in the late 2000s that drew increased attention to widespread problems of food insecurity in smallholder contexts. At the same time, as summarized by Lipton (2010: 1402), the evidence suggests that the proportion of farmland in low income countries that is cultivated in smallholdings has been rising, not falling as was expected by proponents of the growth strategies pursued over recent decades. Also, in several surveyed developing countries, farmland has shifted toward the lowest size categories between 1986 and 2002 (p. 1402), while Jayne et al. (2010) in a review of five African countries suggest that many small farm households “are approaching landlessness” – with at least 25 per cent of small-scale farm households controlling less than 0.11 hectare per capita (p. 1386).

Responses to the growing recognition of these issues have involved sharply differing views about the potential roles of smallholder/peasant agriculture (relative to large/commercial forms of production) in delivering poverty reduction and food security, especially in Africa. The consensus that emerged from one of the most comprehensive examinations of the evidence about the future potential for smallholder farming in developing countries was

broadly positive.³ Starting from a question about whether small farms actually do have a future in low-income countries, the integrating overview (Hazell et al. 2007) concluded: “The case for smallholder development as one of the main ways to reduce poverty remains compelling”. (p.ix), and this view was repeated in the later synthesis (Wiggins et al. 2010a): “Overall this collection of papers suggests that small farm development is not only desirable for its impacts on poverty, but also feasible”. (p. 1346).

This type of generally positive perspective is, of course, bounded and narrowed in various ways: only certain types and proportions of smallholders are likely to be able to develop the agricultural component of their livelihoods in ways that significantly reduce their poverty and enhance their food security; they are likely to be able to follow such routes or pathways only in local contexts with certain economic, institutional, social and political characteristics; and significant policy interventions will usually be needed even to exploit the more positive of those socio-political and economic spaces. Consequently, as stressed by Jayne et al (2010), “There is no one future for small farms in Africa...” (p. 1384). Instead there are several different pathways from current situations, with different groups of smallholder facing differing constraints in pursuing them. One illustration of such diversity is provided by Brooks et al. (2009) who identify nine different pathways to improve, or diversify away from, increasingly challenged maize production in Kenya.

Other perspectives are much more negative about the potential of smallholder agriculture, sometimes simply dismissing it as irrelevant to achieving either poverty reduction or more widely dispersed food security. For example, the influential development economist Paul Collier has argued that peasant agriculture is unable to meet contemporary challenges, and that “large organizations are better suited to cope with investment, marketing chains and regulation”. Consequently he decries the fact that “... for years global development agencies have been leery of commercial agriculture, basing their agricultural strategies instead on raising peasant production”. He dismisses this view as resting on “a giant of romantic populism”, and asserts that: “... contrary to the romantics, the world needs more commercial agriculture, not less” (Collier 2008).

Underlying such different opinions about the prospects for smallholder and larger-scale commercial agriculture are different views, often only implicit, about the relative potential for change and innovation in smallholder production – virtually non-existent for those with views like those of Collier, but perhaps significant in the view of others, provided more effective approaches are taken to innovation. But there is virtually no systematic evidence to sustain either view.

Yes, there is a large body of descriptive case studies of different modes of innovation in smallholder agriculture but, as we show later, very little of that permits general conclusions to be drawn about the potential effectiveness of any of them individually, or even of all of them together. There are also numerous estimates of the rates of return to various kinds of agricultural R&D (aggregated by countries, institutes or crops), but we have found none about the rate of return to expenditures on any or all modes of innovation centred on

³ This examination involved several steps. It originated in a workshop in the UK organised by the International Food Policy Research Institute (IFPRI), the Overseas Development Institute (ODI), and Imperial College, London – with the proceedings published in IFPRI (2005). An integration of that work with the wider literature was subsequently added (Hazell et al. 2007); and most of the original papers plus the integrated review were published with an updated overview (Wiggins et al. 2010b).

smallholder production. There are, of course, econometric studies of the economic *consequences* of innovation, and these can point to very broad and general characteristics of directions of innovation that would be desirable in smallholder agriculture. For example, Lipton (2010) identifies the kind of ideal poverty-reducing innovation trajectory - one that would result in (a) innovation-induced reductions in relative farm prices slower than the innovation-induced growth of total factor productivity, and (b) innovation-induced growth of land yields rising faster than increases in labour productivity – so pulling up rural wage rates or employment.

But what does one actually do by way of resource allocation to innovation in order to achieve innovation *outcomes* along those lines? What kinds of organizational systems and processes are most likely to be effective in raising the rate of implemented innovation in smallholder production, and in aligning its trajectory in the most beneficial directions? In particular, what scales of resource allocation to which forms of farmers' experimentation, innovation and demand-pulling on the formal R&D system are likely to provide the most effective complement to more centralized knowledge-production, technology development and provision of support services?

There seems to be very little information to inform policy decision-making about such questions. This takes us to the third of the intersecting areas of interest we cover in the paper – about the development and use of innovation indicators in policy-oriented research about innovation in smallholder production.

Policy decision-making about resource allocation to innovation and about broad aspects of its organization is widely supported by various types of analyses that draw heavily on an underlying body of indicators of various aspects of the innovation process and its outcomes. This is especially the case with respect to policy-oriented analysis of innovation in industrial production. In this area the long-standing availability of data and indicators of R&D inputs to innovation has been complemented in recent decades by a wealth of information about many other aspects of innovation – in particular about inputs to innovation other than R&D, about features of the process by which it is achieved, and about neglected aspects of the innovation outputs from it.

But policy about innovation in agriculture in developing countries seems to be much less richly supported by innovation-related data and indicators - as suggested in a number of recent studies (Spielman and Birner 2008; ASTI 2009; Daane et al. 2009). We explore this issue with particular respect to indicators and analysis to support policy-making concerned with grassroots-participatory innovation in smallholder agriculture. We suggest both broad steps that need to be taken and some of the more detailed issues that would need to be addressed.

The paper is organized as follows. Section 2 elaborates on the role of innovation indicators in policy-oriented analysis, outlining the status of their development and use with respect to innovation in industry and services in comparison with agriculture. Section 3 provides a review of the available literature about grassroots-participatory innovation in smallholder agriculture in developing countries in general. Section 4 sets the background for the specific case studies of grassroots innovation: the smallholder agricultural sector in South Africa, the village and organizations involved and the approach taken to the research. Section 5 presents the results of those studies. Section 6 discusses a number of detailed issues about policy research and indicator development that emerge from the previous sections, and Section 7

sketches a number of action steps to scale up such research and indicator development and bring them into the mainstream of policy analysis for agricultural development.

2 INNOVATION INDICATORS: AN OVERVIEW OF SCOPE AND ORIGINS

Three broad aspects of innovation indicators are outlined here. The first two, dealing with the aspects of innovation activities they illuminate and the paths of development they follow, relate primarily to indicators that have been developed to illuminate innovation in the industrial and service sectors in advanced economies, the focus of relatively intensive and diverse approaches since the middle of the twentieth century. The third is concerned specifically with the development of indicators relating to innovation in agriculture.

2.1 Aspects of innovation illuminated by innovation indicators

Table 2.1 provides a highly selective list of the main aspects of innovative activity that are commonly reflected in indicators of innovation – or more generally, in science, technology and innovation (STI) indicators. These fall under five broad headings: *inputs* to innovation, the *actors* involved, the *innovation process*, the *outputs* from that process, and the wider *impacts and consequences*.

In relation to that framework, the focus of this study on grassroots-participatory modes of innovation is concerned primarily with issues about *actors* and *processes*. It is about divisions of labour between innovation actors which, compared with patterns in more conventional modes, involve more significant roles being played by farmers; and it is about processes of innovation that involve particular kinds of knowledge, particular patterns of knowledge flows and sources, and particular forms of organizational scale, structure, process and behaviour. At the same time, though, important policy and management issues about grassroots-participatory modes of innovation raise questions about the inputs to them, the outputs from them and the wider impacts and consequences that follow – all addressed in a comparative way with respect to more conventional modes of innovation.

It is important to emphasize that the kinds of innovation indicators that currently happen to be widely available have been developed to meet changing interests and needs over time, as well as to reflect growing understanding about innovation. Consequently the array of STI-related phenomena currently illuminated by indicators (as in the selective list in Table 2.1) reflects considerable change and development that has occurred since the mid-twentieth century when STI indicators began to be compiled and standardized within and between countries.

Between the 1950s and 1970s the main focus was on the inputs to innovation. These were identified primarily as inputs of research and development (R&D) - or more precisely, inputs of new knowledge derived from R&D. This perspective was reflected in the first major step to develop internationally standardized STI indicators: the OECD manual of standard practice for surveys of research and experimental development – the Frascati Manual (OECD 1963)

Through the 1970s and 1980s it became increasingly clear that indicators based on statistics collected under Frascati standardization reflected only very limited aspects of innovation. In particular R&D encompassed only part of the spectrum of scientific and technological inputs contributing to innovation, omitting other significant and often quantitatively more important kinds of technological, engineering and marketing activities involved in implementing innovation. At the same time, the omission of systematic indicators covering the outputs from

Table 2.1 Aspects of Innovation Commonly Illuminated by Innovation Indicators

1. **INPUTS to Innovation**
 - e.g. - **Research and Development (R&D)**
 - e.g. - Expenditure
 - Numbers of scientists, engineers, technicians
 - **Design and engineering (D&E)**
 - e.g. - Expenditure
 - Numbers of scientists, engineers, technicians
 - **The existing stock of knowledge**
 - e.g. Numbers and types of patents in relevant areas
 - **Other**
2. **Innovation ACTORS**
 - e.g. - **Funding Sources**
 - e.g. - Government, Business enterprises, Other
 - **Performers of R&D or D&E**
 - e.g. - Government, Business enterprises, Universities, Other
 - **Firm-types**
 - e.g. - Large, small
 - High-tech, Low-tech
 - Local, MNC affiliate
 - **Types of Individual**
 - e.g. Old, young, 'stars', 'gatekeepers';
 - **Other**
3. **Innovation PROCESS**
 - e.g. - **Types of knowledge used**
 - e.g. - 'Science', 'Technology'
 - Research-derived, experience-derived;
 - Patented, not-patented
 - **Knowledge flows and sources**
 - e.g. - intra-firm, external
 - Type of external (customer, supplier, university, etc.)
 - **Organizational scale, structure, process and behaviour**
 - Numerous characteristics
 - **Other**
4. **OUTPUTS from Innovation Process**
 - e.g. - **Inventions (Intermediate outputs)**
 - e.g. - patented, not patented
 - **Implemented innovations**
 - e.g. - Radically novel/incremental; New to world/new to market/new to firm
 - Technological (Process, product)/Organizational
 - **Additions to stock of knowledge**
 - e.g. Published academic papers
 - **Other**
5. **IMPACTS AND CONSEQUENCES**
 - e.g. - **Economic performance**
 - e.g. Costs, productivity, exports, product/output profile and structure, growth
 - **Socio-political changes**
 - e.g. (Un)employment, gender roles and positions, leisure patterns, military power
 - **Environmental impacts**
 - e.g. Local wastes, emissions and ecology, global impacts.
 - **Other**

innovation was increasingly seen as a major constraint on useful analysis - in particular the omission of indicators to reflect difference in their qualitative significance, as well as the exclusive focus on technological innovations and the neglect of organizational types of innovation. Other limitations were noted with respect to indicators reflecting aspects of the *process* of innovation. These were coming to be seen as increasingly important issues because the innovation process links innovation inputs and outputs, and differences in the way this process occurred seemed to have important effects on the input-output relationship. But available indicators threw little light on such differences or their implications. The significance of these limitations became even more evident as the ‘systemic’ nature of innovation was increasingly recognized as important, leading to a greater focus on interactions and knowledge flows between different actors as central to the effectiveness of the process of innovation.

These concerns led to a second major step in the international standardization of STI indicators: the OECD Guidelines for Collecting and Interpreting Innovation Data – the Oslo Manual (OECD 1992). The growing number of innovation surveys conducted under that framework led to a greatly increased availability of data to develop a new array of indicators – in particular: (i) about other, non-R&D inputs to innovation, (ii) about the outputs of innovations and their differing degrees significance, as reflected in their technological novelty (new to the world, to the market and to the firm), and (iii) about knowledge flows between actors involved in the process of innovation.

Over the next decade the scope of these standardized innovation surveys was further extended (Gault 2010: 37-44) in two ways: (i) to cover innovation in service industries as well as in manufacturing that had been the sole focus of the initial surveys, and (ii) to include forms of ‘organizational’ innovation that often seemed to be as important as the technological forms that had hitherto been the focus of attention. These developments were incorporated in revisions of the Oslo Manual and OECD/Eurostat (2005), the latest version, covers a substantially wider range of aspects of innovation than the first in 1992.⁴

2.2 Innovation indicators: data sources and paths of development

Innovation indicators are perhaps most commonly thought of as being based on sources of internationally comparable data such as those discussed above in connection with the development of the Frascati and Oslo Manuals: large-scale surveys, organized at a national level by government statistical agencies and applying internationally standardized definitions and methods. But this type of indicator accounts for only a small proportion of the indicators commonly used in analysing innovation activities. It is just the tip of a deep iceberg (Level A in Figure 2.1). The rest of the iceberg can be roughly split into two strata.

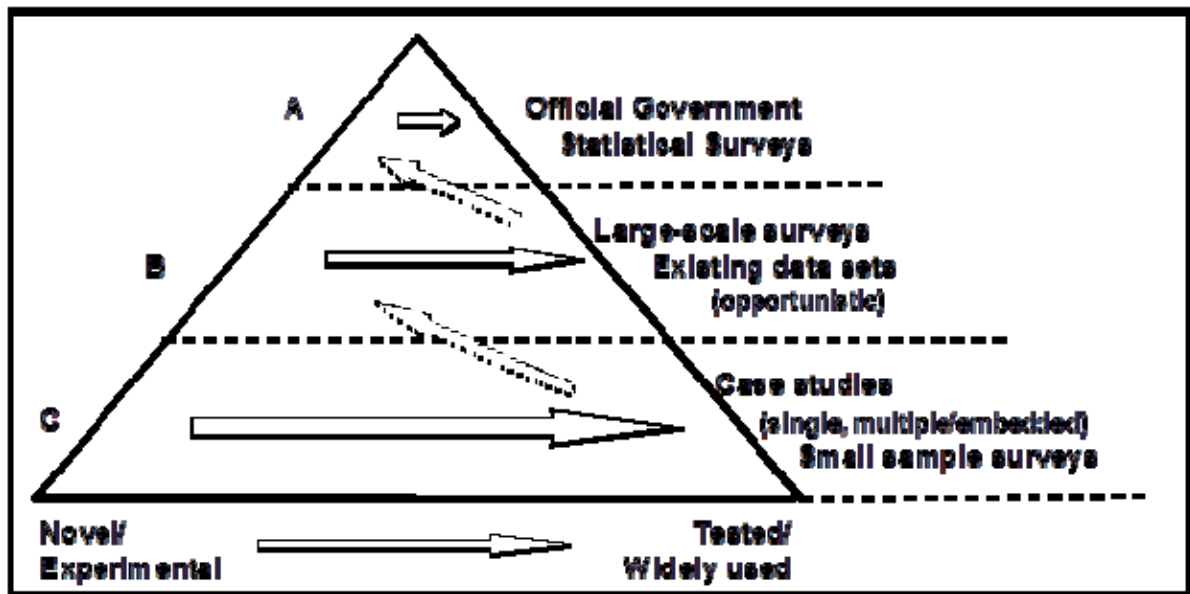
At the base (Level C) are indicators derived from, and largely used within, a wide range of case studies and small sample surveys. The cases in such studies may be about individual units of analysis (e.g. people, organizations or industries), or they may be about small groups of such entities – for instance, multiple contrasting cases embedded within a single comparative analysis. They may also rest on data from small-scale surveys – for example surveys of small samples of firms in an industry case study. This whole spectrum of analysis depends heavily on the use and development of indicators to reflect the characteristics of

⁴ An interesting reflection of the broader scope of the later perspectives is provided by a change in the title – covering “Innovations” in general in 2005, rather than focusing only on “Technological innovations” in 1992.

interest. These may be expressed in numerical form, but they may also consist of qualitatively described classifications and differentiated categories. Almost all of the literature reviewed later in Section 3 is located at this level in the iceberg.

The level above that (Level B) consists of indicators derived from much larger original surveys designed to cover samples or populations numbered in hundreds or thousands of units. They may also be derived more opportunistically from existing data sets that have been compiled for other purposes – for example from the public administration of the patent system, or from statistics already collected about economic production or international trade. The first type of survey (purpose designed) may be undertaken by individual academics and research groups, or by organizations like consultancy firms; and they may be one-off or regularly repeated events. Here again a large and widening array of indicators has been developed to reflect a host of different aspects of innovative activity.

Figure 2.1 Innovation-related data and indicators: Sources and development paths



Source: Bell (unpublished)

However the constant development of new indicators is not merely located *at* one or other of the three levels. Figure 2.1 also illustrates a different kind of change involving horizontal and vertical *movement through* the iceberg. On the horizontal axis, indicators often start as novel and experimental constructs designed for the idiosyncratic purposes of particular studies. Over time some of them are found to be particularly useful and are replicated and re-used in different studies. As they are tested and perhaps refined, some may become well established and widely used as ‘standards’ for commonly analysed problems and questions. In such instances, particular indicators may rise vertically up the iceberg. If they have been initially developed and refined in case-study applications at Level (C), they may be adopted for use in larger scale surveys, perhaps initially on an experimental basis again – thus shifting both upwards and leftwards in Figure 2.1. Similarly, some types of well-tested indicators based on data from large-scale surveys at Level (B) may come to be seen as illuminating particularly important issues at a national level, and data to construct them may be sought via official government surveys at Level (A).

An important feature of these kinds of development paths is the evolution of conceptual consolidation and indicator standardization. As particular questions about aspects of innovation emerge as especially interesting or as particularly relevant to policy or management concerns, the growing body of research in that area tends initially to develop a diversity of different ways of conceptualising the phenomena involved. Different approaches to classification, measurement and indicator development follow, and for a time it is often difficult or impossible to do either of two things: (i) compare meaningfully between different analyses that are supposedly about similar issues, and (ii) combine the results of such analyses in order to derive more aggregated and generalizable observations. Such phases of diversity and disaggregation can occur at both Levels B and C in the iceberg structure, but are inherently less likely at Level A.

But such diversity of concepts and indicators may come to be consolidated and standardized as part of the process of moving to the right across Levels B or C. This may permit aggregation and comparison - for example in meta-analyses of large bodies of case study material. On the way, of course, diversity and individuality is lost; compromises are made to achieve standardization; and simplification inevitably loses sight of aspects and issues thought important by some of the participants in the process.⁵ These difficulties may be particularly significant as one moves upwards in the structure because, for example, case study analysis typically works with a much wider diversity of questions and data categories than large surveys. Consequently considerable simplifications, omissions and compromises are likely to be required to move up from Level C to Level B. Those may be greater still in efforts to harmonize and simplify into international frameworks at Level A the diversity of approaches that have been developed in different countries at Level B.

This issue is a matter of considerable importance later in the paper (Section 3) where a review of two different bodies of case-study literature about grassroots-participatory innovation suggests that in one of them hardly any of this conceptual consolidation and indicator standardization has taken place. Diversity and differentiation still dominate even after thirty years, and little or no comparative or aggregated analysis of the material is possible.

The aspects of STI indicator development noted above highlight the importance of a simple issue. The process of developing the types of indicators that are most commonly discussed (those at the standardized tip of the iceberg structure) has been deeply embedded in a system of research and analysis. This system does not simply use those indicators. It creates them, develops them and aligns them with the interests and needs thought important by the participants – though for the most part so far those have been participants in the advanced economies.

This process underpinned the development of the first major step in the international standardization in the Frascati Manual. This did not simply drop into use as the result of a bureaucratic initiative. Its development was deeply embedded in and emerged from a large number of experiments and disparate surveys designed to try and measure the scale and

⁵ But this is not necessarily a one-way street. Elements of renewed diversity may be introduced if needs and interests call for them. Indeed, the design, management and funding of research can combine consolidation and standardization with elements of newly needed experiment and diversity - as reflected in the successive revisions of the Frascati and Oslo manuals.

composition of various kinds of scientific and technological activity. Starting with surveys by the US National Research Council in the 1920s, these were undertaken in different ways by individual academics and a wide variety of government organizations in the United States, Canada, the UK and several other European countries over subsequent decades until diversity began to converge around the methodology of the US National Science Foundation in the late 1950s. With minor variations, it was this long-evolved framework that became the core of the system that was standardized in the OECD manual.

The same was true of the other major steps in indicator development noted above. For example most of the key elements of the Oslo Manual emerged from several decades of detailed analyses and experiments with indicators relating to such things as patterns of knowledge flow among innovation actors, the role of non-R&D inputs to innovation, the nature and role of innovation outputs with varying degrees of ‘significance’, the characteristics of organizational innovations, or the particular characteristics of innovation in the service sector.

In other words, in the context of the advanced OECD economies, the innovation indicators that have come to be available internationally at Level A have been ‘grown’ endogenously within a deep system of research and analysis, and largely by evolving first through Levels B and C.

In contrast, it has been common for developing countries to skip directly to Level A at the top of the iceberg by transferring the necessary ‘technology’ (frameworks, methods and practices) from the more advanced economies. For example, this approach to developing their indicator systems is currently being followed by governments in a number of African countries (NEPAD 2005). When such imitated indicators adequately reflect aspects of innovation activities that are important in the different contexts, it is a huge advantage to be able to by-pass the costs and time that would otherwise be needed to develop a portfolio of appropriate indicators *de novo*. Governments can fairly rapidly generate useful information that is instantly comparable with corresponding information about a wide range of other countries.⁶

This potential advantage is not available, however, with respect to grassroots-participatory modes of innovation in agriculture because existing innovation indicators can shed little direct light on these particular modes of innovation. But even that dim illumination may be useful in a less direct way because a significant part of the work on indicator development in the advanced economies has been concerned with identifying different modes of innovation and their relative effectiveness in achieving innovation outputs.

For example, a pioneering study of different ways of organising and managing innovation in industrial firms (Burns and Stalker, 1961) distinguished between ‘mechanistic’ and ‘organic’ modes of innovation. This study was clearly located at Level C in the iceberg structure – based on observations in about twenty firms, with the distinction between the two modes resting on qualitatively descriptive indicators derived from contrasting observations of eleven

⁶ But when the existing array of readily imitable indicators is less well aligned with the more important aspects of innovation activity in the new contexts, the consequences can be less fortunate. The existence of highly visible indicators about relatively low priority aspects of innovation activities and processes can help to keep policy makers’ attention focused on those issues; while the absence of adequate indicators about higher priority issues can help to leave those issues low on the policy makers’ agenda – or even off it altogether.

aspects of organization and behaviour. One of the main conclusions of this work was that, although there were differences in effectiveness between the two modes, neither was pervasively superior in all circumstances. Each of them was more effective in achieving different kinds of innovation in different circumstances.

This has subsequently been a common theme in the analysis of innovation. For example, in another pioneering study, Pavitt (1984) used a small number of indicators derived from a survey of innovations to demonstrate that different ways of organising innovation were used in different kinds of industry.⁷ This led directly to later studies that identified different kinds of ‘sectoral innovation systems’ that could be characterized by a relatively small number of indicators. Particular modes of innovation were found to be sector-specific – i.e. found to be effective for achieving some forms of innovation in some kinds of sector, but not for achieving other kinds of innovation in others.

The creation of rich data sources from Oslo Manual-type innovation surveys has opened up new ways of examining this issue. These have drawn heavily on indicators about the *process* of innovation (in particular about different types of knowledge, different patterns of knowledge flow, and different kinds of organizational structure and behaviour); and they have integrated those indicator arrays via cluster analysis methods to identify distinctly different ways of undertaking innovation. For example, Jensen et al. (2007) identified two different modes of innovation in Danish manufacturing firms: a ‘Science-Technology-Innovation’ (STI) mode and a ‘Doing-Using-Interacting’ (DUI) mode. Neither of these was pervasively more effective than the other. Each was relatively successful for particular kinds of firm in particular circumstances, and the combination of the two was most effective in yet other kinds of situation. In another example, Tether and Tajar (2008) used a purpose-designed survey to identify three different ways of undertaking innovation in European manufacturing and service firms. One of these was an ‘organizational-cooperation’ mode of innovation. This differed substantially from more conventionally recognized forms of technological product and process innovation and, as in other studies of this type, it was found to be characteristic of innovation in a particular kind of context – in this case among particular groups of service sector firms.

As noted above, these kinds of analysis and application of innovation indicators can illuminate questions about grassroots-participatory modes of innovation in agriculture only rather indirectly. That may be useful in two respects. The first is about research design and methods – for example about the use of cluster analysis techniques to address questions about different modes of innovation and their relative merits. The second is about underlying perspectives in addressing policy or management questions about grassroots-participatory *processes* of innovation – in particular about recognising the context-specificity of different ways of achieving innovation, rather than setting up the questions in terms of identifying single best ways of organising innovation pervasively across all agricultural circumstances.

But, with respect to more specific issues about innovation indicators and grassroots participatory modes of innovation, the kinds of studies sketched above offer nothing that would be useful. In other words an imitative approach to indicator development is more or less impossible since there is virtually nothing relevant to transfer. The key issue must

⁷ Although this analysis developed and used indicators based on a Level B-type survey, it relied heavily on prior case studies that had identified some of the variables that seemed relevant to the differentiation of sector-specific modes of innovation.

therefore be about a process of endogenous creation and development. The main purpose of this paper is to examine the extent to which that is under way (Sections 3) and to explore how it might be taken further forward (Sections 4-7).

2.3 The development of agricultural innovation indicators

The approach to developing and using agriculture-related STI indicators has been similar in several respects to that outlined above in connection with manufacturing and services. There is a body responsible for supporting and coordinating the national compilation of internationally comparable statistics - not the OECD but the Agricultural Science and Technology Indicators (ASTI) initiative at the International Food Policy Research Institute (IFPRI), one of the component organizations of the Consultative Group for International Agricultural Research (CGIAR). Also, the ASTI-supported collection and processing of data about agricultural R&D follows the basic principles and methods of the OECD Frascati Manual.

However, in one important respect the two approaches have been different: the range of innovation indicators is much more limited for agriculture than for the industrial and service sectors. There has not been for agriculture an equivalent process to the continuing development of new data and indicators about manufacturing and service sector innovation that followed the initial development of the Frascati framework. Nevertheless, a new impetus to engage in such a process has emerged in the last few years. This opening up of what may be a new phase of debate about innovation indicators is a potentially important part of the context for the issues about grassroots-participatory innovation that are discussed later in this paper. Comment is therefore provided here about two aspects of that situation: (i) the relatively narrow range of existing agricultural STI data and indicators, and (ii) aspects of the recent debate about widening that range.

(i) The narrow range of Agricultural STI indicators

The statistics and indicators developed through the ASTI initiative via national Level A-type surveys cover only a relatively limited range of the categories listed earlier in Table 2.1. The main focus is on *inputs* to innovation, but this covers only R&D and its funding and performance by formally organized R&D actors in government, higher education, large business enterprises and the donor-NGO community. Innovation *output* data and indicators are also available, but on a less systematic and regular basis via Level B-type surveys or case studies at Level C. These include, for example, data about new varieties released from plant breeding, from which it is possible to develop estimates of the rate of release (an indicator of the scale of output from R&D)⁸ or the speed of release relative to the start of the research (an indicator of the performance efficiency of R&D). It is also common to collect data about the *implementation* of innovation by farmers, usually described as their ‘adoption’ of new technologies developed by formally organized R&D. These data permit estimates of the rate of adoption – an indicator commonly used to reflect the output performance of R&D.

Considerable use is also made of statistical data about the economic aspects of agricultural production, providing indicators of such things as the scale of production, land yields, capital and labour productivity, and total factor productivity. These in turn are commonly used to assess *ex post* the long-term impacts of R&D-based innovation, as in numerous estimates of the rate of return to R&D – in aggregate or disaggregated in various ways (e.g. by crop-

⁸ Alene et al. (2011) provide a recent example of the use of this indicator, as well as the limitations and difficulties, in a study of the effectiveness of agricultural R&D in Sub-Saharan Africa.

specific categories). Similar impact analyses are used *ex ante* to assess the prospective returns to R&D so helping to shape both the overall scale of resource allocation to R&D and its orientation towards particular purposes – hence, it is hoped, influencing both the rate and direction of innovation.

One kind of limitation cuts across these indicators of inputs, actors and outputs: apart from the execution of formally organized R&D by large farming enterprises, these parts of the system of indicators take virtually no account of farmers as actors in the innovation system, either as suppliers of inputs to innovation or as producers of innovation outputs. Instead, farmers (especially smallholder farmers) only come into the picture as ‘adopters’ of ready-to-use technologies after they have been developed by non-farmer actors. This is reinforced by a limitation in the treatment of innovation outputs. There appears to have been no development of indicators to reflect qualitative differences in the ‘significance’ of innovation outputs – for example, distinguishing between ‘radical’ or new to world/new to market innovations and those that are ‘incremental’, ‘new to farm’ or ‘new to village’. Since farmer roles are likely to be more concentrated at the end of the spectrum concerned with incremental or new to farm/village innovations, the statistical invisibility of that type of innovation (compared to the kind of innovation that, for example, meets the formal requirements to be registered as a ‘new variety’) adds to the statistical invisibility of farmers as actors in the innovation process.

Consequently, if it happens to be the case that farmers themselves play more significant roles in the innovation system than merely adopting innovations developed by other actors, the STI indicator framework would be failing to measure perhaps a large part of the innovation system. The review of literature about grassroots participatory innovation in Section 3 of this paper suggests that this may not be an entirely fanciful speculation. There is evidence that farmers, including smallholder farmers, *do* play more significant roles. What is unclear is quite what those roles are, how significant they are, and how that significance varies across different agricultural circumstances.

The possible importance of farmers in the innovation process highlights a further large gap in the framework of available indicators of agricultural innovation. Very little attention is given to aspects of the innovation *process* – Block 3 in Table 2.1 earlier. There is little or no structured data about different forms of knowledge used in innovation – for example, research-derived and experience-derived knowledge, a distinction that has been found to be important in a growing number of studies of different modes of innovation in the advanced OECD countries. Nor are data available about knowledge flows in innovation. The general presumption is that, as a fairly uniform pattern, most of it flows one-way to innovation-adopting farmers from formal public or private R&D organizations – a pattern found to characterize only some modes of innovation but not others in OECD economies. In connection with organizational aspects of the innovation process, structured data and indicators are available about very macro-level differences and changes (e.g. between public and private or national and international). Also, at the level of case studies, some attention has been given to extremely micro-level issues such as management practices in laboratories. But there seems to be no structured information about differences in broader aspects of organizational structure and process in undertaking innovation - in particular those concerned with different forms of division of labour between various actors, including farmers, and the modes of coordination between them.

This process-related gap in the framework of available STI indicators is matched by a gap in the large body of analysis that seeks to explain differences in what are commonly taken to be

aspects of the output or impact (or performance) of innovation activities - for example rates of adoption of technologies or, more indirectly, rates of growth of agricultural productivity. In very broad terms, the explanatory factors most commonly examined are about characteristics of (i) the technology adopting farmers, (ii) the market and other aspects of the socio-institutional context of farms, (iii) the technology (e.g. its appropriateness and profitability), and (iv) the scale of R&D inputs. Very rarely examined are aspects of the *process* of innovation.⁹

However, as noted earlier, studies of innovation in the manufacturing and service sectors in OECD economies have suggested that differences in aspects of process influence the relationship between inputs and outputs. Moreover, when integrated with differences in knowledge inputs and types of output, these kinds of process-related differences were important in differentiating modes of innovation that seem to be particularly effective in particular circumstances. As suggested later in this paper, there seem to be grounds for thinking that similar relationships may hold for modes of innovation in the context of smallholder agriculture. For example, there is fragmentary evidence to suggest that, compared with conventional modes of plant breeding, grassroots-participatory may be associated with (i) the development of more appropriate (and hence more profitable) innovations in risk-prone and heterogeneous environments, (ii) faster varietal release, and (iii) faster rates of technology adoption. In some circumstances they may also be associated with lower inputs of formal R&D personnel 'per unit of innovation'. This is in principle potentially important issue in contexts where such staff resources in formal R&D are extraordinarily scarce - such as most of those in Africa, including South Africa (Beintema and Stads 2011).

(ii) A new debate about widening the range of agricultural STI indicators

Over the last five years or so there has been renewed interest in agricultural STI indicators, especially with reference to their adequacy for informing policy and management in developing countries. A combination of three issues appears to have prompted this interest. Firstly, as with concerns about indicators relating to innovation in industry in OECD countries in the post-Frascati/pre-Oslo years, growing interest in bringing innovation system perspectives to bear more strongly on agricultural innovation (e.g. World Bank, 2007) appears to have prompted questions about the adequacy of an indicator framework that concentrates so heavily on indicators of only R&D inputs. Secondly, the revival of interest in policy issues about agricultural development, especially in Africa, has contributed to raising questions about agricultural innovation higher up the agendas of policy-makers and donors. Thirdly, more specifically the Bill and Melinda Gates Foundation has committed substantial new funding to work concerned with agricultural STI indicators.

Three initiatives can be used to reflect some of the main features of this renewed interest: (i) a number of studies and an international consultative conference organized by The Technical Centre for Agricultural and Rural Cooperation (CTA) (Daane, et al., 2009); (ii) a consultation

⁹ An exception is the study of long-term agricultural development in Japan from the late 19th century by Hayami and Yamada (1991). This sought to explain different phases of productivity growth in agriculture and it brought 'institutional aspects' centrally into that analysis. Among these were aspects of what is discussed here as the 'process' (or 'mode') of innovation; and one form of process in which experienced farmers (*rono*) played significantly active roles was identified as particularly important in explaining high rates of productivity growth (especially in land yields) at the end of the 19th century and early 20th.

workshop organized by the Agricultural Science and Technology Indicators initiative (ASTI, 2009); and (iii) the exploratory development of a new overall agricultural STI indicator (Spielman and Birner, 2008; Spielman and Kelemework, 2009).¹⁰

The reports on all three of these initiatives frame their questions about indicators in ‘innovation system’ perspectives, and this leads to a common emphasis on exploring the development of a wider range of indicators than those currently available. This was particularly clear in the ASTI workshop about “Identifying *Supplementary* Indicators”. After an opening component about adopting an agricultural innovation system perspective, its agenda centred on four aspects of a possibly wider array of indicators: (i) deepening the traditional input indicators, (ii) extending output indicators beyond immediate outputs (e.g. new plant varieties or published papers) to include longer term impacts and the impact pathways running to them from R&D; (iii) identifying process indicators covering, for example, linkages in R&D networks; and (iv) developing indicators about aspects of the international dimensions of national systems. The exploratory study by Spielman and Kelemework (2009) provided a similarly extensive perspective – integrating 41 different indicators of aspects of innovation systems into a single Agriculture, Development and Innovation Index (ADII).

However this emphasis on widening the scope of the current indicator system may deliver less than initially promised. In the case of the ASTI workshop, for example, one of the main conclusions was that “rather than expanding the number of indicators,” ASTI should “invest more in the analysis and use of the current set of indicators” (p.2). This was especially so in the case of additional input indicators where the conclusion was that the necessary data should only be collected in response to a clear need expressed by policymakers.

More positive views about widening the scope of indicators arose only in connection with output (or performance) indicators. In particular, following an introduction about innovation system frameworks, the CTA initiative (Daane, et al., 2009) concentrated almost entirely on performance indicators running along impact pathways from short term outputs to longer term impacts concerned with such broad concerns as improved rural livelihoods, sustainable use of natural resources, competitive agro-product chains, and equitable development. The conclusions from the ASTI workshop were also positive about improving output indicators. However, rather than widening the range of these, the recommendation was that any increased effort in this area should focus on collecting more systematically a limited range of existing types of indicators (e.g. about new varieties, ‘new technologies’, patents and publications)¹¹.

From the perspective of this paper, it was in the treatment of process indicators that the initial questions about widening scope were most significantly narrowed down. Apart from the limited direct attention given to the process category in these reports, one other issue

¹⁰ These are not the only initiatives in the area, but they seem to reflect the broad features of what has been happening more widely.

¹¹ The part of the discussion that centred on “new technologies” raised a particularly interesting issue about how to define them. This led to the conclusion that: “The great disadvantage when trying to measure new technologies is that there is no internationally accepted standard for what constitutes a new technology Therefore in order to construct a meaningful output indicator, it is necessary to develop a definition of what constitutes a new technology and the various forms it can take.” (p.6). This is reminiscent of the discussion about qualitative differences in the significance of industrial innovations that led to the classification of different types of innovation output in the Oslo Manual.

contributed to this narrowing. The perspective on innovation systems seemed to be interpreted only at an aggregated national level and in terms of a fixed structural system configuration. This involved *given types* of inputs (largely inputs of formally organized R&D), *given types* of actors (largely the array of formally organized R&D performers), and *given types* of linkages (largely those that run among the R&D actors and from those innovation-producing organizations to technologically passive innovation-adopting farmers). These system dimensions might be quantitatively increased (e.g. higher levels of R&D expenditure) or strengthened (e.g. more numerous links among formal R&D performers). But the structure of elements in 'the' national system was seen as essentially fixed.¹² Hence, there was little interest in possible indicators of *different types* of innovation processes which, relative to the 'standard' existing system configuration, might involve for example the use of *different types* of knowledge by *different types* of innovation actor, involving *different kinds* of knowledge linkages, and perhaps leading to *different types* of innovation outputs and *different kinds* of technological change paths in smallholder agriculture.

This interpretation was particularly striking in the development of the Agriculture, Development and Innovation Index (ADII) by Spielman and Kelemework (2009). The primary purpose of the ADII was to permit benchmark comparisons to be made between the overall innovativeness of aggregated national agricultural innovation systems. What was not considered in this or the other reports was the possibility that qualitatively different structural configurations of innovation process might exist in particular circumstances at levels of aggregation below the national entity. This forecloses on policy debate about whether differences in such sub-national modes of innovation might have important implications for system outputs and performance, and hence about whether some of them might be much more widely used than at present. Sections 3-7 in this report explore whether such questions might be relevant in the case of grassroots-participatory modes of innovation, and whether this might warrant the development of different kinds of innovation indicator.

3 GRASSROOTS AND PARTICIPATORY INNOVATION: PREVIOUS ANALYSIS AND INDICATOR DEVELOPMENT

As noted earlier, grassroots innovation, as examined later in the case studies in this paper, are treated together with a much wider range of modes of innovation in smallholder agriculture with broadly similar features that distinguish them from more conventional ways of organising agricultural innovation. The significance of these different ways of innovating began to be recognized by agricultural and social scientists and development officials in the late-1970s. Then, over the thirty years since the early 1980s their use, predominantly in smallholder contexts, has expanded in scale while developing a widening diversity of approaches.

Three strands of literature have contributed to, and reflected on, these efforts to implement new forms of agricultural innovation. The first consisted of a number of studies that opened

¹² This interpretation of the innovation system perspective therefore loses sight of its main original purpose in the works of its originators like Chris Freeman, Richard Nelson and Bengt-Åke Lundvall – to act as a framework for analysing *difference* in system configurations and characteristics. It also has no connection with the extensive literature about different modes of innovation as reflected, for example, in structurally different 'sectoral' innovation systems.

up new perspectives in the 1960s and 1970s, acting as a stimulus to the initiatives taken from the 1980s. The second and third have run in parallel with the initiatives undertaken since then, but they have examined them in different ways. One has compiled extensive case studies to promote and report on grassroots-participatory activities, but has contributed little to developing innovation indicators to aid policy and management analysis. In effect, this body of case studies has not moved very far horizontally across Level (C) in the iceberg illustrated earlier in Figure 2.1. The other also consists of case studies, but has been more focused on evaluating grass-roots-participatory innovation. This body of work has contributed substantially to the development of innovation indicators in this area – in effect, moving a considerable distance across Level (C). These three strands of commentary are reviewed below.

3.1 Early perspectives on alternative modes of innovation: Emerging system concepts

The alternative modes of innovation that attracted increasing attention in the 1980s were prompted in large part by three areas of growing understanding about agricultural innovation in developing countries: (i) the limitations of the formally organized innovation system, (ii) the significance of informal and decentralized innovation by farmers, and (iii) the potential gains from linking more closely the formal and informal systems.

(i) The limitations of prevailing formally organized innovation systems

Concerns in the first of these areas focused on the limitations of the innovation process that had underpinned the Green Revolution in the 1960s and 1970s. A key feature of this process was its organizational specialization and centralization. It involved a high level of specialization and division of labour between the component activities involved (e.g. between basic research, applied research, technology development and testing, extension activities and finally the implementation and use of technologies). The ‘front-end’ of these activities, together with several others, was often highly centralized internationally (e.g. in the international centres like CIMMYT and IRRI that came to constitute the CGIAR). Beyond that, within individual developing countries, applied research, technology development and testing, and even extension, were commonly concentrated in central locations at considerable distances from the final activities of implementing and using the new technologies.

As it manifested itself in developing country contexts, this combination of activities has frequently been described as a ‘linear’, one-way, technology-transfer process. But it is worth bearing in mind that it was no such thing in the context of the advanced economies where, by the mid-twentieth century, these arrangements had evolved over two centuries or more. In those contexts the process did not merely involve a one-way flow of knowledge and technologies from researchers to farmers. Knowledge and information also flowed in the other direction from farmers to researchers, together with farmer-driven influence and demand on the R&D process. At the same time this bi-directional R&D system was linked into a network of other actors, many of them business enterprises, which developed and supplied various component elements of the technologies finally used. Those complex interacting networks of innovation actors were embedded in wider institutional contexts. Two parts of these were particularly important in ensuring that the activities on the ‘supply side’ of the innovation process (in particular the increasingly specialized and differentiated upstream R&D activities) were reasonably well aligned with farmers’ needs and conditions on the demand side: (i) commercial markets in the case of private supply-side actors, and (ii) the political influence and representation of farmers and farming communities in the case of publicly funded suppliers. These institutions were combined in differing ways across societies and over time, and their effectiveness also varied, but in general they played an

important system-integrating role – in effect ensuring that supply-side actors were ‘accountable’ to clients – through either commercial or political mechanisms.

As it evolved over time, that complex, interactive, networked and institutionally embedded system had been highly effective in the advanced economies in generating the technological basis for agricultural innovation and development.¹³ However, the system was much less effective as it travelled outside the advanced economies from about the 1920s. Arguably this was because, as attempts were made to move it around the world, only some of the component parts of the system were moved – usually just the upstream, centralized, publicly funded and publicly performed R&D components.

Nevertheless, even when elements of this R&D spine of the system were transferred to developing countries such as Mexico, the Philippines and India in the 1940s - 1960s, they were again highly successful. They developed the Green Revolution technologies that transformed agriculture and rural livelihoods in large parts of the developing world, especially in Asia and Latin America. These parts were characterized by: (i) considerable agro-ecological homogeneity over substantial areas, combined with relatively simple farming systems; (ii) significant capital support for farming in the form of infrastructure such as roads and irrigation, and perhaps also machinery; (iii) relatively low levels of risk of wide yield variations; and (iv) relatively strong connections to supporting institutions such as markets for inputs, outputs and credit. In those contexts the new technologies for high-yielding rice, maize and wheat production, were rapidly introduced on both large and small farms, albeit more slowly on the latter.

However, the revolution was much less successful in contributing to agricultural change in other large parts of the developing world with different contexts for agricultural production. It was increasingly argued that this reflected limitations in the underlying centralized innovation process. This was seen as being unable to provide the kinds of technology needed in differentiated, complex, usually rain-fed and risk-prone agro-ecological environments with limited access to infrastructural capital goods and markets.¹⁴ This was particularly problematic because farming in these contexts typically provides a substantial, though variable, part of the livelihoods of large proportions of smallholder and ‘resource-poor’ farmers in Asia, Latin America and especially Africa. Efforts therefore began to be made to explore alternative approaches to research and innovation that would be more effective in these types of context.

(ii) The significance of informal and decentralized innovation systems

This second area of growing understanding was about kinds of innovative activity that were organized in a radically different way: the informal and decentralized innovative activities of resource-poor farmers themselves. Part of this understanding came from studies that challenged the stereotypical characterization of resource-poor farmers as ‘irrational’ technological laggards who persisted in using apparently inefficient and outmoded agricultural technologies. For example several studies in the early 1970s demonstrated that mixed cropping was a rational strategy for African farmers – e.g. Leakey (1970) and Belshaw and Hall (1972) in East Africa, and Norman (1974) in Northern Nigeria. These studies called

¹³ Though many have questioned the extent to which, in recent decades, innovation has been led by the dominant influence of market institutions towards increasingly industrialised forms of agriculture.

¹⁴ The introduction of farming systems research by some centralised R&D organizations had limited success in addressing the challenges faced in these kinds of context.

into question the value in those regions of centralized agricultural research and extension that had hitherto concentrated on supposedly superior single-cropping strategies.

These studies also drew attention to the existence of significant bodies of local technical knowledge that underpinned persisting use of such local technologies. Often described as 'indigenous technical knowledge', these knowledge systems were frequently seen merely as repositories of static understanding inherited from the past, along with the 'outdated' operational technologies with which they were associated. However, a growing number of agricultural scientists began to report on the technological creativity of farmers engaged actively in various forms of continuing experimentation, testing and technology development. For example Brammer (1980) reported on applied research being undertaken by peasants in Bangladesh, noting that "some innovations don't wait for experts". Biggs (1980) summarized other Asian examples, noting that:

"These examples show that the rural communities in different parts of Asia are not mere passive recipients of technology that is transferred to them from Western countries or formal research and development programmes. In agricultural communities there continues to be a dynamic and productive informal research system in its own right..." (p.25)

Richards (1985) identified such patterns of creative technology development by smallholder farmers in Sierra Leone and Nigeria. He also noted the disconnection between such grassroots innovation and the activities of formally organized agricultural R&D:

"The conclusion to these case-studies is simple to state. West African food-crop producers are inventive, but development agencies rarely harness this inventiveness because they misunderstand the nature of both the agriculture and politics of communities where food production is a major interest. The consequences of these misunderstandings continue to permeate research and development directed at the small-holder farming sector." (p. 116)

(iii) New perspectives on the linking of formal and informal innovation systems

As increasing recognition of the limitations of large parts of the formal agricultural R&D system began to merge with greater understanding of the innovative activity of smallholder farmers, there was increasing interest in exploring how the two kinds of innovation process might interact more effectively. This interaction was, for example, the focus of a workshop in 1978 (Chambers 1979) where one contribution (Bell 1979) sharply contrasted two types of interaction. Focusing on the local knowledge of farmers, he described one type as an 'inside-to-out' flow of technical *knowledge* that would be "extracted from its indigenous context" for use in contributing to centralized research and development. The other flowed from 'outside-to-in', so "augmenting and reinforcing" indigenous capabilities for creating, acquiring and absorbing technical knowledge. (pp. 49-50).

Biggs and Clay (1981) provided an important step in elaborating on that interaction, with an emphasis on the 'augmenting and reinforcing' perspective. They identified a dual structure in agricultural R&D systems, involving (i) a formal and centrally organized component and (ii) its informal counterpart. Noting the importance of the two components but also their limitations when acting on their own, the authors argued that in principle they were highly complementary. However the interaction between the two was highly variable in practice - as indicated by the dotted links (A) and (B) in Panel 1 of Figure 3.1. In some circumstances, as

in the development of dwarf wheat varieties at CIMMYT in Mexico in the 1960s, these links were strong: important understanding from farmers' experience and problems was acquired by the formal system via Link (A) to inform research; and new technologies were effectively transferred via Link (B) for on-farm testing and use by farmers. But in other circumstances, such as those faced by resource-poor farmers in complex, heterogeneous and risk-prone environments, both of those connections were typically very weak or non-existent.

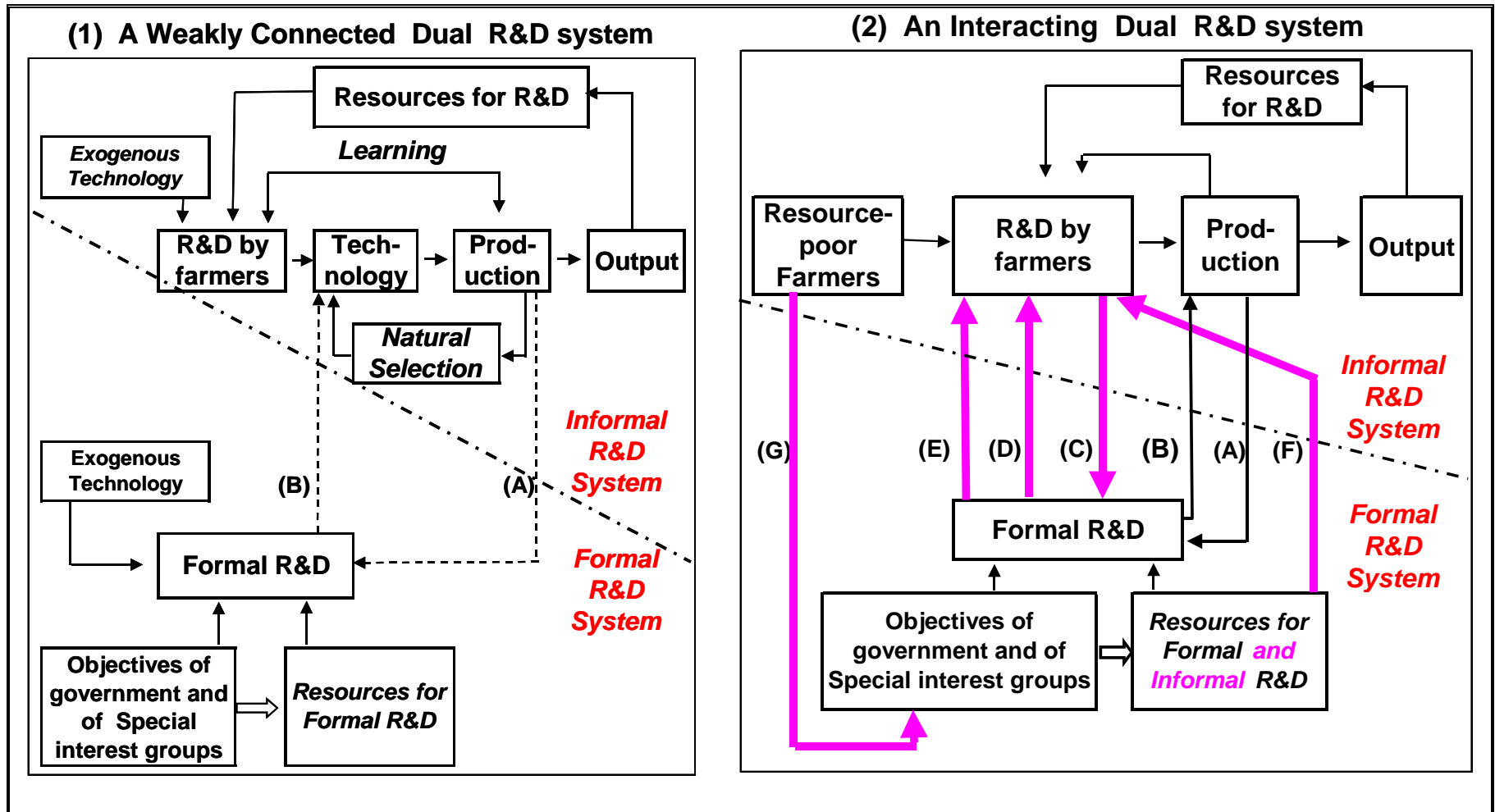
The authors further argued that the overall innovation process would gain from a wider range of stronger relationships between the two component sub-systems – as in Panel 2 of Figure 3.1. Formal R&D activities would be more effective if they included greater participation by farmers from the informal component of the dual system – so providing not only stronger and more pervasive feedback gathered by scientists and extension agents from the experience of farmers' production (Link A), but also knowledge provided by farmers from their own R&D activities at earlier stages of decision-making about objectives and plans for formally organized R&D (Link C). At the same time, local informal R&D would be more effective if the formal component of the system took more explicit steps to strengthen and reinforce the informal, rather than concentrating solely on trying to provide 'finished' technologies for adoption more or less directly in farmers' production (Link B). This would involve also providing greater opportunities for farmers to test, adapt and improve new technologies that were supplied into their R&D activities (via Link D), as well as supplying flows of knowledge, skills and methods to strengthen farmers' own R&D capabilities (via Link E).¹⁵

The authors argued that the decentralization of innovative activity achieved by these forms of greater farmer participation in the process could result in overall system gains – in two ways. First, innovation activities would not only achieve faster rates of innovation, they would also shift innovation in directions that more effectively addressed locally relevant demands, needs and opportunities. Second, other win-win gains might be particularly important in an era of tightening resource allocation to formal R&D and extension:

“A further reason for strengthening local participation in technical innovation is the high cost of developing location-specific technologies for a diversity of environments Where farmers and groups can be encouraged to choose and adapt crop varieties, cultivation practices and input use to their own environment, the scale of the responsibilities weighing upon the formal system will be reduced to more manageable proportions.” (p. 333)

¹⁵ Others were less sanguine about the benefits of such complementary interaction. Richards (1985) for example noted that interventions by the formal R&D component in some circumstances could be diversionary, slowing down the rate of change in indigenous innovation activities. Consequently he argued that the formal component of the system might consider two kinds of strategy. One would be 'positive' - along the lines of the augmenting and reinforcing approach emphasised by Biggs and Clay. But the second would be a 'minimalist' strategy' that maintained a 'space' for peasant R&D by focusing specifically on the kinds of problems that farmers could not handle adequately by themselves.

Figure 3.1 A Dual Agricultural R&D System: Alternative Modes of Interaction



Source: Adapted in Bell (unpublished) from Biggs and Clay (1981)

But the potential for such strengthening was seen as highly constrained. Biggs and Clay were perhaps the first to raise the point that greater inclusion of smallholders in the overall innovation system would both raise costs for the farmers and involve re-allocating resources between the two components of the system – i.e. introducing Link F in Panel 2 of Figure 3.1. This highlighted the importance of the fact that both components of the innovation system were deeply embedded in wider political and institutional contexts.¹⁶ These contexts shaped the modes of innovation undertaken, the resources allocated to them and the social distribution of benefits arising from them.¹⁷ The implication was that if greater resources beyond those of smallholder farmers themselves were to be allocated to their informal innovation activities (via Link F), then resource-poor farmers would need to compete with other interest groups and effectively influence government objectives (Link G) in order to change the distribution of resources between formal and informal innovation.

From the mid-1980s variations on these ideas about the two forms of innovation and their interaction attracted growing attention from funders of agricultural development and practitioners in national and international research and extension organizations, and also in a wide range of development NGOs. Projects to implement and test new forms of ‘participatory’ R&D and ‘grassroots’ innovation proliferated. In effect, a growing body of experiments were made to develop and implement radically novel ways of organising agricultural innovation.

At the same time, as noted earlier, two parallel streams of studies over the next twenty-five years examined the experience of these projects. Yet the two strands were surprisingly disconnected, with very limited cross-linking between them. One, reviewed in Section 3.2 below, was a widely publicized body of work that provided a rich descriptive reportage on numerous projects and programmes, using qualitative analytical perspectives on their key features and effectiveness. But it has neither developed nor used systematic indicators of innovative activities to support that analysis. The other, reviewed in Section 3.2, was a much less visible stream of work that has been more systematically evaluative, and has developed and applied not only an analytical framework to reflect key features of these non-conventional approaches to innovation, but also a set of indicators to illuminate analysis and policy.

3.2 Promoting and reporting on 25 years of innovation: An indicator-free approach

Much of this first strand of literature consisted of detailed case-study observations of the proliferating experiments and innovations. Many of these have been published as individual

¹⁶ At least in some parts of the discussions on this issue the term ‘institutions’ was used to refer not merely to ‘organizations’ (e.g. research institutes), but more widely to social political and cultural structures, processes and norms that shaped innovative activity. Biggs and Clay (1981) for example noted that “economically and politically superordinate elements within agricultural societies” would be likely to capture disproportionate shares of the benefits from innovation, while special interest groups and vested interests embedded within organizations would be likely to shape the activities of, and the technologies generated by, formal research programmes.

¹⁷ In this respect, these ideas about the importance of the institutional, including political, context of agricultural R&D systems in developing countries anticipated an important component of the later development of innovation system concepts with reference to industrial innovation in advanced economies (e.g. Freeman, 1988; Lundvall, 1992; and Nelson, 1993).

reports, journal papers and book chapters.¹⁸ But a large number have been compiled in a series of widely publicized books. Six of these, probably the more widely known, are listed in Table 3.1, and these are used as the main basis for the review in this section of the paper.¹⁹

Table 3.1 Grassroots/Participatory Innovation: Selected Compilations of Case Studies since 1989

Chambers et al. (1989) <i>Farmer first: Farmer innovation and agricultural research</i>	Proceedings from a seminal 1987 workshop and included 7 illustrative cases of practical applications of participatory methods. Most projects involved inside-to-out knowledge flows from farmers to improve centralized research.
Haverkort et al. (1991) <i>Joining Farmers' experiments: Experiences in participatory technology development</i>	Drew on 16 illustrative cases of participatory technology development, highlighting the importance of outside-to-in processes designed to support and reinforce farmer innovation.
Scoones and Thompson. (1994) <i>Beyond farmer first: Rural people's knowledge, agricultural research and extension practice</i>	A wide array of papers included 26 reviews of cases of participatory projects and autonomous farmer innovation. These highlight under-emphasized dimensions of changing innovation processes – concerned with knowledge and power relationships; participatory behaviour, attitudes and methods; and institutional constraints.
Reij and Waters-Bayer (2001) <i>Farmer innovation in Africa: A source of inspiration for agricultural development</i>	Provides outlines of 28 cases of farmer-led innovation and participatory projects supported through two donor-funded programmes in the 1990s. Notes limitations of previous participatory innovation activities as scientist-led to support centralized R&D. Stresses farmer innovation and farmer led initiative as more effective basis for developmental innovation. Emphasizes aim of strengthening farmer capabilities to sustain continuous and cumulative innovation paths.
Scoones and Thompson (2009) <i>Farmer first revisited: Innovation for agricultural research and development</i>	Examination of twenty years' experience included reviews of about 27 specific cases of bottom-up, farmer-centred technology development and innovation projects. Notes flourishing proliferation of methods, processes, actors and networks, aims and perspectives, with growing emphases on personal and professional behaviours and reflexivity. But participatory/grassroots activity is still only marginal to mainstream practice. So questions about governance of innovation systems, bureaucracy and political processes are important.
Sanginga et al. (2009a) <i>Innovation Africa: Enriching farmers' livelihoods</i>	Included 18 case studies of African experience of grassroots/participatory activities. These explore moving beyond the formalities of participation to more collaborative partnerships, and emphasize the need to embrace a wide range of actors and market-led processes in innovation systems. Again the call is for more emphasis on farmer-led innovation capability building, both in farmer groups and organizations and among agricultural development professionals

Numerous threads can be identified running through this literature. Three have been selected as particularly relevant for the purposes of this paper: (i) changing emphases within a widening array of aims and challenges; (ii) increasing diversity and differentiation in

¹⁸ This literature stretches beyond material that explicitly focuses on the characteristics of these innovation processes. It also includes the scientific and technical literature that notes aspects of participatory processes only as incidental features of reporting on scientific and technical issues. For example Kongo et al. (2010) briefly comment on aspects of the “participatory approach” that was used in a hydrological monitoring study in South Africa – incidentally in the same village area as the case studies reported later.

¹⁹ We do not claim either that these compilations are systematically representative of the wide body of literature on grassroots/participatory innovation or that the experiences they review about 120 illustrative cases) are representative of the even wider range of practice in this area. Nor do the selective comments here constitute a systematic review of even this body of work.

analytical perspectives and approaches to practice; and (iii) the limited development and use of STI indicators for analytical and policy purposes.

(i) Changing emphases, aims and challenges

Until the early 1980s the primary aims pursued by advocates of participatory approaches to innovation were concerned with two outcomes: (i) increasing the *rate* of implemented innovation and (ii) shifting its *direction* to be more aligned with meeting the needs of disadvantaged farmers, primarily in smallholder contexts. The impacts of such approaches were seen mainly in terms of more frequent implementation of technological changes that were more ‘relevant’ to resource-poor/small-holder farmers – with the greater relevance contributing to the increased frequency of implemented innovation. But other kinds of impact were also envisaged at that time, and these were extended and given greater emphasis over later years.

- The early aims about poverty reduction were later reinforced as this issue rose to a dominant position in the development agenda, becoming embedded at the top of the Millennium Development Goals in 2000.
- Rather than merely focusing on the implementation of individual steps of innovation, more explicit emphasis was given to the aim of strengthening farmers’ own innovation capabilities – often explicitly seen as a means of fostering more continuous and cumulative processes of grassroots innovation.
- The early studies typically referred to gender-undifferentiated categories of farmers (e.g. ‘resource-poor farmers’), but increasing emphasis came to be given to aims concerned specifically with the positions of women as both participants in agricultural (and other) technology development and as potential beneficiaries from associated innovation.²⁰
- Although some of the early interest in ‘informal’ innovation included views that it was likely to contribute to more environmentally sustainable agriculture (see especially Richards, 1985), the pursuit of sustainable forms of agriculture became an increasingly explicit aim of grassroots/participatory modes of innovation.
- In recent years a further dimension has been added to that sustainability aim by emphasis on the importance of grassroots/participatory innovation as a basis for adaptive and resilient responses to climate change – a necessary complement to the contributions of more centralized and formally organized research and development that will be inherently unable on their own to meet the scale and diversity of the expected needs for innovation.

This widening range of aims and expectations about the potential impacts from, grassroots/participatory innovation processes raised the significance of two challenges facing practitioners and analysts in this field: one about the overall scale of efforts to implement grassroots/participatory forms of technology development, the other about the qualitative characteristics of those efforts

²⁰ This was reflected for example in the establishment of the Participatory and Gender Analysis Programme by the CGIAR in 1997

First, despite the growing number of projects and programmes, it was increasingly recognized that the overall quantitative significance of participatory technology development was very limited, and that it was usually marginal to the main bodies of agricultural R&D activity in the sense of being funded via short-term projects and programmes by external donors. By the end of the 2000s, the time of the last two compilations in Table 3.1, several observers offered the view that the scale of activity in this area was at best static and limited, and probably even reversing:

- Robert Chambers, one of the leading contributors to opening up the field in the early-1980s, suggested that: “Many of the challenges are still those of 20 years ago. The paradigms of pipeline research and of top-down packages of practices passed on to farmers is resilient and keeps reasserting itself” (Chambers 2009, p. xxii).
- This was strongly endorsed by Jacqueline Ashby reflecting her own experience in the CGIAR: “The idea of doing research with farmers has gradually dwindled to a few marginalized activities nursed by individuals committed to the concept, but lacking hard-core, institutional support” (Ashby 2009a, p. 42).
- In the case of the Indian agricultural research system, a series of organizational reforms had failed to alter the dominance of the linear process of technological development running from “the science that generates it to the extension effort that disseminates it and the farmer who uses it” (Sulaiman 2009: 182).
- Commenting specifically on Africa, the editors of Sanginga et al. (2009) reported the view that the region was “... currently experiencing the return of the conventional ‘diffusion of innovations’ model”, while a number of large recent initiatives in agricultural research appear to be “reverting to the Green Revolution model”. (p.375).

The second challenge, about the qualitative characteristics of participatory innovation projects, centred on the form of the participation involved: within projects labelled as ‘participatory’, the type of participation frequently seemed very limited. In many cases it seemed to be oriented towards what Bell (1979) had described as ‘extractive’ arrangements – appearing at best to be designed only to elicit flows of information and understanding from farmers for the purpose of improving centralized R&D, without supporting and strengthening farmers’ own innovation activities.

Behind that, as emphasized by Ashby (2009a), there often lay the capture of the participatory agenda by elite groups that shaped the innovation process along conventional supply-driven lines.

“Increasingly, FPR²¹ became perceived as a way to convince farmers (and donors) that the existing supply of agricultural R&D was on track to benefit the poorProgramme directors used the ‘farmer participatory’ label as a sales pitch to compete successfully for development ... project funding. As a result, the notion of conducting research with farmers became steadily diluted. A hybrid approach to FPR was popularized especially at senior management levelsThis involved farmers in validating the supply of technology coming out of the established, pipeline-style of research.” (p.41)

²¹ Farmer Participatory Research

Thus by the late 1990s it was apparent that the challenge was not simply about how to shift a larger quantity of overall agricultural R&D effort towards modes of technology development that were participatory and farmer-led in significant ways. What was faced was the greater challenge about achieving change in that direction within the wider institutional contexts of agricultural R&D: the interest groups, power relationships, bureaucratic structures and political processes that shape the allocation and use of resources for innovation. For Scoones and Thompson (2009, p.13), reflecting the observations of Ashby (2009), this raised questions not simply about the supply side of the innovation process. At least as important, they argued, were questions about articulating effective demand from poor farmers and about developing governance and political arrangements that would ensure accountability on the part of those who are supposed to respond effectively to that demand – re-emphasising the kinds of institutional issue that had been highlighted nearly thirty years earlier by Biggs and Clay and summarized above as Link (G) in Figure 3.1, Panel 2.

(ii) Increasing diversity and differentiation in practice and analysis

Proliferation and diversity have been striking features of both practice and analysis in this area since the mid-1980s. With respect to practice, there has been a steadily increasing diversity in the actors involved in supporting, promoting and implementing participatory innovation projects and activities: a widening array of donors, NGOs, universities and government agencies. This has been accompanied by a widening range of different approaches to organising participatory innovation, as well as a growing portfolio of more detailed methods and techniques for fostering and implementing those approaches: methods of stimulating the engagement of farmers, techniques of consultation and enquiry, and tools for assisting farmers to enumerate and report observations and assess options. Increasing attention has also been given to an array of personal and micro-organizational characteristics that facilitate or constrain effective participation: personal attitudes and behaviours, personal and professional status perceptions, along with methods for stimulating personal and organizational reflexivity.

The parallel stream of observation and analysis has demonstrated a similarly growing diversity. In part this has been about the institutional context of participatory modes of innovation. This has involved a widening array of both the institutional phenomena examined and the conceptual frameworks used to discuss them (e.g. Thompson and Scoones 1994, Clark 2002, Hall et al. 2003, and Biggs 2008). This diversity is usefully considered at two levels:

- The first might be called ‘macro-institutional’. This includes some of the things that have already been noted in this paper: the kinds of socio-political environments within which the innovation process and its participating organizations are embedded, including the mechanisms by which R&D actors are held accountable to different interest groups and to society as a whole, and also the power relations between different groups involved in using, creating and communicating knowledge in connection with agricultural innovation.
- The second includes institutions that are embedded in organizations and communities. In research organizations this might involve such things as the rules and norms governing how research priorities emerge and are promoted, how research performance is evaluated and by whom, or how organizations reflect and learn. In rural communities it might include rules and norms about such things as communal land-use, gender roles, other dimensions of community hierarchy and power, or arrangements for sharing/appropriating knowledge.

But diversity in analysis has been much greater at a third level concerned with organizational aspects of the innovation process itself. This has focused on the structure of relationships through which it takes place, especially different kinds of division of labour and their coordination - differences that have been referred to in this paper as differing 'forms' or 'modes' of innovation.²²

The case study literature has not only described this rapidly growing diversity of new modes of innovation; it has also actively contributed to it in the form of product differentiating advocacy of apparently novel approaches within the widening proliferation. Sharp contrasts have been drawn between different 'brands' of participatory and grassroots innovation; and even when these have involved what seem to be quite minor variations they have been vigorously differentiated and 'marketed' as offering advantages over others. Perhaps not surprisingly the editors of the last compilation of studies listed in Table 3.1 emphasized the need to "move beyond false dichotomies" and associated "unhelpful debates" (Sanginga et al. 2009b: 377).

(iii) The limited development and use of STI indicators

The preoccupation with singular instances and their differences has gone beyond being merely unhelpful. It has contributed to a significant limitation in the literature over this long period: the scant attention given to comparison, aggregation and synthesis. For example, among the 120 or so case-studies compiled in the publications listed in Table 3.1, there is almost no systematic comparison of even small sub-groups of cases. More importantly, the absence of any systematic typological framework and consistent pattern of reporting makes it almost impossible for others to attempt any comparative or aggregated analysis retrospectively.

Consequently it is impossible to draw on this literature to answer two kinds of policy-related question about this approach to innovation. What is the scale of the activity? What is its impact?

There are two aspects to the question about scale. One is about the *overall magnitude of this broad approach to innovation as a whole*. As noted earlier in this paper, this has frequently been seen as an important issue: along with repeated concern about the apparently marginal scale of grassroots/participatory modes of innovation relative to others, there have been frequent calls for scaling up and mainstreaming financial support for these approaches. But over twenty-five years the kind of literature identified in Table 3.1 has not provided empirical evidence about what the scale of these activities actually is, let alone a credible indication of whether and how that might have been changing.

²² These kinds of change and difference are described variously in the literature as 'organizational' or 'institutional'. In that context it is pertinent to recall the argument of Nelson and Sampat (2001) that "...it is a mistake to try and make the term 'institutions' cover too much conceptual ground. At the least, the term ought to refer to a set of things at the same causal level". (p.39). Indeed it is tempting to adopt here their concept of 'social technology' (see also Nelson 2008). Distinguished from 'physical technology', this refers to the standardised ways in which "knowledgeable people act and interact where the effective coordination of interaction is key to accomplishment". (p. 44). From that perspective, developing new 'social technologies' in the form of new kinds of division of labour and coordination seems to be precisely what has been involved in the development of grassroots/participatory modes of agricultural innovation over the last thirty years or so. However, as we note below, this field is already replete with conceptual and terminological differentiation, and we would not wish to add more at this stage. We therefore continue to use the terms 'mode' or 'form' of innovation to refer to these kinds of change.

A second aspect of the scale issue arises at a more disaggregated level: *what is the relative scale of different modes of grassroots/participatory innovation?* As also noted earlier in this paper, the case-study literature has offered considerable comment on this issue. In particular, a frequent observation has been that some types of participatory innovation have been much more common than others, and there have even been claims that this distribution has changed over time to include greater/smaller proportions of more/less participatory modes of innovation. However, there is virtually no systematic evidence about such magnitudes and their change over time.

With these two kinds of limitation, one of the key planks of empirical support is missing from the policy arguments about increasing the allocation of resources towards non-conventional modes of agricultural innovation in general or to particular kinds of participatory innovation particular.²³ But problem about these limitations is not simply the absence of quantitative estimates of scale. It is more fundamental. There is no accepted conceptual basis for even starting to compile numbers. The case-study literature has continued to produce a proliferation of case descriptions for twenty-five years, but has developed no agreed framework for identifying what this domain consists of, and hence which modes of innovation are to be counted as ‘grassroots’ and/or ‘participatory’. Nor has it pursued the kinds of conceptual consolidation required to combine examples into typologies of different kinds of grassroots/participatory innovation – a precondition for any attempt to assess their relative magnitudes.²⁴

In principle one might also expect innovation indicators to have been developed as a basis for addressing questions about the *impacts achieved* by grassroots/participatory innovation. For example, as noted already, there has been a widening range of important claims about ways in which grassroots/participatory modes of innovation will yield significant benefits compared with more conventional approaches. However, while there are plausible illustrations of many of these impacts in individual projects, there has been little aggregation or suitably comparative analysis to provide an adequate basis for demonstrating the extent to which such claims have actually been realized.

Similarly, two other kinds of question about impact have been raised but not answered. Firstly, a large part of the discussion around the diversifying array of different forms of innovation has been about the advantages of particular participatory modes *relative to others*. However, although there have been numerous descriptions of the merits of individual instances of particular ways of doing things, there has been very little analysis to answer this type of comparative question at a more generalizable level. Secondly, there has also been

²³ This seems to have been the view of a former policy-maker in this field, as a Managing Director of the Rockefeller Foundation. In a Foreword to the last book in the list in Table 3.1, he noted the lack of systematic attention that had been given to these issues about scaling up and financial sustainability, along with the limited impact on policy. He emphasized that “evidence-based guidance on both issues is required urgently so that ... greater long-term impact [can be] achieved.” (Matlon, 2009, pp. xvi-xvii)

²⁴ There were some partial exceptions. In particular, as increasing attention was given to ‘innovation systems’ as a framework for analysing innovation activities, attempts were made to develop frameworks that differentiated this from previous perspectives. For example, in the compilation edited by Scoones and Thompson (2009), Hall (2009) presented a typology that distinguished between (i) Classic National Research Systems, (ii) Classic Agricultural Knowledge and Information Systems, and (iii) Agricultural Innovation Systems. But these were too aggregated and generalised to act as frameworks for analysing the concrete experiences involved in various forms of participatory/grassroots technology development and innovation.

some discussion about the importance of contexts in shaping the impacts of participatory modes of innovation, with questions raised about *whether particular modes 'work' better in some kinds of context than in others*. Answers to such questions are a necessary accompaniment to policy arguments about scaling up resource allocation to participatory approaches. Given the diversity of arrangements falling under the general category of 'participatory', one needs to be able to offer advice about which should be expanded in which kinds of agricultural context - but the accumulated case study observations offer no such guidance.

The paucity of answers to these kinds of question about the outcomes and impacts of participatory modes of innovation does not stem simply from an absence of evaluative analyses in this body of case-study literature.

On the contrary, there has been a considerable amount. But most of it has been of two types: (i) assessments of issues such as participatory methods, procedures and behaviours, designed to provide learning-centred feedback to help improve processes, or (ii) assessments of impacts in order to meet the accountability requirements of individual agencies and donors involved in particular projects and programmes. Thus most of the observations of outcomes and impacts appear to have been 'internal' to particular projects and programmes, rather than being designed to face 'outwards' to influence policy and resource allocation. At the same time, comparison and aggregation across broad bodies of experience has rarely been attempted. But as noted earlier, the necessary conceptual and typological basis for doing so has been more or less absent.

In sustaining these limitations through such a long sequence of published work, this strand of the case-study literature has remained surprisingly disconnected from a smaller and much less publicized second strand that has sought to address issues about typology, comparison and evaluation.

3.3 Steps towards typological, evaluative and comparative analysis

Table 3.2 provides a selective list of contributions to this second stream of studies over the twenty years between 1989 and 2009. As with the previous list in Table 3.1, these are not systematically representative of the whole field of evaluative studies of grassroots and participatory modes of innovation. Nor do the following comments on the work in this list constitute a systematic review. Instead the focus is on only five selected aspects of the work:

- (i) Its development of conceptual and typological frameworks to identify the scope of participatory/grassroots innovation and its different forms;
- (ii) Its assessment and evaluation of the outputs, outcomes and impacts of these modes of innovation;
- (iii) Its examination of inputs and costs;
- (iv) Its assessment of the incidence and scale of these modes of innovation;
- (v) A broad imbalance in its orientation.

A common feature of the three activities under (ii), (iii) and (iv) is that, from the perspective of participants in agricultural innovation, they make important contributions to forms of assessment and evaluation that may be used to support 'external' policy purposes, and not only 'internal' purposes concerned with the management of projects and programmes. They provide important parts of a basis for addressing broad questions about resource allocation to

participatory modes of innovation in general and to specific kinds of participatory mode in particular.

Table 3.2 Grassroots/Participatory Innovation: Selected Contributions to Comparative Assessment and Impact Evaluation

Biggs (1989) <i>Resource-Poor Farmer Participation in Research: A synthesis of experiences from nine national agricultural research systems.</i>	Probably the first attempt at systematic comparative assessment of participatory research in practice. Developed a typological framework to review more than 20 research programmes, showing most were primarily designed to provide knowledge flows from farmers to inform centralized research – though several changed over time towards more collaborative forms of process.
Okali et al. (1994) <i>Farmer participatory research: Rhetoric and reality.</i>	Aiming to assess rapidly expanding participatory practice, modified Biggs' typological framework to review 11 projects with various forms of participatory research. Most involved knowledge flows from farmers to improve centralized research, with limited strengthening of farmer innovation.
Lilja and Ashby (1999). <i>Types of participatory research based on locus of decision making.</i>	Developed significantly modified version of the Biggs' typological framework – focusing on decision-making aspects of innovation projects
Johnson, et al. (2001), <i>Characterising and measuring the effects of incorporating stakeholder participation in natural resource management research...</i> [See also Johnson, et al., 2003]	A major advance in assessing impacts of participatory innovation. Examines three large projects in Indonesia, Malawi and Honduras, assessing: (i) technologies developed and their adoption, (ii) contributions to strengthening human and social capital, (iii) feedback links to formal research' and (iv) costs of research. Incorporates a gender dimension in the assessments.
Probst and Hagmann (2003) <i>Understanding participatory research in the context of natural resource management</i>	Embeds categories of participation in a much broader typological framework of research and innovation projects, and reviews CGIAR practice.
Ceccarelli et al. (2003), <i>A methodological study on participatory barley breeding II.</i>	A detailed analysis of the short term (1 year) performance of varieties selected in contrasting participatory and conventional ways. Demonstrates feasibility and significant benefits of decentralized organization for several purposes – especially adaptation to diverse and/or stressed environments.
Ashby and Lilja. (2004) <i>Participatory Research: Does it work? Evidence from participatory plant breeding</i>	Preliminary assessment of the impacts of nearly 150 participatory research projects of various types: suggesting participation yields high returns in production and greater efficiencies in the innovation process.
Lilja and Bellon (2006) <i>Analysis of participatory research projects in the International Maize and Wheat Improvement Center.</i>	A review of the use of participatory methods in then-current CIMMYT research, based on a questionnaire-based survey of 18 scientists covering 18 projects.
Lilja and Dixon (2008) <i>Responding to the challenges of impact assessment of participatory research and gender analysis.</i>	Introduction to journal special issue on impact assessment of agricultural research and innovation. Reviews broad issues relating specifically to participatory approaches.
Ashby (2009b) <i>The impact of participatory plant breeding</i>	Important synthesis of key issues and the latest 'state of play' in the evaluation of participatory research and innovation, with a review of impact assessments of experience across fifty projects.

(i) The development of conceptual and typological frameworks

What seems to have been the first step towards empirically based conceptual framing of different modes of participatory innovation was taken in the report by Biggs (1989). This synthesized a set of studies that had been carried out since 1986 covering more than twenty programmes of On-Farm, Client-Oriented Research (OFCOR) in nine countries in Latin America, Africa and Asia. The OFCOR programmes selected for review had been started during the 1970s and early-1980s and had not been designed with explicit ‘participatory’ aims and organizational arrangements. But they were pre-cursors of such modes of innovation, and a basic typology for the comparative analysis was couched explicitly in terms of different modes of “participation of farmers in research” (p. 4).

By synthesising qualitative differences in detailed distinguishing features of each of six characteristics of the programmes, this framework distinguished between four types of participatory relationship: contractual, consultative, collaborative and collegial - as shown with their summary descriptors in Panel (A) of Table 3.3 below. Two features of the descriptors merit comment. They focus heavily on: (i) differences in the *underlying purpose*: farmers providing services for researchers at the ‘contractual’ end of the spectrum, and researchers encouraging and strengthening the informal R&D system at the ‘collegial’ end,²⁵ and (ii) differences in the innovation *activities undertaken* by farmers and researchers (the division of labour in the innovation process). Less prominent in the summaries, but present in the underlying descriptions of distinguishing features, was an emphasis on *decision-taking roles* – e.g. about who defines and selects the participating farmers.

This exploratory framework was subsequently taken up and modified in the study by Okali and colleagues (1994) - as indicated by Panel B in Table 3.3,²⁶ which also indicates in Panel (C) roughly how terms use in this paper (‘conventional’, ‘participatory’ and ‘grassroots’) map on to the different modes of innovation in these two frameworks.

One of the modifications to the Biggs categories by Okali and colleagues was to locate them in a more complete framework by extending beyond both ends of the spectrum of participatory relationships to include (i) a purely centralized, non-participatory mode of research, and (ii) a totally decentralized mode of technology development by farmers themselves – the autonomous informal innovation sub-system. A second modification recognized two issues. Firstly, particular innovation projects might involve different modes at different stages of the research process running from the identification of opportunities for innovation (diagnosis), through the identification of ideas and options, to the testing and adaptation of possible innovations. Secondly, the outcomes and impacts of particular modes of innovation might vary depending on the stage in the process at which it occurred. Rows were therefore added to the extended array of column categories in the overall framework in order to incorporate such stages into the basic framework.²⁷ Thus, as illustrated by the heavier shaded sections in Table 3.3, they suggested that what is referred to here as ‘conventional’

²⁵ The more detailed descriptions underlying this category are more explicit about the nature of the encouragement provided: e.g. “Understanding and strengthening informal R&D”.

²⁶ It had previously been reproduced in an important review of the role of social science analysis in agricultural research for the rural poor, supported by the International Development Research Centre of Canada (Biggs and Farrington 1991),

²⁷ This elaboration was important, but was still limited by its roots in the analysis of only research (actually research and development) and not innovation. For some purposes therefore it might be important to add a further row – e.g. ‘implementation’.

agricultural research commonly involved some degree of farmer participation in one of the three rows, while decentralized, farmer-only research involved none.

Table 3.3 Modes of Participatory Technological Development: Some Initial Steps Towards Conceptual Consolidation

(A) Biggs (1989)		DIFFERENT TYPES OF PARTICIPATORY INNOVATION			
		CONTRACTUAL	CONSULTATIVE	COLLABORATIVE	COLLEGIAL
		Farmers, land and services are hired or borrowed, e.g. the researcher contracts with the farmer to provide specific types of land.	There is a doctor-patient relationship. Researchers consult farmers, diagnose their problems, and try to find solutions	Researchers and farmers are partners in the research process and continuously collaborate in activities	Researchers actively encourage the informal R&D system in rural areas

Stages in Research process	CENTRALIZED: RESEARCHERS ONLY	CONTRACTUAL (AS ABOVE)	CONSULTATIVE (AS ABOVE)	COLLABORATIVE (AS ABOVE)	COLLEGIAL (AS ABOVE)	DE-CENTRALIZED FARMERS ONLY
	Identify Opportunities					
Identify ideas/Options						
Test and Adapt						

(C) This paper

Source: Adapted in Bell (unpublished) from Biggs (1989) and Okali et al. (1994)

However, the authors of this elaboration of the earlier Biggs framework recognized that this was still only an exploratory further step that required still further elaboration and use in practice before being widely accepted as a basis for analysis, management and indicator development (p.127). But no further steps along these lines appear to have been taken until the conceptual and typological study by Lilja and Ashby (1999) at an early stage in the work of the CGIAR Program on Participatory Research and Gender Analysis (PRGA) located primarily at the Centro Internacional de Agricultura Tropical (CIAT) in Colombia.

This study again took off from the earlier typologies of Biggs (1989) and Okali et al. (1994), using similar categories of participatory modes of R&D,²⁸ and also differentiating between stages of the innovation process. But beneath these similarities with the earlier approaches there was a significant adaptation. The different modes of research were defined on the basis of a narrower set of process characteristics: focused specifically on the decision-making

²⁸ A minor adaptation was the consolidation of the 'researchers only' and 'contractual' categories into a single 'conventional' mode.

elements of technology development projects, rather than also incorporating differences in (a) the purposes of participation and (b) the division of labour in actually ‘doing’ the innovative activities. However, the authors clearly recognized this limitation and envisaged the development of less narrow bases for classification.²⁹

With further minor modifications, this typology – as outlined in Table 3.4 below - was applied in an evaluation of three participatory research and innovation projects (Johnson et al. 2001, 2003). But in this and subsequent work by the CIAT-based PRGA group, there was a more important development in the basis for differentiating modes of participatory innovation.

Table 3.4 Modes of Participatory Technological Development: An Emphasis on Decision-Making

Johnson et al. (2003)*				
CONVENTIONAL (No farmer participation)	CONSULTATIVE (Functional participation)	COLLABORATIVE (Empowering participation)	COLLEGIAL (Empowering participation)	FARMER EXPERIMENTATION (No researcher participation)
Scientists make the decisions alone without organized communication with farmers	Scientists make the <i>decision</i> alone, but with organized communication with farmers. Scientists know about farmers’ opinions, preferences and priorities through organized one-way communication with them, and may or may not let this information affect their <i>decisions</i>	<i>Decision-making</i> authority is shared. Scientists and farmers know about one another’s opinions, preferences and priorities through organized two-way communication. <i>Decisions</i> made jointly and no party has a right to revoke the shared <i>decisions</i>	Farmer make the <i>decisions</i> collectively or through individual farmers who are in organized communication with scientists. Farmers know about scientists opinions, preferences, proposals and priorities through organized communication, and may or may not let this information affect their <i>decisions</i> .	Farmers make the <i>decisions</i> individually or in a group without organized communication with scientists

* Some of the descriptors are slightly abbreviated from the original.

This involved widening the primary focus on patterns of decision-making as the basis for the typology by also taking account of a distinction between the broad aims or approaches of a participatory research or innovation project. This involved a simple dichotomy between ‘functional’ and ‘empowering’ approaches. As outlined in Johnson et al. (2003), a *functional* approach is concerned with using participation to increase the efficiency and effectiveness of the innovation process – using the knowledge of farmers and stronger communication between researchers and farmers to achieve better technologies and adoption outcomes or the completion of projects faster or at lower costs. *Empowering* approaches aim to enhance rural people’s “capacity and tools to innovate and to influence research agendas” and this can “lead to fundamental changes in the nature of the innovation process, bringing in new actors and altering power relationships”. (p.289). As indicated in Table 3.4, the authors associated this distinction with the different types of participation based on differences in decision-making:

²⁹ “There are functions other than decision-making in participatory processes but we are not including these other functions in this tool yet”. (p.1)

by definition, functional approaches are identified with consultative modes, whereas empowering approaches are associated with collaborative and collegial modes.

The grassroots innovation projects that are the subject of the case studies later in the paper were designed with explicit objectives about ‘empowerment’ in the sense discussed here. However, the approach to classification followed here is not that suggested by Johnson and colleagues because there is a difficulty about the way the Functional vs Empowering distinction is identified with the basic Consultative, Collaborative and Collegial categories in the basic typology (as in Table 3.4). By aligning the two kinds of distinction in this way, collaborative and collegial modes of participation are *defined* as not being concerned with functional aims about process effectiveness and efficiency, while consultative modes are *defined* as having no empowerment effects.

Neither association is necessarily the case, and the approach used in this paper will follow more along the lines of the earlier typologies in Biggs (1989) or Okali et al. (1994) in which alternative modes of participatory research and innovation are defined in terms of organizational features reflecting the division of labour and its co-ordination, as well as aspects of the *ex ante* intentions and purposes.³⁰ This leaves achieved *ex post* consequences such as functional effectiveness and efficiency or empowerment effects to be treated as variable outcomes and impacts of the different modes of innovation – an important variability that is left open as a matter for empirical enquiry, not something that is given in advance by definitional alignment.³¹ In effect, this was the approach actually taken in practice in Johnson et al. (2001, 2003), and by other colleagues in the PRGA in their later assessment of outcomes and impacts of participatory projects, as is discussed immediately below.

(ii) Assessing and evaluating outputs, outcomes and impacts

It is in the area of assessing and evaluating outputs, outcomes and impacts that this strand of literature has made its greatest contribution. Studies have sought to go beyond merely describing illustrative examples of apparent consequences of participatory modes of research and innovation by assessing more systematically how such consequences are associated with groups of innovation projects consolidated into different categories along the lines discussed above.

Some of this analysis has been concerned with evaluating various organizational and managerial characteristics of participatory *processes* and, as in the descriptive case study literature, this focus has been intended primarily to serve ‘internal’ management purposes. This was a major focus, for example, of the early review by Biggs (1989), centred on the role of various kinds of meeting as a means of strengthening farmer participation. It continued as an important element in several later studies – for example in a review of participatory

³⁰ In principle, of course, it would be good if the development of typologies by ‘manual’ methods of aligning different dimensions of innovation processes (as in Biggs, 1989; Okali et al. 1994; and Johnson et al. 2001, 2003) could now be augmented by multivariate clustering methods. It is therefore encouraging that exploratory work along these lines using multiple correspondence analysis of data for 49 participatory plant breeding programmes has been undertaken within the CIAT-based PRGA programme (Ashby 2009b: 657).

³¹ Also, this approach does not exclude ‘conventional’ and ‘farmer experimentation’ modes of innovation from the evaluative scheme by leaving them not associated with either functional or empowerment characteristics. Instead, it allows the possibility that they also may have *ex ante* purposes of those types (perhaps both). It also envisages that it may be useful to assess *ex post* the variable extent to which those categories achieve elements of functional effectiveness and efficiency or dimensions of empowerment.

research in CYMMYT (Lilja and Bellon, 2006) or in the detailed examination of methods of organising participatory processes of variety selection by Ceccarelli and colleagues (2003).

However, the main contribution in this area has been in connection with the wider outcomes and impacts of participatory/grassroots modes of innovation. Not surprisingly, this was not a feature of the earlier studies. It was largely absent from the review by Biggs. Then, although Okali and colleagues (1994) had originally intended to examine these issues, they found that available information about the outcomes and impacts of their selected programmes was very limited, and what existed was inadequately structured to allow impacts to be attributed clearly to alternative modes of R&D.

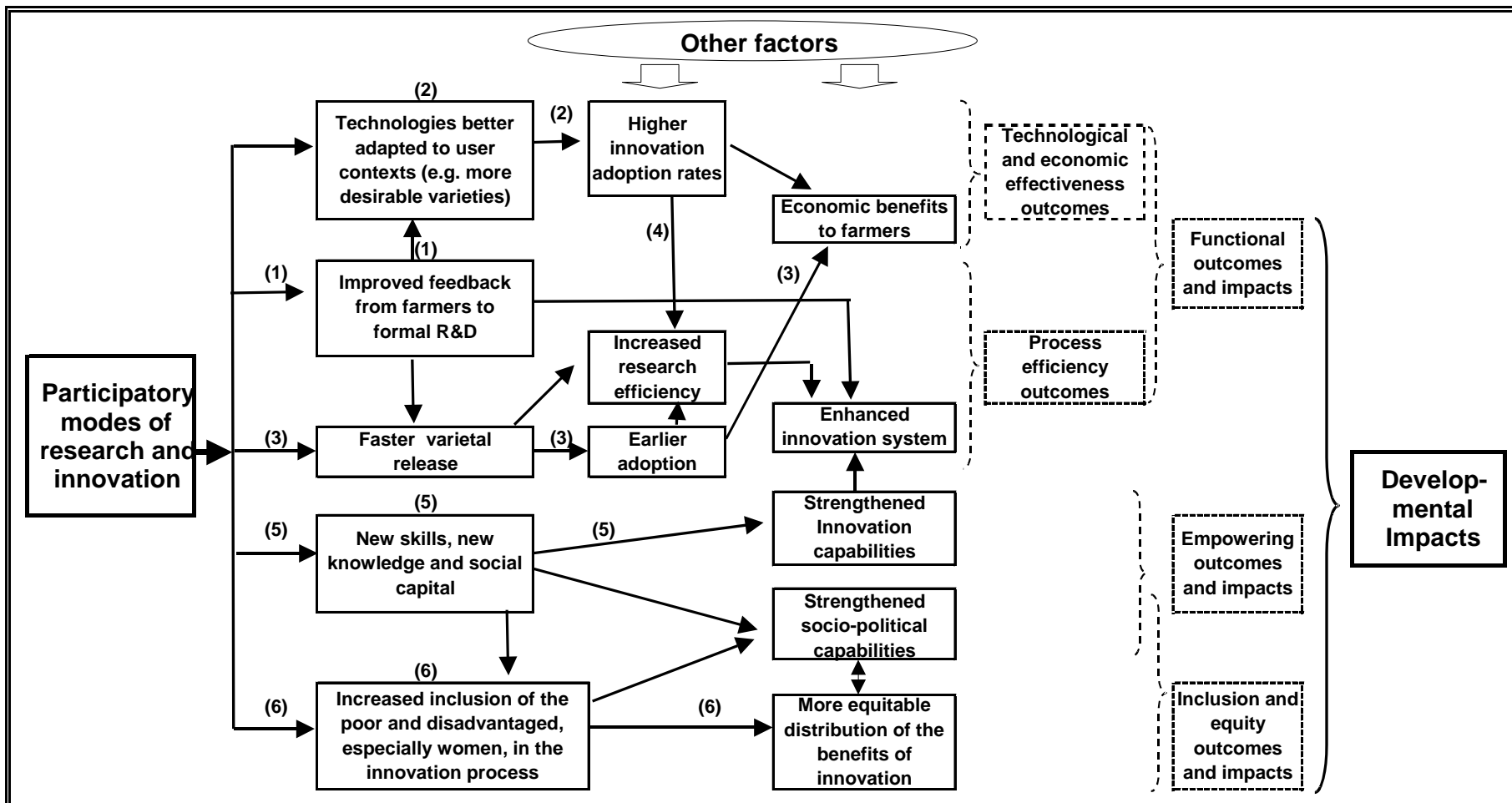
A large part of the contribution has been made in the series of studies by the PRGA programme. An important foundation for this was their emphasis on understanding the complex networks of causal relationships lying between innovation activities and their outcomes and impacts, especially longer term developmental impacts. Without this understanding one cannot reliably attribute observed ‘impacts’ to research and innovation activities rather than many other factors.³²

These issues are usually discussed in terms that differentiate between outputs, outcomes and impacts. But there are differences in quite how these distinctions are drawn and used, and the approach followed here is that of Ashby (2009b), who uses the term ‘impact pathways’ to refer to interacting sequences of causal relationships running from participatory/grassroots modes of research and innovation to developmental impacts. Within these pathways she focuses on specific cause-effect relationships without becoming too bogged down in terminological details (pp. 657-665).

Figure 3.2 outlines *selected parts* of this structure of impact pathways. It also illustrates the kinds of indicator used by Ashby and PRGA colleagues to examine the validity of hypothesized causal relationships within the structure. Some were already commonly used in the evaluation of conventional agricultural R&D. These included indicators of technological and economic effectiveness (e.g. various aspects of the performance of crop varieties, the rate of innovation adoption and the associated benefits for farmers), as well as indicators of efficiency in the research process itself (e.g. the speed to varietal release). Others were indicators reflecting less commonly evaluated aspects of process efficiency (e.g. the extent and form of feedback from farmers to formal R&D activities). Yet others reflected issues that had previously been much less commonly used, in particular, those concerned with: (i) empowerment outcomes and impacts (e.g. the extent and forms of new skills, knowledge and social capital that were created in association with participatory modes of innovation), and (ii) inclusion and equity outcomes (e.g. the extent and ways in which innovation activities included the poor and disadvantaged, in particular women, leading to different directions of innovation and more equitable distribution of its benefits).

³² This difficulty about attributing observed economic and other events as consequences of research inputs is important not only for assessing the impacts of grassroots-participatory modes of innovation. It is just as important for conventional modes of innovation – for example, in connection with estimating rates of return to agricultural R&D, where some would argue that the problem of is still far from adequately recognised.

Figure 3.2 Selected Pathways from Participatory-Grassroots Modes of Research and Innovation to Longer Term Development Impacts



Source: Adapted in Bell (unpublished) from Ashby (2009b: 657-665)

Three items in the list of literature in Table 3.2 provide overviews of evidence about various causal relationships within the structure of impact pathways: Johnson et al (2001, 2003), Ashby and Lilja (2004) and Ashby’s broader review (2009b) of the evidence that was available by the late-2000s. That evidence is drawn on here in order to comment on six particular relationships that are components of the structure of impact pathways shown in Figure 3.2. The evidence relates to participatory research and innovation that was mainly, but not totally, based on plant breeding, and it is derived from studies using a variety of methods ranging across surveys of scientists’ opinions, more intensive project analyses and appraisals, detailed experimental trials and wider production surveys.

Pathway Component 1 Participatory/grassroots (P/G) modes of research and innovation improve farmer feedback to formal research, so altering research objectives, priorities and practices in ways that contribute to the development of technologies that are better adapted to user contexts.

All three studies compile extensive evidence to confirm expectations that participation by farmers, especially at early stages of projects, results in more intensive feedback about their preferences and production conditions, and this contributes to shifting the focus and direction of research so that better adapted technologies are made available. Ashby (2009b) summarizes the most recent position as follows.

“This experience, now so diverse with respect to crops, cultures, and production environments, demonstrates the efficacy of participatory selection in producing varieties for poor farmers who are otherwise excluded by conventional crop improvement programmes” (p. 661)

Pathway Component 2 P/G modes of research and innovation, by producing more desirable varieties, lead to higher rates of adoption. .

Although the number of longer-term adoption studies of technologies developed via participatory/grassroots approaches remains limited, this expectation also seems well founded. For example, these modes of innovation have enabled breeding programmes in several countries to break through adoption bottlenecks and prolonged prior periods of non-adoption of new technologies developed by conventional approaches.

Pathway Component 3 P/G modes of research and innovation also lead to faster varietal release, leading to earlier adoption, so increasing the stream of benefits to farmers.

Several studies have demonstrated that participatory approaches to technology development have substantially reduced the time that would otherwise have been required to release varieties for use – in one case, for example, the technology development process arrived at that point three years earlier than the nine years that would have been involved in more conventional approaches. This acceleration of the innovation process has effects on its efficiency, freeing up resources to undertake additional innovation projects – as discussed later in connection with the costs of participatory/grassroots modes. But it also has a considerable effect on the benefits arising for farmers, primarily as a result of their earlier adoption of beneficial technologies. For example, Ashby and Lilja (2004) report the results of a carefully comparative analysis of the discounted research-induced benefits from different approaches to innovation for barley production in Syria. The benefits from technology development via three different participatory approaches were in a range from twice to five times greater than those from conventional breeding approaches (p.8). Ashby (2009b) explains that most of the difference was attributed to the way P/G modes of innovation

“reduced the amount of time it took for improved varieties to get into farmers’ fields” (p.663).

Pathway By generating more desirable varieties with accelerated adoption paths, P/G modes of
Component 4 research and innovation improve research efficiency.

As well as raising efficiency in the innovation process because of faster progress to varietal release, participatory approaches may also generate another effect on process efficiency. By bringing farmers knowledge and understanding to bear on the research process, efforts to pursue what would later prove to be ineffective directions of technology development seem to be reduced. Such knowledge and understanding helps to bring potentially more desirable technology characteristics *into* the technology development process, while also screening *out* of the process less desirable directions of development, so reducing the probability of going all the way to promoting varieties with poor acceptability - and hence reducing the research resources allocated to such innovatory ‘dead ends’ (Ashby, 2009b: 663).

Pathway P/G modes of research and innovation foster the development of new skills, new
Component 5 knowledge and social capital that enhance innovation capabilities.

Johnson et al. (2001, 2003) indicated that in some of the three participatory projects they studied farmer-researchers “did enhance their experimentation skills” (p.298). To some extent this was a matter of experience accumulation as farmers engaged in R&D activities – relatively passive learning-by-doing. But explicit effort to build substantial training activities and learning opportunities into projects appears to have been more effective in developing technology development competences. In particular, in one case, concerned with developing soil conservation practices in Honduras, the project provided intensive training for a select group of farmers who became ‘farmer-promoters’ in the project, some of whom later went on to work with other agricultural and development projects.³³ This project also illustrated the longer-term potential of such explicit investment in farmers’ capabilities. A substantial proportion of the farmers moved beyond the agronomic practices developed and introduced by the original project. They independently experimented with alternatives and improvements and introduced new practices – so “demonstrating a capacity to innovate beyond the adoption of recommended practices”. (p.301). In effect the investment in empowerment components of the project had contributed to creating an autonomous capacity for sustained innovation.

But the evidence was mixed between and within the cases in this study, and in some the increase in capabilities was modest at best. At the same time, evidence of the development of broader social or community capital was scant. Ashby’s later review (2009b) suggested that little advance in understanding in this area had been made by the end of the decade. Several studies had shown how farmers in participatory projects might acquire additional research and technology development skills, while research staff in the formal system might also enhance their skills in using participatory approaches. Also as the value of decentralized research being undertaken on-site in low-potential and marginal environments was becoming recognized, so also was the associated need to offset the potentially higher costs of decentralized technology development by strengthening farmers’ skills to permit more significant delegation of research tasks. However, Ashby’s broad conclusion was that

³³ This is reminiscent of the practice in Japan at the end of the 19th century and early 20th, when the limited resources of the nascent formal agricultural research system were supplemented by the services of experienced or ‘veteran’ farmers – rono. These were employed as itinerant instructors to assist on branch research stations and more widely as ‘informal’ extension agents to support localised experimentation and diffusion of improved varieties and agronomic practices. (Hayami and Yamada, 1991)

systematic evidence about these important empowerment-related outcomes and impacts was seriously inadequate.

This is an important limitation because, in principle, a large part of the potential significance of participatory/grassroots modes of innovation does not arise only at the level of individual projects – i.e. in the form of technological and economic gains following from an increased number of participatory projects. It arises also at the system level. It is about structural transformation of significant parts of the agricultural innovation *system* along the lines discussed earlier in connection with the arguments of Biggs and Clay (1981) about effective integration of the informal and formal innovation sub-systems (as illustrated in Figure 3.1). A central part of the argument about such system-level transformation rests on a combination of two of the impact pathways sketched in Figure 3.2: (i) this empowerment-centred Pathway 5 running via the augmentation of skills, knowledge and social capital, and (ii) the long-term institutionalization of Pathway 1 involving improved feedback links between farmers and formal R&D.

Pathway Component 6 P/G modes of research and innovation increase inclusion of the poor and disadvantaged, especially women, in the innovation process, so leading to more equitably distributed benefits.

There are two aspects of this relationship. One, essentially an element of the relationship in Pathway Component 1, is about whether, as a result of participatory modes of research, women and disadvantaged farmers gain any effective traction on the technology development process so as to shift it in directions more consistent with their own interests. The second is about whether, with or without such traction on the technology development process, the distribution of subsequent benefits from the technological results of participatory modes of innovation is shifted towards disadvantaged groups more equitably than would arise under more conventional approaches.

Ashby and Lilja (2004) indicated that there is some evidence of the first effect. For example, in one multi-country project involving consultative participation in the testing stage, the programme researchers considered that:

“... by consulting women and involving them in varietal evaluation, the programme had included varietal traits that women know about, and especially gender-related varietal preferences, leading to better acceptability and faster adoption of the varieties.” (p.8)

Ashby (2009b) reported the existence of other instances, but also noted that the participation of women might also be slight or absent even in more generally participatory projects. In other words, there did not seem to be any necessary connection between generally participatory modes of innovation and the specific inclusion of disadvantaged groups in the process.

She also emphasized that the second aspect of the relationship, namely the distribution of the benefits of implemented innovation, was also not necessarily shaped towards equitable patterns simply as a consequence of generally participatory approaches in the process. She noted in particular an instance where the participants from richer households captured a disproportionate share of the returns, such that the participatory mode of innovation involved in effect “a transfer of wealth to the richer households from the intermediate investors”, and

this reinforced the gender bias in the distribution of benefits. Her conclusion from the evidence was therefore that:

“The lesson here is that participation can lead to the exclusion of important groups of beneficiaries, such as women, depending on prevailing customs and norms, especially if participation is based on self-selection.” (p.665)

In other words, nearly thirty years later, these conclusions are again in line with the emphasis given by Biggs and Clay (1981) to the powerful role of institutional factors in shaping not only who participates in the innovation process but also who benefits from its implemented results.

(iii) Taking account of inputs and costs

From one perspective the use of participatory approaches appears to involve *adding* elements and activities into the innovation process. Correspondingly the most immediately visible effects can appear to be additional costs, and the evidence from project reviews indicates that such costs do arise. These can include such things as costs for additional communication and coordination; farmers’ costs in undertaking research and associated travel; costs for more dispersed fieldwork by formal system research staff; costs for training of researchers – both farmer participants and formal system researchers; costs of greater seed use, and perhaps costs for more complex forms of analysis.

But the costs of such additional inputs to projects account for only a relatively small part of the overall cost picture. Firstly, all these kinds of operational costs are typically a relatively small proportion of total R&D costs. For example, Ashby (2009b) reports that they accounted for only 23 per cent of total budgets in a number of participatory and conventional projects in Syria, and the added costs in the participatory projects amounted to only 3 per cent of the total. (p.663). Secondly, some of these costs may in any case be initial once-off costs, such as training farmers in research-related skills, that would probably fall in subsequent projects.

A more important part of the wider picture seems to be the less immediately visible cost *reductions* that can arise with participatory approaches. Some of these may involve substitution effects as farmer participants undertake research and technology development activities in lieu of (usually much more expensive) formal system staff. Other kinds of reduction may be efficiency effects – e.g. as noted above: (i) accelerating the technology development process so that applicable innovation outputs are made available in shorter times, perhaps cutting several years of expenditure off the costs of achieving those outputs; or (ii) reducing the incidence of technology development efforts committed to unproductive innovation dead-ends.

Within this broader picture the question of financial *sustainability* may sometimes be as significant as the actual level of costs incurred – in particular in cases where costs are initially met by external sources such as NGOs and other donors. Despite the common concern about this issue within discussions about ‘mainstreaming’ participatory innovation within the established research institutes and budgets, there seems to be only one study of this issue – covering a number of seed diffusion projects to enhance genetic diversity in farmer experimentation in beans, maize and rice in Cuba and Mexico (Labrada 2009). This suggests a positive relationship between the intensity of participation and local financial sustainability: the greater the ‘degree’ of participation, the greater the extent to which costs were met locally and the lower the dependence on external funding.

But these observations about costs are just fragments, and there is no basis for going beyond the cautious summary offered by Ashby (2009b) with respect to costs and participatory plant breeding (PPB):

“Clearly more analysis of the way PPB affects costs would help to clarify this debate, but at present we cannot conclude that PPB automatically represents a major increase in cost for a breeding programme.” (p.663)

But then the *benefits* from participatory innovation need to be brought alongside the cost picture in order to assess cost *effectiveness*. The necessary evidence is scant, but it is at least illuminating to recall the case reported by Ashby and Lilja (2004) where the discounted present value of benefits from participatory technology development for barley production in Syria were two to five times greater than those from conventional breeding approaches. If benefit streams even at the lower end of this range were more generally associated with participatory modes of innovation, they would more than offset what usually seem to be relatively small increases in costs.

But those results reflect the benefit streams from only a single phase of technology development, and ideally one also needs to take account of the cumulative effects that arise over time. This is potentially important because, scattered through this body of evaluative studies, there are small observations of dynamic learning effects: farmers augment their skills in innovation activities over time; formal system researchers become better at working in participatory modes (as well as learning about the merits of participatory approaches); and links between formal organizations and farmer communities may become more socially embedded.

Such learning processes seem likely to affect both costs and benefits. For example, the relationship between participation and falling external costs in the case of Cuban and Mexican seed projects was not simply cross sectional between different projects. It seems to have reflected dynamic learning effects as projects became more effectively and extensively participative over time (Labrada 2009: 607). With respect to benefits, the case of soil conservation projects in Honduras suggests that cumulative learning by farmers beyond the initial training-intensive project led them into a phase of self-sustained innovative activity yielding considerable further benefits beyond those from the initial phase (Johnson et al. 2003: 294, 301).

However, these observations about benefit streams, even without any consideration of dynamic learning effects, are even more fragmentary than the evidence about costs, and Ashby’s cautious generalization about the latter (above) applies even more forcibly here.

(iv) The incidence and scale of grassroots and participatory modes of innovation

A thin thread of observations about the scale or incidence of participatory modes of innovation runs through this body of literature. However this is almost entirely concerned with questions about the relative scale of different modes of participatory/grassroots innovation, not about the scale of these non-conventional approaches to innovation as a whole or relative to conventional modes.

The early study by Biggs (1989) addressed the question of the relative incidence of different modes of participatory innovation in two ways, both based on the number of programmes falling into the different categories of his typology (Panel (A) in Table 3.3). Firstly, it demonstrated the initial distribution of programmes at the time of their inception: largely

concentrated in the ‘contractual’ and ‘consultative’ categories towards the left of the figure with none in the ‘collegiate’ category on the right. Secondly, it also examined how that distribution changed over time: many of the programmes changed little and continued in their initial modes, and some shifted leftwards, usually from consultative towards more contractual modes. However a significant number shifted in the opposite direction, mainly from consultative towards collaborative modes, and one from a collaborative to a collegiate form of relationship. Such diversity, including shifts ‘to the right’, contrast with views expressed in the discursive case-study literature.

Although the study mapped the initial and changing distribution of research activities across the modes of participation only in terms of the number of programmes, information was also available about the size of each of the OFCOR programme - in terms of the number of scientist-years involved (varying between 14 and 104), and also in terms of the number of those person-years as a proportion of the total number in each of the national agricultural research systems responsible for the programmes (varying between 6 per cent in Ecuador and 34 per cent in Guatemala).³⁴ Thus it would probably have been feasible to map the quantitative features of the participatory projects in terms of these person-year inputs,³⁵ covering not only their distribution between the different modes of participatory activity, but also their relative significance within the overall agricultural research systems in each country.

But rather than building on the start made in this study, only very fragmentary efforts have subsequently been made to map the scale of participatory/grassroots research. Some studies have offered fairly discursive assessments of the distribution of groups and samples of participatory projects between different participatory modes. For example, Okali et al. (1994) examined the experience of eleven agricultural research programmes in South Asia and Africa that had incorporated participatory elements of organization, and they offered comments about how the distribution of these across different modes of participation seemed to have been changing:

“... there has been something of a shift from a contractual/consultative relationship. On the other hand, we would argue, there has not been significant progress in creating a ‘collegiate interface’ between formal research and farmers’ own experimental activities” ... We believe that this apparent lack of progress reflects the fact that despite the rhetoric and several pieces of much-cited literature, few programmes appear to have yet understood how to interact with farmers’ own experimental interests and skills”. (pp. 94-95)

Subsequent studies have advanced little beyond such discursive comment. In a few instances budget expenditure figures have been used to indicate the scale of particular samples of participatory projects being examined (e.g. Ashby and Lilja 2004: 2). But such magnitudes have not been set in the context of similar figures for ‘conventional’ modes of research in order to identify the *relative* scale of participatory and conventional modes in particular organizations, regions, fields or national agricultural research systems. Nor have they been broken down by different modes of participatory innovation. Also, there appear to have been

³⁴ See Table 1 in Biggs (1989: 4)

³⁵ In the early development of indicators of the scale and composition of R&D in OECD countries and also in the USSR during the 1930s - 1950s, measurement was often based on person-years of researchers, engineers and so forth, rather than on less accessible or reliable financial expenditure data. Such people-based indicators of scale remain important for several types of analysis.

no analyses along the lines in the early Biggs study to assess whether and how the incidence of different modes of innovation has changed over time.

Thus there remains a large gap in understanding about very basic aspects of the scale of participatory innovation, and there has been almost no development of indicators to contribute to policy debates about scaling up and ‘mainstreaming’ these approaches to innovation. This is a significant gap because, as Ashby (2009b) concludes in her review of the impacts of participatory innovation in the specific area of participatory plant breeding (PPB), active engagement in such ‘external’ policy debate about scale is important:

“To realize its full potential on a large scale, PPB requires organizational, policy and legal changes in both international and national plant breeding.” (p.666)

Statistical indicators about the scale of participatory modes of agricultural innovation will obviously not achieve such changes on their own, any more than will better indicators of outcomes, impacts and costs. As ever, there remain:

“...tenacious obstacles to the institutionalization of PPB because science bureaucracies and the political elites that fund them, resist being accountable to poor farmers as clients.”

But that seems all the more a reason to develop a much stronger body of evidence and associated indicators to illuminate where, how, why and on what scale participatory approaches to innovation may be effective and preferred ways of undertaking agricultural innovation. But to repeat the basic point about the system-centred framework suggested by Biggs and Clay (1981), that is about strengthening overall innovation systems through stronger and more diverse forms of complementary integration between formal and informal sub-systems. That perspective helps to highlight a substantial imbalance in the orientation of most of the comparative and evaluative literature that has been reviewed here.

(v) A broad imbalance in orientation

Almost all the studies in this strand of literature have focused on projects and activities that have their roots in the formal agricultural R&D system. In effect, the viewpoint has been from the left hand side of the typologies in Tables 3.3 and 3.4. The dominant questions have therefore been about how, how far and with what consequences movements have been made from conventional modes of innovation at that end of the typological spectrum towards less conventional modes at the other end.

Almost totally absent, at least from this body of literature, have been studies with a viewpoint from the right-hand side of the typologies – a viewpoint that *starts* in the domain of decentralized, farmer-only innovation. From that perspective at the grassroots end of the spectrum, initial questions would be about the incidence and characteristics of that mode of innovation on its own, with subsequent questions about how, how far and with what consequences movements have been made *from right to left* across the categories in the typologies. Such questions might include:

- Does there actually exist on a widespread basis a neglected and vibrant informal innovation system supporting smallholder agriculture? In what circumstances does this arise, and what is different about the circumstances where it does not?

- To what extent and how does this innovative activity generate effective demand on the formal component of the innovation system? What happens to this demand, and what kinds of links emerge between the informal and formal system components - and how?
- How far are shifts made into modes of innovation towards the left of the typological spectrum by initiatives starting from the right hand end? How are those steps implemented?
- What is the division of innovative labour between actors in the two components of the system, and how is this coordinated? How do these aspects of the innovation process differ across modes of innovation moving leftwards from farmer-only innovation at the right-hand end of the spectrum?
- What consequences follow from these different approaches to innovation and from shifts between them?
- What constraints impinge on movements from right to left and on the consequences that follow?

The case studies reported in the next sections of the paper take this ‘right-to-left’ perspective. They are about innovation-centred initiatives that started in smallholder farming, not in the plans or programmes of the formal R&D system in South Africa; and they are about ‘grassroots’ developments of relationships with that formal system. They do not attempt to address the whole spectrum of questions noted above, but they aim to illuminate at least some aspects of some of the issues involved.

4 THE CONTEXT OF THE CASE-STUDIES

Two cases of grassroots innovation in South African smallholder agriculture were examined. These cover what are probably the two main developmental routes calling for innovation in smallholder agriculture, not only in South Africa but in Africa more generally. The first case, concerned in general terms with improving *highly localized activities* in order to enhance livelihoods and food security *within* the community, centred on developing an alternative method of small-scale potato production. The second, concerned with raising cash incomes by connecting local production more effectively into supply chains *running to markets outside the local area*, centred on initiating the production of a new cash crop (cherry peppers) and on developing a new market outlet. Both were located in Potshini, a village in rural KwaZulu-Natal, and were supported by the PROLINNOVA network and its associated FAIR programme.

This section provides background information about these aspects of the context of the case studies: smallholder production in South Africa, the village of Potshini, and the project-supporting organizations. It also provides brief comment about the approach taken in the case-study research.

4.1 Smallholder agriculture in South Africa

Smallholder production is particularly important in South Africa, not because of the scale of its contribution to overall economic output, which is small, but because of its historical significance, as well as its current centrality to major economic, social and perhaps growing political concerns. The focus of this paper is on the current socio-economic issues, but since

these cannot be disconnected from the history and politics, a brief glimpse of those might be useful for non-South African readers.

Since at least the mid-twentieth century smallholder agriculture in South Africa has been more or less synonymous with the agriculture of black farmers. But that has not always been the case, and the history of the sector has been simply described by Vink and van Zyl (1999) as a long process of disempowerment of this part of the black population, running from the early decades of the last century. They summarize the process as follows.

“African family farming was relatively viable in the latter half of the 19th century, and in some areas well into the 20th century. African owner operated and tenant farming proved to be as efficient as the large-scale settler farming of that time. African farmers adopted new technologies, entered new industries and out-competed large-scale settler farmers in many of the emerging agricultural markets. At present, however, African agriculture is largely associated with the economy of the former Homelands, where it contributes little to household income and generally fails to provide even basic subsistence needs.” (p. 61)

The connection between those two situations was a long series of policy measures that progressively suppressed small-scale, black agriculture, allocated the most productive agricultural land to white, large-scale farming, and restricted black agriculture to a set of scheduled ‘Native Reserves’, later ‘Homelands’, located for the most part in areas of relatively marginal land. As a matter of intended policy, household income in these areas became heavily dependent on income from agricultural labour on large-scale farms or from migrant labour in mines and urban industry or services. In contrast and in parallel, a wide range of policy measures were put in place to subsidize and protect large-scale white commercial farming.

The result was not merely a highly skewed distribution of farms, with a very small proportion generating a very large share of output and income - a common feature of agricultural sectors, especially in developing economies. Instead there was a sharply differentiated bi-modal distribution – an extreme form of dual structure. But one should not be too statistically precise about the situation because one feature of the smallholder component of that structure was that it was almost entirely unmeasured during the apartheid era. With the homelands covered inadequately, or not at all, in statistical surveys until 1994 (Kirsten and Moldenhauer, 2006), the smallholder sector was statistically excluded as well as being every other kind of excluded.³⁶

Nevertheless, rudimentary information is available about the late-1980s when, as summarized by Vink and van Zyl (1999: 67), nearly 90 per cent of actively farmed agricultural land was in white areas. It supported a rural population of 5.3 million, more than 90 per cent of whom were African wage labourers on larger-scale, commercial farms. In contrast, the remaining agricultural land in the homelands supported over 13 million people on the basis of average individual land holdings of about one hectare. In effect, the African family farming sector had been all but eliminated and African peasants had been transformed into wage workers, a large proportion of whom (especially of the adult male population) were absent from their rural communities for long periods. Agricultural capital for farming in this context was at very low levels and human capital in the form of skills and experience had been substantially eroded.

³⁶ Detailed analyses by Liebenberg (2011) have thrown light on aspects of this statistical exclusion and its implications for understanding even the quite recent economic history of South African agriculture. [Not referenced unless it is 2011]

At the same time, access to agricultural services was very limited and supported by levels of public expenditure that were much lower than those provided for the already knowledge-rich large-scale sector.

After 1994 the framework of discriminatory legislation was dismantled; measures to introduce several types of land reform were introduced, though implemented very slowly; and the research and extension services were reorganized in ways intended to provide greater support to smallholder agriculture, though the total number of agricultural research scientists has fallen (Sandrey and Vink 2008, Vink and van Rooyen 2009). However, a number of surveys since the mid-1990s appear to leave the magnitude and composition of the smallholder/small-scale agriculture sub-sector still unclear (Kirsten and Moldenhauer 2006, Pauw 2007, Aliber and Hart 2009, Drimie et al. 2009). This lack of clarity largely reflects the great complexity of what is bundled together under the general heading of ‘smallholder’ farming. At the heart of this complexity are widely differing degrees to which rural households engage in agriculture, combined with the different ways they do so and the different purposes they have. Moreover, individuals and households may move in and out of agriculture from year to year.

The counterpart to that is that households draw on multiple sources of income, among which farm income often plays a relatively small role among wage income, pensions and grants, remittances and others – only 23 per cent on average in former homelands households in 2000 (Kirsten and Moldenhauer 2006: 67). The extent to which food security depends on subsistence agriculture also varies widely. But even when agricultural production is relatively small, it can play an important supplementary role, and one estimate of a core group for whom agricultural activity provides a significant basis for their food security is that “some 4 million people from over 2.5 million households, mostly residing in the former homelands ... are engaged in agriculture as a means of supplementing household food supplies” (Aliber and Hart 2009: 454). All that complexity varies across geographical areas, and those areas involve varying degrees and types of stressed agricultural conditions, with access to input and product markets also highly variable – though usually poor and often absent.

Perhaps not surprisingly, views about broad policy responses to this complexity vary widely. But, cutting across that diversity, views about the specific role of agricultural research and innovation, seem to differ between two kinds of analysis: (i) those that focus specifically on aspects of smallholder agriculture and ‘work back’ from there to raise questions about research and innovation, and (ii) those that focus primarily on characteristics of the research and innovation system and ‘work forward’ from there to consider its role in South African agriculture.

Among studies that focus specifically on the smallholder sector, there is general agreement about five innovation-related issues: (i) the disparity in innovation capabilities between its two components is a critically important factor underpinning the dual structure; (ii) successful innovations in smallholder agriculture have typically involved significant new knowledge inputs such as farming experience, extension visits and increased training; (iii) since the 1990s there has been a significant effort to reorient the provision of inputs by research and extension services towards smallholder farming; but (iv) these services have not been able to support an adequately rapid or widespread development of either market-linked agricultural production or improvement in the supplement to food security provided by small-scale subsistence farming – and the total scale of research and extension services has been falling. Finally however, those limitations are far from being the only obstacles to achieving such

impacts because other, often more binding constraints are set by adverse agronomic conditions (with these being exacerbated by climate change), by limited physical infrastructure such as transport access to product markets; and by institutional constraints such as insecure land tenure and access to credit.

Most of the comment about addressing the constrained impact achieved by research and extension services has centred on orienting a larger scale of research and extension resources towards the smallholder sector and developing a stronger system of linkages to *deliver* new technologies to smallholder farmers. However, in some instances, it is recognized that the particular characteristics of agriculture in those contexts may require different kinds of innovation process: types of innovation that would, for example, give greater attention to “villagers’ indigenous agricultural practices” (Aliber and Hart 2009: 454) or that would involve “participatory research, information dissemination and capacity building ...” (Ortmann and King 2011: 406). That perspective is treated more extensively by Botha (1999)

However, a different perspective seems to be offered by studies that have focused primarily on the country’s agricultural research and innovation system and moved from there to address questions about its role in contributing to change in the agriculture. Here the existence of the deeply dual structure of the agricultural economy is commonly almost invisible. So also are explicit discussions about whether or how the formal R&D and innovation system might need to develop distinctly different ways of achieving innovation in order to respond to that duality.

For example, a review of agricultural research between the early 1970s and the late 1990s (Liebenberg, et al. 2004) made almost no reference to the dual structure of the agricultural sector that faced the research system. It did include very brief comment about refocusing research towards small-scale farming and the needs of poor farmers in disadvantaged communities (p.2), but the analysis concentrated almost entirely on broad trends and developments in research activities at the level of the overall national system . Even the disaggregation of that analysis under a heading of *Research Orientation* dealt with only two kinds of orientation: the allocation of resources between (i) different commodities and (ii) different thematic foci (e.g. crop research; livestock, pest and disease control; or post-harvest technologies). A third kind of orientation – between the two sharply different agricultural sub-sectors – was not discussed. Some years later a very similar perspective was taken in an immensely thorough and longer-term review of the sources, structure and trends in South African agricultural R&D between 1910 and 2007 (Liebenberg et al. 2011). Again, even with reference to the 1960s - 1980s period, the discussion was entirely about R&D in relation to a unitary South African agriculture. This broad perspective carried through to the analysis of more detailed aspects of the R&D system. For example, using eleven annual estimates over the period 1910 to 2007, details about research and extension intensities were examined with reference to only the national entity and without any comment about whether or how there might have existed disparities in the intensities between different parts of the dual structure.³⁷

³⁷ In any case, the underlying data relating to the smallholder sector are inadequate to provide a satisfactory picture of even the national aggregate, let alone of any disparities between the components of its dual structure. These intensity indicators measured R&D and extension expenditure as a proportion of farm value added, agricultural GDP, the total number of farms, the total population, the farm worker population and the total farm area; but the data about the smallholder components of these are either inadequate or absent (Liebenberg 2011 and personal communication).

These kinds of analysis perhaps help to reinforce, and certainly do not challenge, perceptions agricultural research and innovation constitute a singular *type* (or mode) of activity. Changes in the scale of this activity may be examined (e.g. in terms of expenditure or personnel), and changes in the system's broad organizational and governance arrangements may also be identified. But essentially the key structural characteristics of the innovation *process* are taken as given. Thus any questions about how the system might better address smallholder agriculture tend to concentrate on re-orienting greater quantities of R&D resources towards smallholder farming and on strengthening the links needed to deliver new technologies to it.

This kind of perspective also dominates policy documents. For example, *The Strategic Plan for South African Agriculture* of 2001 noted "the legacy of exclusion and discrimination in South African agriculture", but its section about research, education and extension said nothing about current imbalances and focused only on expanding the aggregate scale of expenditure these activities – planning to raise it as a proportion of agricultural GNP from 1.4 per cent to 3 per cent. Also, although it highlighted that the research system had in the past a "bias in favour of large-scale farmers", no specific element of strategy was proposed to redress that bias in future.

The later *National Agricultural Research and Development Strategy* (Department of Agriculture, 2008) was a little less narrowly focused. It noted, albeit briefly, the importance of such issues as: broadening access and participation (p.3), articulating the needs of the Second Economy (p. 4), and strengthening the demand side of agricultural research (p.5). However the broad overall concern was about the scale of the research system and its staffing, and its ability to contribute to aggregate growth in the economy. Neither the *Objectives* nor the *Guiding Principles* of the strategy identified issues specifically related to smallholder farming within the dual structure of agriculture.

However, there was one small exception to this overall emphasis. The *Strategy* was set in a perspective about delivering technologies to their users ("One of the greatest challenges in the research fraternity is getting the technologies to the farmers who need these most."- p iii). But there was also an explicit recognition that, if innovation was to contribute to sustained and equitable development, there would need to be different modes of innovation that depended much less on such delivery-focused processes:

"The traditional linear approach of researcher-extension agent-farmer or end user is limiting in the current South African farming system. *Other approaches, such as participatory action research and farmer-to-farmer learning are more appropriate*". (p.12, emphasis added)

The case studies in this paper explore that claim, and also aspects of the kinds of analysis and indicator development that might be needed to examine it more thoroughly and more extensively.

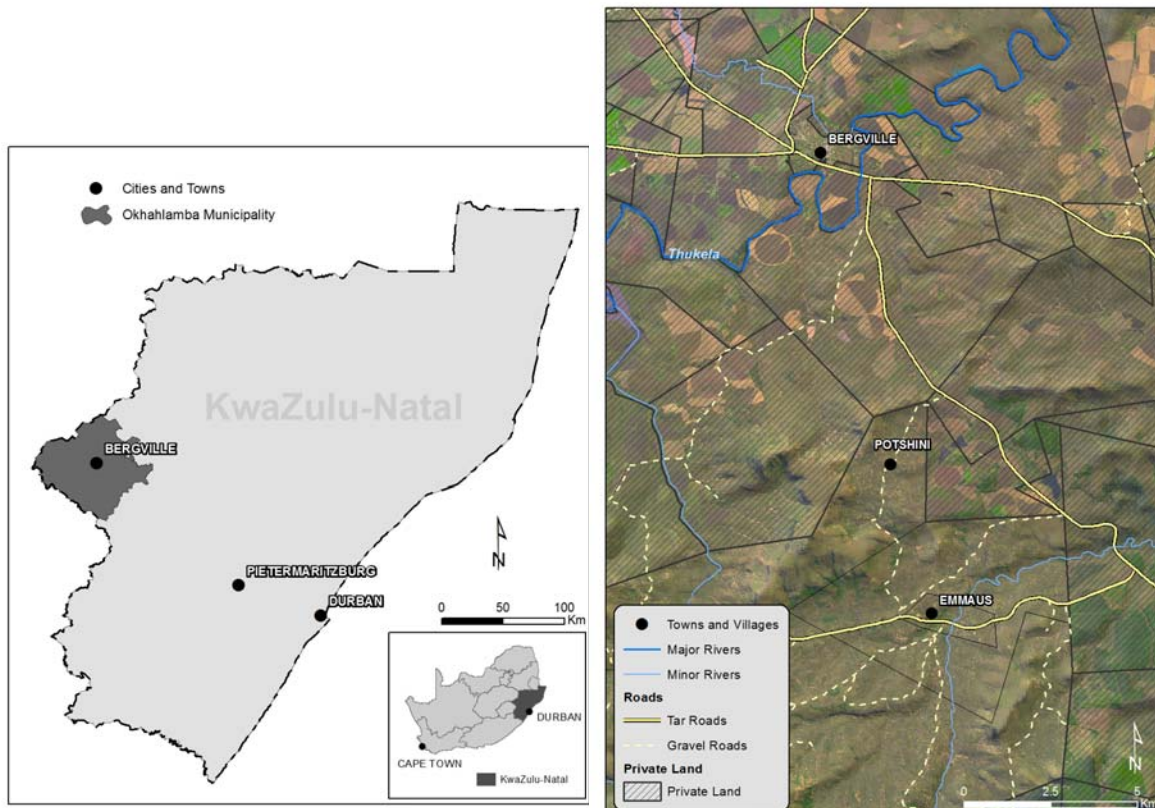
4.2 The Village Context: Potshini

Potshini, which falls within the Okhahlamba Local Municipality is a rural village situated approximately 25km from the closest town, Bergville (See Figure 4.1). It falls under the Greater Emmaus area, which was previously a Catholic mission and has a large government hospital. The area is characterized by high household densities, which in turn has resulted in small land allocations per household for cropping purposes. Livestock ownership includes cattle, goats and horses. Livestock graze on open access communal grazing areas, which are perceived by the local community to be too limited for the number of households, although

stocking densities are lower than in nearby former homeland areas (areas designated for settlement of black communities during apartheid).

Potshini is just one of four closely associated villages (the others are Nokopela, Mlimeleni and Nyonyana), which are bounded by commercial farms. These are large-scale operations that focus on wheat and maize in winter under irrigation, potatoes and maize in summer as well as sheep production.

Figure 4.1: Maps showing the location of the study site



Members of households living at Potshini rely on a range of sources of income, the largest of which is generally the government social grants which include old age pensions, child support grants and disability pensions. In addition, remittances from family members working in the large urban centres, casual (*togt*) work within the rural community and on the surrounding commercial farms, as well as formal employment as farm labourers on the commercial farms also contribute to sustaining households. Returns from agricultural activities in reality make a smaller contribution than other sources to the economic wellbeing of these rural households, though they do contribute to household food security and livestock plays an important role in dealing with unforeseen expenses such as funerals or medical needs.

Underlying these complex livelihoods, the population of Potshini faces the same dual challenge as most other smallholder communities in South Africa: HIV/AIDS and the migration of adults, especially adult males, to employment in distant urban areas. Consequently these communities demonstrate the paradox of shortages of important kinds of labour in a society with very high aggregate levels of unemployment. Typically, therefore,

this leaves older women having to carry a very large part of the agricultural (and other) labour burden required to sustain the family and its food security.

Agricultural activities within Potshini mainly include dryland maize and drybean production in the summer months when the majority of the rainfall is received. Some vegetable production takes place in home gardens, mainly for household needs, with small surpluses sold locally.

Before the initiatives examined in these case-studies, smallholder farmers in Potshini had already been involved with a number of different organizations and projects concerned with research and innovation activities. For example between 2000 and 2004 the Agricultural Research Council implemented a 'Landcare' project to introduce a range of practices and cropping patterns oriented towards soil conservation. In addition to this, at least two projects involving explicit 'participatory' approaches to changes in water use and management have been implemented. One was a water management monitoring project undertaken in the mid-2000s. This had involved a range of local stakeholders in the research, with considerable involvement by the Sivusimpilo Farmers Forum covering the Emmaus area (Rockström et al. 2004; Kongo et al. 2010). The other was concerned with developing and applying water use practices (e.g. in small gardens). This also appears to have engaged widespread involvement in the Potshini community (Sturdy et al. 2008).

4.3 The organizational context: PROLINNOVA and FAIR

The two cases examined in this paper are both associated with wider initiatives supported through a network called PROLINNOVA³⁸ - an international network of organizations that is active in some 20 countries throughout the developing world. The network promotes innovation processes and appreciates the role that local innovativeness can play in overcoming challenges faced by smallholder farmers and rural communities (Wettasinha and Waters-Bayer 2010).

PROLINNOVA has recognized that farmers have the capacities to conduct their own experiments and investigations, but also recognizes that these processes can be strengthened through creating linkages with other actors who can bring knowledge, new ideas or access to markets. PROLINNOVA-South Africa, the local arm of the network, has participated in a sub-programme of PROLINNOVA called FAIR ('Farmer access to Innovation Resources). FAIR is an action research initiative that has piloted the concept of local innovation support funds (LISFs) as vehicles for facilitating access to resources for supporting farmer experimentation. The initiative has been focused in the Okhahlamba District of KwaZulu-Natal. The two main support organizations involved with the FAIR project are Farmer Support Group (FSG), which is an outreach arm of the University of KwaZulu-Natal and SaveAct, a non-governmental organization that supports savings and credit-related initiatives. SaveAct and FSG have worked together to support technical, financial and institutional aspects of FAIR.

LISFs have been conceptualized as locally managed funds that community members can approach for support of local innovation processes. Thus they put funds in the hands of farmers or structures that directly represent farmers, so that they can support farmer experimentation not only with funds, but by establishing linkages with other actors such as markets, researchers and input suppliers. LISFs are a means of allowing farmers to define the

³⁸ PROLINNOVA is an acronym for 'promoting local innovation in ecologically oriented agriculture and natural resource management',

research agenda more effectively and participate in the development of improved technologies or systems of organization.

The FAIR project recognized the need to establish a local structure to manage the funds and also the need to strengthen the institutional environment/context in which innovation takes place. This led to the establishment of the Hlahlindlela Trust, which is the legal entity that manages the funds, and support to the Sivosimpilo Okhahlamba Farmers Forum (SOFF), which is a platform representing farmers from a number of different communities including those where FAIR is active. The SOFF had already been established in the area prior to the FAIR initiative.

The SOFF supports farmer-to-farmer sharing and encourages innovative behaviour. It has been effective in stimulating farmer experimentation as well as allowing for dissemination of the outcomes of the innovation / experimentation processes. Farmers with ideas for which they planned to apply to Hlahlindlela Trust for support are encouraged to first share their ideas at the SOFF meetings. The Hlahlindlela Trust members then facilitate discussions regarding compliance with criteria for receiving funding and if the idea is found to be satisfactory, then the innovator is encouraged to fill in an application form for submission to the Trust's screening sub-committee. The Hlahlindlela Trust has a number of sub-committees responsible for tasks such as screening applications (according to a set of criteria) and monitoring experimentation and other activities such as cross-visits, which are funded in order to encourage innovation.

The criteria for selecting innovations / experiments to be supported by the LISF include:

- Innovator has prior record of experience with food production, agriculture and/or natural resource management.
- Preferably innovator has some prior experience of innovation.
- The idea is technically, economically and institutionally feasible / acceptable.
- The idea is replicable amongst the poor and vulnerable.
- The innovator is able to meet the requirements for own contribution.
- The innovator is willing to share the results with others.

The team responsible for monitoring and evaluation not only monitors the experimentation processes, but also evaluates the outcomes of other activities (or learning events) The committee then provides feedback on progress at the HT meetings. FSG and other players have been supporting the M&E committee to conduct participatory evaluation. Generally experiments are monitored against the original objective, such as the performance of the crop or livestock. The level of commitment of the innovator is also assessed. The M&E team has also been provided with a digital camera to assist with monitoring the experimentation process. Photography is a method used in the community to document innovations, particularly relevant given the limited levels of literacy.

Though the functions of the HT are currently limited to implementation of the FAIR project, it is envisaged that it could fundraise for other community development activities and create an opportunity for community members to participate in buying of inputs in bulk. The Trust is not yet fully functional and still needs to improve a number of its roles such as reporting of meetings and monitoring of project activities.

4.4 The approach to the case-study research

FAIR supported a total of six innovation projects in 2009/10 (see Table 4.1). As indicated, these were individually quite small projects. The total cost of support for each was around R10,000 – R16,000 (E1000 – E1,600). Within this, the direct, project-specific costs were a small part of the total, except in the Cherry peppers case. These included inputs (such as seedlings and fertilizer) and some support in terms of transportation required, for example, for learning and exchange visits. The supplementary and indirect cost component, the last column in the table, was much more substantial. This covered the general facilitation and advice that FSG and other collaborating actors provided, and also the costs of supplementary experimentation directly related to the innovation.

Table 4.1 Grassroots innovation supported by fair in 2009/10

Innovator(s)	Description of the innovation supported	Direct Cost of support (Rands)	Supplementary/ Indirect Support (Rands)
1. Phuthumani and Walani Farmer Groups	<u>Cherry pepper trial</u> : Testing of a new cash crop, exploration of marketing opportunities and strengthening of relationship with neighbouring commercial farmer.	6,000.00	10,125
2. Sicelumusa Farmer Learning Group	<u>Green manure/cover crops</u> : Testing of different types of legumes (i.e. velvet beans, sun hemp, clover, cowpeas) as crops to be incorporated into the soil, and allowed to decompose for a given period before planting of the following crops.	1,468	11,400
3. Elakho-Ithuba Farmer Learning Group	<u>Livestock fodder supplements</u> : Testing the performance of various fodder species (lucerne, turnip and cocksfoot) for feeding milk cows in winter	834	9,351
4. Thabani Madondo	<u>Potato mulching practice</u> : Testing of a new method of planting potatoes under a layer of mulch against conventional tillage.	808	13,680
5. Khethiwe Hlongwane	<u>Planting vegetables in bags</u> : Test the performance of spinach grown in bags containing either compost or manure	975	12,375
6. Ellen Moloji	<u>Mole prevention in potatoes</u> : Investigating the use of corrugated iron to prevent mole damage by burying the iron and planting on top of it.	408.00	15,290

The two case studies explored here were selected from the group of six and were undertaken as small studies at a relatively early stage in the two innovation processes. Given the fairly limited steps into implementation of both cases at the time of the research, they were not intended as detailed evaluations but instead the aims of the research were more exploratory -

in two respects in particular: (i) to outline broad characteristics of innovative activities at the grassroots end of the typological spectrum discussed earlier, and (ii) to consider issues about policy-related evaluation and indicators that might be important both for this type of innovation and more generally for evaluation of participatory/grassroots modes of innovation at this stage in their development in South Africa.

Previous research by the authors provided considerable background information about the cases. In addition, interviews took place with the farmer innovators involved in both cases. In order to better understand the type of support required for these projects, interviews were held with members of the institutions that have been involved in the implementation of the FAIR programme, namely the Hlahlindlela Trust, which manages the funds, and the SOFF, which supports farmer-to-farmer sharing and encourages innovation.

The discussions with the smallholder farmers involved in each of the cases followed a common framework designed to trace, and elicit information about, the development of the projects through a sequence of phases: pre-existing conditions, origins and initial triggers, activities and linkages, commercialization (where relevant, outcomes and dissemination). Due to the informal nature of local innovation and joint experimentation, it was not easy to track the innovation processes, but the authors believe the information obtained provides an adequately accurate record of the main aspects in each case.

The discussions also helped in identifying indicators that could be used for two more detailed purposes: to measure the impact of grassroots innovation on livelihoods as well as indicators to quantify the extent to which farmer experimentation and local innovation was taking place in the community.

5 THE CASE STUDIES: MAIN FINDINGS

The main characteristics of each of the case studies are described here, but the discussion starts with comments on a set of circumstances that were common to both.

5.1 The demand for innovation support

An initial expectation underlying the FAIR initiative was that there would be a significant demand for funding and other support for autonomous, or at least farmer-led, projects in the community. To date, however, as reflected in the number of applications funded, the demand for support has been much lower than those expectations, despite the fact that the fund has been openly available to anyone within the community as long as the proposed idea is innovative enough to meet the criteria for support.

It is not clear why this has been so. On the one hand, the relatively low demand for support may stem from a relatively low incidence of autonomous innovative activity in the community, and hence a low demand for funding to support it. It is certainly the case that autonomous innovation by smallholder farmers is not a concept that has previously received much attention in South Africa in general; and in the specific context of Potshini one respondent - Thabani Madondo, a local farmer innovator – suggested that the pursuit of innovative solutions is not the most common response to problems: “Many people when faced with a problem just stop their production”. Consequently, those who were applying were only people who had an understanding of what constitutes innovative behaviour and, in Mr Madondo’s words: “those who have their own ideas about ways to solve problems they are

facing”. The limited demand for support might suggest that such people were relatively few and perhaps also that many previous research initiatives in the area were researcher-driven rather than farmer-led.

On the other hand, it may be that the issue was not about the low incidence of autonomous innovation *per se*, but about the demand specifically for *funding support* for such innovation. People are not accustomed to accessing funds for the sort of activities supported through LISF. They are familiar with applying for funds for items that they need for production (for example a pump or fencing), but not with funding instruments that assist with materials or support for experimentation or innovation. In addition, as suggested by Mr Madondo, there may be people with potentially eligible projects who do not apply because they do not want to share their ideas with the rest of the community.

Whatever the underlying reasons may have been, the limited demand for support for innovation (so far) highlights the importance of systems or platforms that are able to stimulate farmer experimentation. The SOFF, which was established with support from FSG to facilitate sharing between farmers, has proved valuable as such a mechanism. It has also allowed for effective sharing of the outcomes of joint experimentation processes supported by FAIR. Besides the cases that are presented to the SOFF by farmer innovators seeking funding support, the forum also provides an opportunity for sharing knowledge about innovations that do not require support from the LISF. This sharing of innovations appears to help farmers understand and develop solutions to their problems.

5.2 Case 1: Innovation in potato production

The innovator

Thabani Madondo is an active community member and farmer in Potshini. He is one of three leaders of SOFF and is also a member of HT. He has been experimenting with conservation agriculture and sustainable farming techniques and processes for nearly six years. Together with other farmers, he has worked with a number of organizations involved in several agricultural and community-based natural resource management activities, including those of the University of KwaZulu-Natal and the Agricultural Research Council. It appears that the cumulative learning and empowering effects of his involvement in other research initiatives, which have to some extent been of a participatory nature, may have played a role in Mr Madondo’s innovative nature. Alternatively, it could be that he has in fact become involved in these initiatives because he has an ‘enquiring mind’ and an interest in research.

Project origins and the triggers for innovation

During a visit from a pastor that took place during the earlier conservation agriculture initiative, Mr Madondo came across an idea of growing potatoes under mulch rather than using the conventional method of planting them in the soil. He was motivated to experiment with this method because he saw the challenges being experienced in his community because of the loss of the economically active sector of the population through HIV/AIDS or migration to the urban areas. In particular the trigger for pursuing the idea was the difficulties encountered by older women in ploughing the soil, managing the crop and digging to harvest it. In addition, women and children in rural areas often have to juggle a number of different chores and responsibilities. Freeing up time by making use of labour-saving technologies means that this time can be used for other household chores or for education-related activities such as studying or homework. Consequently he saw the alternative mulch-based method not as a way of transforming all potato production in the area but as a way of reducing the labour

requirements for growing potatoes in people's home gardens as a means of improving their food security.

Apart from the prospect of reducing labour requirement in this focused way, there were other potential benefits from the new technique. It offered a potential to build soil structure and improve soil fertility. Also, directly after plots have been harvested, they can be used to grow another type of crop, which also saves time. In addition, even without considering the impact of HIV/AIDS, women and children in rural areas often have to juggle a number of different chores and responsibilities. Freeing up time by making use of labour-saving technologies means that this time can be used for other household chores or for education-related activities such as studying or homework.

The research and experimentation

Mr Madondo conducted a small experiment on his own and concluded that the technique had much potential. Through another PROLINNOVA-South Africa initiative aimed at piloting joint experimentation processes, he developed a proposal to support this experiment. He then worked on the experiment with staff from another organization working in the area, Mahlathini Organics (see below) and FSG. The experiment compared the performance of potatoes grown using the two techniques, i.e. conventional planting and planting under a layer of grass mulch. Joint planning was done for experimentation and the innovator led the experimentation process. Mr Madondo had ideas about different depths of mulch and different materials to use for mulching. As described below, these plans and ideas evolved into a phase of experimental activities both within the village and in collaboration with a wider range of organizations. Beyond that initial phase, Mr Madondo has continued with a second phase of experimentation supported by FAIR. He is considering different planting times as well as different mulching materials.

The intention underlying this experimentation was obviously not initiated by the farmer to develop a radically novel type of innovation. Nor was it about developing an innovation that would be 'new-to-the-market' in South Africa. The idea was prompted by experience with this production method in Lesotho, but instead of 'adopting' a ready-made technology off the shelf, Mr Madondo decided to try the idea within the local context. He also had to do some 'guess work' as he had only received some fairly sketchy information about the production practice and had not seen it for himself. Moreover those gaps in knowledge do not seem to have been unknown only to the inhabitants of Potshini. The pattern of collaborative research with other actors outside the village, in particular researchers from the research station, suggests that the required knowledge for implementing this new practice was not readily available to others either. In other words this seems to have been something like a 'new-to-the-local-area' innovation that called for creating a significant amount of locally novel knowledge.

The development of links to complementary knowledge sources

Once Mr Madondo's own experimentation with the mulching practice was under way, a number of other actors were drawn in to contributing to the innovation process. The diversity of these contributors was striking. As noted above, Mahlathini organics became involved. This privately run organization, which provide rural development expertise, was already involved in water harvesting activities with Mr Madondo and other farmers in Potshini. Erna Kruger, a researcher from Mahlathini Organics, who supports farmers with technical knowledge related to crop production, provided technical support to the initiative and gave advice to the innovator regarding experimental design, data collection, record keeping and

monitoring. FSG facilitated linkages and collaboration in two broad ways. At the village level it facilitated the joint experimentation process and the sharing of experiences through the farmers' forum. At a wider level it also supported the development of links with knowledge sources outside the village. It facilitated the involvement of the researchers from the Provincial Department of Agriculture who are responsible for on-station and on-farm experimentation. As a result, the researchers replicated the experiment on the research station. Thereafter, FSG facilitated a cross visit to CEDARA, the research station of the KwaZulu-Natal Department of Agriculture, where the experiment was replicated on-station with additional treatments. This allowed for sharing of ideas and experiences which informed the farmer experimentation being undertaken in Potshini.

Outcomes of the innovation process

The first year of experimentation in 2008 revealed some interesting results, which would need to be confirmed by subsequent cropping seasons. In terms of productivity, the mulching practice resulted in a 26.7% reduction in yield, when compared with conventional production. The experiment showed that germination rates were lower with the mulched plots, which was thought to be responsible for the total weight of potatoes produced under mulch in October 2008 being 184.6kg, versus 252kg for those grown conventionally on a similar sized plot (Malinga et al. 2010). Mr Madondo believed this poor result was largely the result of the material used for mulching, which inhibited germination. He still believed that the benefit of the reduced labour requirement outweighed the reduction in yield and undertook to continue experimenting.

An effort was made to quantify the labour saving benefit of the mulching technique compared against conventional production (See Table 5.1). The comparison was based on a limited area as might be planted within a household garden (Approximately 48m² in area). Mr Madondo's estimate of labour requirements revealed that the mulching technique resulted in a 72.1% reduction in labour. In an effort to quantify these impacts, the reduction in yield and the reduction in labour were also expressed in monetary terms based on the area that was used to estimate labour requirements. Based on the proportional reduction in yield, a loss of 51kg (valued at some R179), would be almost offset by the reduction in labour, valued at R176 (at a rate of R8/hour – the current minimum wage). From this one starts to recognize that less conventional measures of 'success', such as the extent to which they reduce labour requirements may, under certain circumstances, be just as important to people as the issue of yield. The new method might well be preferable in the light of local priorities – something that might not have been apparent from simply examining yield changes with respect to general agricultural production.

Dissemination of the findings

Despite fact that the yield results were not as favourable as had been expected, Mr Madondo organized an information day to share the progress on the experiment with SOFF members who participated in the planting of the experiment. Having heard about the outcomes of Mr Madondo's experiment, four small-scale farmers from other locations went on to replicate the experiment, while another farmer innovator, Mr Mcijeni Mbhele, investigated ways to improve the system by making more efficient use of the mulch. In addition, after Cedara had conducted its on-station replications of the earlier village trials, it held an open day March 2009 to share the results with farmers from all over KwaZulu-Natal.

Table 5.1: Comparison of labour required for 48m² of potatoes

Conventional practice	Timeframe	Mulching practice	Time-frame
Manual 'ploughing'	8 hours	<i>Assume that the farmer has a source of dry bean residue for mulching</i> Collect the mulch	1 hour
Open furrows	2 hours	Lay the potatoes, Water the soil, Place the mulch (15cm), Water the mulch, Cover with a second layer of mulch (15cm), Water the mulch. <i>Assume no fertilizer is applied</i>	4 hours
Apply fertilizer / manure	20 minutes		
Cover with soil	5 minutes		
Place seed potato	5 minutes		
Cover seed potatoes	30 minutes		
Hand-weeding	2 hours	No weeding	0
Watering (if no rain)	1.5 hours every two weeks	Watering (if no use)	1.5 hours every two weeks
Ridge I	1 hour	No ridging	0
Weed (hand-hoe)	2 hours	No weeding	0
Ridge II	1 hour	No ridging	0
Hand-weed	4 hours	No weeding	0
Harvesting	8 hours	Harvesting	2 hours
TOTAL TIME	30.5 hours	TOTAL TIME	8.5 hours

5.3 Case 2: Introducing a new cash crop and a new marketing arrangement

The Innovators

In 2009, farmers who participate in the SOFF started discussions about the possibilities of growing new high value cash-crops rather than the more conventional crops such as maize and cabbages. One of the groups represented by the forum, the Walani Group, took the initiative forward by taking a field trip, funded by FAIR, to the Mkondeni Fresh Produce Market in Pietermaritzburg to get an idea of possible crops. Walani is a group of 9 smallholder farmers from Potshini that engage collectively in agricultural production. The Walani Group was formed by a group of farmers that had initially come together in 2001 to form a group called *Isixaxambiji* (which means 'pulling together'). Their main objective was to assist the community with farming activities, but ploughing in particular. They brought together their oxen and were thus able to help each other with draught power to till the land, moving the combined team of oxen from one farmer's field to the next on a rotational basis.

In this case there appears to be a direct connection between the collaborative activities of innovation process and the pre-existing form of collaboration. It seems likely that the prior experience played a role in how the innovation project developed.

Project origins and the triggers for innovation

Following the initial discussion and market visit, the more specific focus of the project was shaped by a discussion between one of the leaders of the farmers' forum and a commercial farmer whose land borders the community of Potshini. The commercial farmer suggested that the smallholders at Potshini should grow 'cherry peppers' (capsicums) that would be supplied to his processing facility - 'Natal Peppers', located at the town of Ladysmith about 100km away. Beyond the general incentive for diversifying into cash crops to generate higher

income in a more reliable market than was achievable with conventional crops, the key trigger for the Walani group was the insight and potential opportunity provided by this discussion with the neighbouring commercial farmer.

It was, however, probably also important that this idea of cherry peppers was not a total novelty for Potshini because some of the smallholder farmers in the village had previously worked as seasonal labourers on the farmer's property and had been involved in the production of the cherry peppers. One of them had even grown a few at home and brought a sample of the fruit to a meeting of the SOFF to share with other farmers. Following the interaction with the commercial farmer, the farmers at the forum then discussed how to explore the opportunity further and undertook to try out the production of the cherry peppers.

The research and experimentation

The Walani group wanted to experiment with the crop under their own circumstances to see whether it could be grown in their area. More specifically, they had three main objectives: (1) to test the performance and survival of the new crop under local conditions, (2) to explore marketing opportunities, and (3) to establish a positive working relationship with the neighbouring commercial farmer and thus to move beyond the 'employer-labourer relationship' that had previously existed (Also much of the interaction in the past had been confined to conflict over the illegal movement of animals from the community onto the commercial farm to find grazing). Thus the innovation process had two kinds of elements – not only technical, but also socio-organizational. Drawing on knowledge provided by the commercial farmer, field staff from FSG assisted the group with planting the crop and applying the fertilizer. While the Walani members managed the crop, for example applying topdressing fertilizer once the crop started fruiting and keeping the crop free of weeds, they were also involved in some adaptation of the planting practices. For example, they incorporated a change in row spacing in order to address the challenge of crop loss resulting from the fact that green peppers were knocked from the bushes during the harvesting process. They felt that by widening the inter-row space, this loss could be minimized. They have also lengthened the inter-row space (the space between plants within a row) as they believe that the initial spacing resulted into interference between plants at the fruiting stage.

Thus, as with the research involved in Case 1, this case was again not simply about adopting a fully 'ready-made' technology. The local experimentation involved more than just feasibility testing to raise confidence in the production technology itself, it also involved the exploration of several technical details that were thought important. In terms of the technical aspects, the experimentation seemed to involve developing understanding about a more limited range of 'unknowns' than in Case 1.

The development of links to complementary knowledge sources

External links to complementary knowledge sources were limited to interactions with the commercial farmer who assisted with the production aspects (technical expertise as well as physical inputs for the trials – such as containers for harvesting) and ultimately provided a market for the crop. Facilitated by the FAIR coordinator, Nomaphelo Shezi, the Walani members had access to the commercial farmer's expertise and markets. They also had an informal arrangement with an employee on the commercial farm who provided the farmers with cheap transportation for collection and delivery of the crop during the experimentation period. Although they did not expect it to be a major difficulty to make alternative arrangements if necessary, once commercial production started, this assistance was a useful

contribution during the testing phase when the farmers were unsure of how the new arrangement would work out.

Commercialization of R&D Results

The Walani group moved beyond the R&D phase and entered the market in the 2009/2010 season. They continued to grow cherry peppers in the 2010/2011 season at an increased scale of production, and with no further support from FAIR. In addition, a number of other farmers groups have also planted cherry peppers to supply to the factory in Ladysmith. In addition, some of the Walani members have extended the initiative further by collecting seed from their crop to produce their own seedlings at home and add a further income stream.

Outcomes of the innovation process

In summary, the innovation process has had three strands: (i) the introduction of a new crop (product innovation), (ii) the establishment of an improved relationship with the commercial farmer (socio-institutional innovation), and (iii) entry into a new supply chain (a marketing innovation). An effort was made to quantify the income generating potential of these linked innovations.

Discussion with the members of the group indicated that during the 2009/2010 growing season, they had supplied approximately 180 lugboxes (each holding some 12kg of fruit) from their 0.25 ha area. Taking costs into account they had made a profit of some R7,500 (approximately 750 Euro). Scaled up to a per-hectare basis, this translates into a gross margin of approximately R30,000 per hectare (approximately 3000 Euro). This is a substantially higher return than could be expected from maize or cabbage production - for example, it is more than twice as high as the standard gross margin (R13,436/ha) for cabbages in 2009/2010 (DAEARD 2010).

Dissemination of findings

Throughout the growing season, other farmer groups came to observe the development of the crop at various stages, while some assisted during the planting of the crop. Farmer-led field days, an innovation market and feedback provided at the SOFF meeting also allowed other farmers to share in the knowledge and experience generated by the experiment. This inspired other groups from different locations to replicate the experiment with technical assistance from the Walani farmers and the FSG team. In addition, a cherry pepper production manual has been compiled and translated into local language and will be shared with the SOFF members. Other Farmer Learning Groups have expressed an interest in growing the crop, which is likely to lead to wider spread of technology and sharing of experiences from the respective communities.

6 DISCUSSION: FROM CASE STUDIES TOWARDS POLICY ANALYSIS

6.1 Summary: The case-study observations

The case studies have described two examples of empowerment-oriented projects designed to foster grassroots innovation – a mode of innovation that has been much less commonly examined than other more functionally oriented types of participatory innovation. While the latter draw farmers into closer interaction with the formal research and extension system, primarily to increase its effectiveness, the two empowerment-oriented projects aimed to strengthen the informal innovation system and to develop its demand-driven knowledge-

sourcing links with the formal. The two studies illuminate five main aspects of the innovation activities in these projects.

- Together with the four associated projects in Potshini that were not examined, the two cases demonstrate that it was possible to identify a number of people in the Potshini community with interests in pursuing their own innovative activities and with latent capabilities to do so. Although the number who initially came forward to obtain support for such activities was unexpectedly low, the existence of these latent interests and capabilities seems consistent with arguments about the potential importance of projects that seek to empower and mobilize such untapped innovation resources.
- With facilitation and funding support, these interests in innovation led into significant experimentation and testing designed to generate not only technical understanding about potentially applicable technologies but also, in one case, to assess new marketing routes and develop new socio-institutional relationships. In the process of undertaking these kinds of experimentation, demand-led links to other sources of knowledge outside the community were developed.
- These activities addressed two kinds of challenge that are important not only in the Potshini community but more widely across other smallholder contexts: (a) the need to develop new income streams based on new market opportunities (the cherry peppers case), and (b) significant socio-economic problems associated with the livelihoods and food security of poor and disadvantaged groups (the potatoes case).
- In both cases the innovation activities led to outcomes with potentially significant beneficial consequences. These seem to have been clear in the cherry pepper case where substantial new income streams were generated as a result of introducing a new crop/product and developing supply links to new markets some distance from the village. In the other case, the positive outcomes were less clear in measurable economic terms (though there are prospects that they can be improved by continuing experimentation); but they also appear to include potentially significant benefits in terms of less visible impacts on family livelihoods and food security, especially for women and children.
- Beyond those fairly immediate benefits from the individual innovation *projects*, there were a few signs of incipient longer term transitions towards more continuous and cumulative innovation processes – though the short time-horizon of the study precludes clear comment on these empowerment effects at this stage.

These few observations obviously provide no basis for generalization about the effectiveness of this empowerment-oriented approach as a means of fostering innovation in smallholder settings. Nor is it possible to develop such a broad view of this approach by linking the observations reported in this paper to those in other reports about similarly empowerment-oriented projects. This is not because other observations are absent. There are quite a number in the literature that was reviewed in Section 3.2.³⁹ However, the heterogeneity of these studies, including this one, precludes meaningful synthesis to create a more aggregate and generalizable picture of the characteristics of these empowerment-oriented forms of grassroots innovation.

³⁹ For example there are several in Reij and Waters-Bayer (2001), especially in Part 5 (Stimulating and Supporting Joint Experimentation), and also in Sanginga et al. (2009a), especially in Parts IV (Local Innovation Processes) and V (Building Capacity for Joint Innovation).

It is even less possible to draw any *comparative* conclusions about the effectiveness of these kinds of empowerment-centred approach *relative to* either more conventional modes or more functional forms of participatory innovation, such those examined in the evaluative literature reviewed earlier in Section 3.3. Although that literature provides more systematic and comparable evidence about impacts, together with a typological framework within which to make such comparisons, and although the observations from this study can be located reasonably well within that typological framework, the limited extent of the analysis of impacts in this study precludes even a small-scale exploratory comparison.

So, in contrast to quite a lot of the disparate case study literature that was reviewed in Section 3.2, this study does not jump from its individual case observations to an argument for scaling up and mainstreaming support for grassroots-participatory innovation. Instead, taking into account the insights provided by the two kinds of literature reviewed in Section 3, as well as these case studies, it is argued that *questions* about scaling up and mainstreaming appear to deserve more serious attention than they have so far received. There *does* seem to be a case for much more systematic analysis of whether, how and in what circumstances greater resources should be allocated to foster forms of grassroots-participatory innovation. That question has implicitly been on the table for more than thirty years. But, the evidence and analysis needed to answer it has so far been inadequate, even in the case of the evaluative studies reviewed in Section 3.3.

Moving beyond those limitations will require new approaches in all three kinds of analysis and indicator development that have contributed to innovation-related policy analysis in other areas, as discussed earlier in Section 2. Possible steps in that direction are outlined later in the concluding Section 7. That follows a discussion of more detailed issues about policy analysis and indicator development that emerge from the case studies.

6.2 The Case Studies: Some more detailed implications

(i) Mapping the innovation process: types of innovation outputs

As discussed earlier in Section 2, the analysis of innovation in industrial contexts has long recognized the importance of differences in the ‘significance’ of innovations. This has led to various classification schemes, one of the most widely used of which is the Oslo Manual distinction between innovations that are new-to-the-world, new-to-the-market and new-to-the-firm. Distinctions along these lines have, however, been much less commonly used in analyses of innovation in agriculture – though, as noted earlier, the importance of this issue was recently recognized by one of the contributors to the emerging debate about widening the range of agricultural innovation indicators.

This issue matters because policy debate about the role of grassroots-participatory innovation should not be about alternatives to conventional modes of innovation that are generally applicable across all circumstances. It should be about different modes of innovation that are likely to have *complementary* roles to play in achieving *different kinds of innovation*, often in different kinds of context - as demonstrated by Biggs and Clay’s (1981) analysis of complementary formal and informal R&D systems, and also by experience in the industrial and service sectors of advanced economies.

The research in the two case studies therefore sought to identify the degree of novelty involved in the two innovations, and efforts were made to apply the Oslo manual distinctions

about new-to-market and new-to-firm. But this raised two kinds of problem that would need to be explored further before an Oslo-type approach could be applied in this type of research.

- It was not clear what should be taken as the relevant innovating entity. In principle, the ‘new-to-firm’ concept might be translated across to this context as ‘new-to-farm’. But in neither of the Potshini cases was a clearly identifiable farm the primary innovating actor. The notion of ‘new-to-village’ might instead have been used, but it was not entirely clear that this was the relevant entity either.
- Even though the innovations in both projects might be similarly classified as, say, ‘new to the local area’, there seemed to be a significant difference between them in the ‘degree of novelty’ they involved - as reflected in the wider range of new knowledge that had to be created as a basis for implementing the potato-mulch innovation compared to the cherry peppers case.

In other words, it may be important to develop for studies of grassroots-participatory innovation a more fine-grained set of distinctions around an agricultural equivalent of the new-to-firm/farm category.

(ii) Mapping the innovation process: Network links to knowledge sources

Over the last two or three decades growing recognition of the networked nature of the innovation process in industry and services has contributed to a shift in policy and management perspectives away from oversimplified linear models of knowledge flow running ‘from-R&D-to-application’. Underlying this general shift, extensive survey and case study data have shown that: (i) diverse kinds of sources are used, (ii) knowledge sources in centralized public organizations such as research institutes and universities are used much less frequently than previously thought, while other kinds of source, especially business enterprises, are drawn on much more frequently; and (iii) these patterns vary across different types of innovation.

However, questions about knowledge networks have been given much less attention in connection with agricultural innovation. This has been especially the case in developing country contexts where attention has focused heavily on the role of centralized organizations such as research institutes and university departments, and where the presumption has been that knowledge links in innovation run in a direct, innovation-delivering line from those organizations to supposedly non-innovating adopters of ready-to-use technologies.

That was not the picture in the two cases examined in this study. Although both of them involved links to sources of knowledge other than the Postshini actors directly involved in the innovation projects, two other features of the knowledge networks did not conform to the commonly expected pattern.

Firstly, there was significant diversity in the knowledge sources and only some were in the formal agricultural research and extension system, and then in only the potatoes case. Others included the pepper-processing firm (Natal Peppers) and a private sector rural development organization (Mahlathini Organics). This has implications for how one might develop more systematic understanding about such networks. In particular, types of survey that are designed to focus only on links with formal research and extension actors would not capture the role played by other kinds of actor in the types of innovation network involved in these

two cases. A more open-ended approach would be necessary to map this knowledge-sourcing dimension of the innovation process.

Second, in both cases the links were demand-driven in the sense that they emerged as a result of (often facilitator-supported) ‘pull’ by the prospective knowledge users. Moreover, the nature of this ‘user-pull’ took a particular form that does not match either of two commonly discussed kinds of farmer ‘demand’ for technology’.

- On the one hand, the pull did not consist merely of demand for a solution to a very broadly defined problem – for example for ‘labour-saving technology to enhance the livelihoods and food security of households headed by (older) women’. A technology had already been identified in the village as potentially relevant for playing such a role, and what was needed was something more specific.
- But on the other hand, the pull was not so specific that it constituted a demand for a ready-made package of immediately usable instructions (e.g. a recipe for growing potatoes in mulch). The viability of such a recipe in the specific context of the village remained much too uncertain for that – at least as far as the potential innovation implementers were concerned. Instead, the demand was for additional knowledge to resolve uncertainties about what would be viable in the local context, and then to *create* the needed recipe. Even in the cherry peppers case where a well-established technology was already in use in the region, additional knowledge and learning about the technology and market was needed, and this required local experimentation based in part on knowledge inputs from external sources.

In other words it was *the process of innovation itself* that generated the ‘pull’ on external sources of complementary knowledge inputs. Thus it was the fostering of innovation that led to links, not the fostering of links that led to innovation.

(iii) Assessing Impacts: Cumulative transformation

Assessing the impact of empowerment-focused innovation projects presents considerable difficulties beyond those associated with assessing the impact of projects involving functional modes of participatory innovation. This is because of the difference in emphasis on the impacts aimed for.

- On the one hand, a large part of the argument for shifting towards increased use of functional modes of innovation centres on the impact of *individual innovation projects or steps*. The underlying proposition is that, in comparison with more conventional modes, functional forms of participatory innovation are likely to result in technologies that are better adapted to, and hence more likely to be adopted in, smallholder-type contexts. Evaluative studies can legitimately focus on those kinds of impact and, as shown earlier in Section 5.3, such studies have provided growing empirical support for this proposition about impacts.
- On the other hand, as discussed earlier in this paper, an important thread in the argument about undertaking ‘empowering’ modes of innovation goes beyond this focus on the gains from individual innovation steps. It is about stimulating a broader and cumulative intensification of innovative activity within smallholder production. This is about increasing the likelihood that individual instances of innovation will be linked into cumulative trajectories of successive innovation steps.

Neither of the case studies sheds much light on these longer term issues – though there was perhaps a glimpse of such a cumulative thread emerging in the step from producing and marketing cherry peppers themselves to the production of cherry pepper seedlings that could potentially reduce reliance on the external source of planting material. This gap is not surprising given the very short time scope of the study running forwards from the concept initiation and R&D phases of the innovation projects. But the case studies do prompt *questions* about this issue – in two groups.

- One group relates *prospectively* to planning and managing empowerment-focused projects. For example: what can one realistically expect by way of cumulative transformation - what kinds of change over what timescales? How do these cumulative transformations evolve and what factors seem to influence them? Hence, what might be done within empowerment-centred projects to increase the probability of more positive trajectories of change?
- The other is more concerned with the *retrospective* evaluation of impacts - for example: what dimensions of cumulative transformation of innovative activity would reflect this kind of empowerment impact? How would one recognize, classify and ‘measure’ them? How would one attribute them to inputs into particular empowerment-focused activities?

The importance of understanding these issues then prompts questions about how to design the necessary research. This is a significant problem because, as in the case studies reported here, analysis of the impacts of innovation projects and programmes is usually set within time boundaries that preclude the observation of long-term cumulative transformations. Consequently, different kinds of organizational and funding arrangements for longer term monitoring of impacts is likely to be needed if understanding about these issues is to be generated.

(iv) Assessing inputs: Initiation and facilitation

The analysis of inputs to innovation has come to rest overwhelmingly on data about inputs to knowledge-creation activities that are summarized as technological R&D (usually measured in terms of expenditure, but sometimes also in terms of the number of people involved). This focus has been widely accepted for analysis across the industrial, services and agricultural sectors.

However, as discussed earlier in Section 2, it has become increasingly well recognized over the last two decades, at least with reference to innovation in industry and services, that this is an excessively narrow perspective and that there is a much wider range of important inputs to innovation. In part these include institutional and organizational inputs, rather than those focused on the technology itself. But also, even with respect to specifically technological inputs, conventionally measured R&D covers only a fraction of what is involved. Omissions include activities lying ‘downstream’ from R&D that act either as a critically important link to the implementation of R&D-based innovation or as the originating source of knowledge for innovations that do not draw on any inputs from R&D.

However, in the domain of agricultural innovation, the inadequacy of measured R&D as an indicator of the technology-related inputs to innovation has been less well recognized. That raises similar problems to those in the industrial domain. In particular, although activities

lying downstream from R&D (e.g. formally organized extension) are often taken into account, informally organized activities providing inputs to innovation are not – in particular knowledge-creation activities undertaken as ‘informal R&D’ by farmers themselves, especially resource-poor smallholder farmers. Consequently, where such unmeasured informal R&D has been important, as in the case studies reported here and in all the other studies of farmers’ innovative activities, analyses of the gains from innovation would be attributed as returns to only the formal R&D component of total R&D – so inflating the apparent returns to that kind of R&D and obscuring the returns to other kinds.

The case studies discussed here also raise questions about another kind of input that may be particularly important in empowerment-type modes of innovation. This is about the initiation and facilitation activities needed to mobilize and strengthen latent innovation interests and capabilities for innovation. In part this may take the form of facilitating support *during* the course of farmers’ R&D activities - in principle a measurable cost of carrying out the R&D. But it may also be an input to innovation that lies ‘*upstream*’ from R&D as normally defined and measured – a prior empowerment investment that creates the conditions for local R&D. Both forms were significant in the Potshini cases:

- *During* the innovation projects, the Local Innovation Support Fund (LISF) and the Farmer Support Group (FSG) facilitated the farmers’ interactions with other actors and their exposure to more structured innovation processes.
- But also, with the low initial demand for innovation funding, a *prior phase* of support was important. The FSG played a substantial role in establishing the farmers’ forum (SOFF) and facilitating other activities that seem to have been necessary to stimulate innovative activity and assist in formulating proposals submitted to the LISF.

Thus simply providing funding for farmers’ innovation activities themselves (e.g. to cover costs of purchasing inputs and materials required for experimentation and testing) would almost certainly not have led to the course of events that was observed. But it seems very unlikely that the costs of these types of activity, especially the up-front mobilising and facilitating type, would be captured in conventional R&D surveys. Yet they would need to be accounted for in assessing the costs of such projects, and their reduction over time might be an important reflection of the extent to which projects of this type contribute to sustained trajectories of cumulatively ‘self-starting’ innovation.

Given their apparent importance, it may be useful to reflect further on the costs of the up-front mobilising- and facilitating-type activities that contributed to creating a conducive environment for R&D on Potshini. In some respects these appear to be very similar to the training, human capital development, and social capital building that have been discussed in the evaluation studies of participatory modes of innovation.⁴⁰ However the intensity and cost of these activities may have to be greater in the type of empowerment-centred projects examined here. Then, it may also be thought that the intensity of such *empowerment*-centred projects, and hence their overall cost, may have to be greater in contexts like South African

⁴⁰ They are also similar in principle to the facilitation roles that are widely discussed in the innovation system literature in connection with the importance and theoretical ‘legitimacy’ of policy measures to overcome ‘system failures’ (and not just market failures) in the innovation process.

where, as expressed by Vink and van Zyl (1999), smallholder agriculture has been subject to a long, cumulative process of *disempowerment* - a multi-dimensional process that encompassed the human, physical and social capital components of innovation capability.

(v) The roots of grassroots innovation: 'Initial conditions' and their history

Most of the case study literature about grassroots-participatory innovation has given scant analytical attention to the issue of initial conditions and their influence on innovation activities. But, alongside intra-project issues such as the participatory methods used or the behaviours of individual participants, initial conditions are likely to play a major role in shaping both the way innovation projects develop and the nature of their outcomes and impacts.

That was probably relevant in the cases examined here where the course of events may have been influenced by the fact that, when the PROLINNOVA/FAIR project started in Potshini, the village already had a considerable stock of experience of innovation projects involving local experimentation, with some of these explicitly organized in 'participatory' modes. One might speculate therefore that Potshini was significantly atypical in this respect: how many other rural communities of about 650 smallholder households in South Africa have experienced a decade of continuous involvement in such innovation or experimentation schemes? Correspondingly, how likely is it that the events reported about these two projects would be replicated in similar projects extended more widely?

This study alone does not provide a basis to answer those questions. But it does provide a stimulus to reflect on the importance of understanding initial conditions and their history in the development of future case-study research in this area. Such understanding may be valuable in at least two ways.

- Understanding longer-term cumulative transformations in innovative activities does not depend solely on monitoring changes over sufficiently long periods *after* the implementation of empowerment-centred projects. Valuable insights may also be generated by looking back to periods *before* such projects in order to examine the origins of their initial conditions. For example, with reference to the Potshini potato-growing case, it would be illuminating to know whether and how Mr Madondo's previous involvement with ARC-led research into no-till crop production had not only stimulated his interest in the alternative potato production method but also helped to build his capacity to engage in informal experimentation?
- Understanding about the history of innovation activities that precede innovation projects is also important for interpreting the results from evaluation studies of the impacts of those projects because it is necessary to establish the counterfactual basis for evaluation – the path that would have been followed without the empowerment project. In the case studies reported here it was not possible to develop that basis very clearly, and it is correspondingly unclear whether the observed innovation activities constituted the continuation of a past trajectory or a substantial departure from it. Given Mr Madondo's previously established personal learning trajectory, the former is quite possible. But the latter seems more likely in the light of the initially limited demand for innovation support, combined with the substantial scale of facilitation support that was needed to stimulate the activities.

While much is unclear about the initial conditions and history underlying these cases, the importance of the issues involved seem clear enough to warrant one general conclusion about the future development of case-study research in this area. Even if the observations from such research continue to be stacked up for another thirty years, they will contribute little to understanding about either the process or the impacts of non-conventional modes of innovation unless much more attention is given to questions about the initial conditions underlying the observations. And that attention will need to be systematic in developing compatible information and standardized indicators in ways that permit cumulative comparison.

7 CONCLUSIONS AND NEXT STEPS

7.1 Conclusions

The combination of case studies and literature reviews in this paper permits three broad conclusions about grassroots-participatory innovation in smallholder farming contexts.

1. There is inadequate evidence to provide support for policy and management decisions about the allocation of resources to these modes of innovation – either collectively as a group of closely related ‘non-conventional’ ways of innovating, or more narrowly with respect to particular functional or empowerment modes within that group.
2. However, there is enough evidence to suggest that much more serious attention should be given to addressing policy- and management-oriented questions about those resource allocation decisions - in particular: should these ways of achieving agricultural innovation in smallholder contexts be supported by more ‘mainstreamed’ and increased resource allocation? If so, which modes of innovation are likely to prove most effective in achieving which kinds of outcome in which kinds of context?
3. A necessary part of the “serious attention” that should be given to such questions is the development of a much better base of analysis and indicators designed to inform and influence policy and management decisions about resource allocation to support grassroots-participatory modes of innovation.

The second of those conclusions merits a little elaboration in order to clarify the basis for moving to the third - in particular: what is the evidence about? That can be summarized under three headings.

- (i) *Effectiveness in research and innovation.* There appear to be prospects that, compared with more conventional approaches, these modes of innovation (in some kinds of context and with respect to some types of innovation) might generate technologies that are better adapted to local agronomic/ecological conditions and more closely matched to social and economic needs and demands - and hence more likely to be adopted more rapidly. Depending on circumstances and on other factors impinging on the relevant impact pathways, these innovation outcomes could contribute to higher income growth and poverty reduction, greater food security, and increased environmental sustainability.

- (ii) *Efficiency in the use of research and innovation resources.* There also appear to be prospects that, in the same kind of comparison and subject to the same qualifications, these grassroots-participatory approaches, rather than adding to the existing costs of equivalent kinds of research and innovation, might reduce them by (i) accelerating the process of innovation and hence shortening the duration of projects, (ii) reducing the incidence of unproductive research routes into ‘dead ends’ with non-adoptable outputs, and (iii) substituting at the margin other contributors to the innovation process (e.g. farmers) for scarce and expensive research scientists and extension agents.
- (iii) *Overall innovation system strengths.* Beyond those prospects of increased effectiveness and efficiency at the level of individual projects, programmes and organizations, there are also longer-term prospects that increased use of these modes of innovation would strengthen broader innovation systems. That is: with (i) a greater diversity of modes of innovation, (ii) a shifted balance towards more decentralized and more autonomous innovation activity at farmer/community level, and (iii) a wider portfolio of stronger links between different system actors and different complementary modes of innovation, it is likely that innovation systems would have more robust and flexible capabilities to address the innovation-demanding challenges and opportunities associated with achieving socio-economic change in contexts of rising environmental stress and global technological developments.

The quality of evidence underlying the first two of these arguments falls along a spectrum from ‘marginally convincing’ to ‘pretty thin’, and in the case of the third it might be described as ‘largely theoretical’. But that does not mean the arguments have no basis at all and should be ignored. That would be too cavalier in a world that is looking for research and innovation to contribute more effectively to meeting the needs of smallholder agricultural communities on the basis of formally organized research and innovation resources that are already scarce in most contexts and becoming scarcer in many.

Instead, the arguments deserve to be more closely examined. That then focuses attention on the third conclusion – about taking steps to strengthen the base of knowledge needed to inform policy and management in this area. Before turning to discuss in the next section what some of those steps might be, two points of general clarifications may be useful.

The first centres on the notion of ‘knowledge needed to inform policy and management’. The emphasis here is on policy and management concerned with broad aspects of resource allocation to these modes of innovation, both in general and with reference to specific types of grassroots-participatory innovation in particular kinds of smallholder context. Consequently, no comment is made here about important types of analysis and indicator development required to inform more detailed aspects of ‘management’ – e.g. about organizational arrangements and methods used in implementing grassroots-participatory activities. The kinds of analysis needed there were described earlier as ‘internally’ oriented, especially towards feedback and learning within implementing organizations, and they would include the kinds of evaluation that are designed to inform decision making that is ‘internal’ to those organizations. This kind of analysis remains important, and a considerable amount of it already takes place – for example within the case-study literature reviewed earlier in Section 3.2. That should continue, preferably being extended, refined and made more comparable across organizations and situations. The point made here is that it needs to be

supplemented by a substantial body of work that is ‘externally’ oriented to inform and influence ‘mainstream’ decisions about resource allocation to areas and types of research and innovation, and those are usually made ‘outside’ the project/programme implementing organizations.⁴¹

The second point is about the role of analysis in informing such decisions. It is certainly important to bear in mind the literature that urges caution in expecting policy-oriented analyses to lead directly to impacts on policy. For example, one study of the role of ex-post impact assessments has suggested they have limited direct effects on donors’ decisions about resource allocation to international agricultural research (Raitzer and Kelley 2008). However that study also drew attention to the more indirect ways in which evaluation studies appear to influence policy decisions and the conceptual frameworks within which they are taken:

“... the primary pathways of influence are indirect and involve incremental improvement to the general understanding of programme functions and as justification for decisions taken on the basis of a range of considerations. Such conceptual influence usually involves combining evaluation findings with other forms of relevant information.” (p.198)

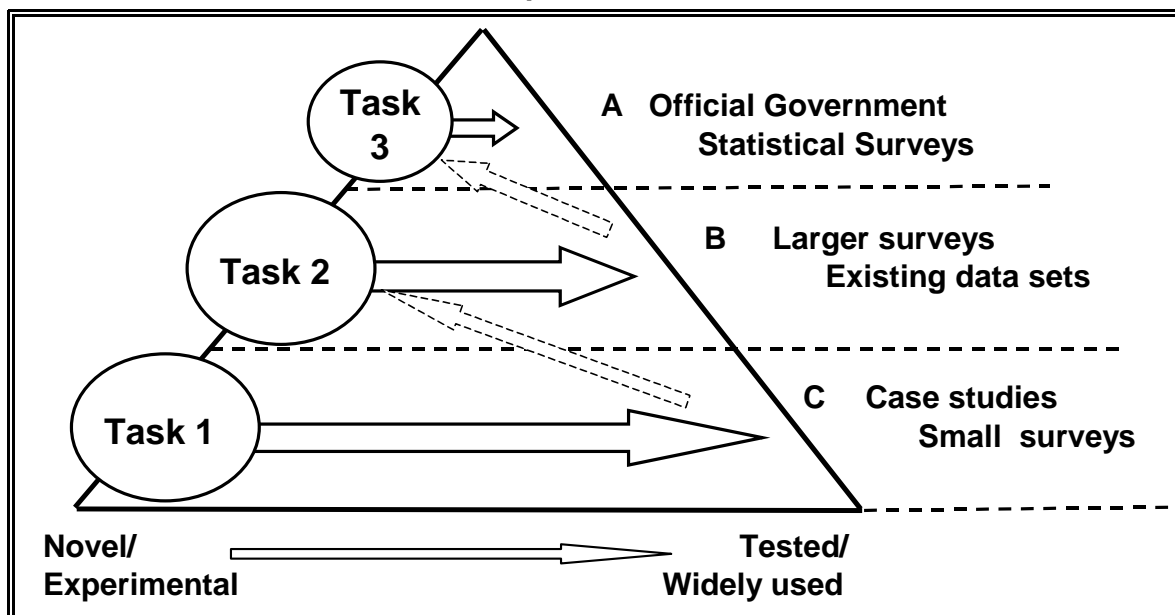
That kind of broader and incremental influence on policy-makers’ perceptions, achieved by a mixture of evaluative and other information, seems particularly pertinent. Given the scant consideration currently given to grassroots-participatory innovation in the policy domain, the issue to be addressed is not about influencing decisions that are already highly placed on decision-making agendas. It is much more about shifting questions about these modes of innovation on to policy makers’ radar screens, and then about moving their visibility upwards on decision agendas.

7.2 Some next steps

An important component of analysis in this area would involve developing a body of accepted indicators about aspects of grassroots-participatory innovation. But that does *not* mean that a first step, or even a particularly important step in the near future, should be about developing indicators based on data collected in large-scale surveys by or for government agencies. There is very little basis for such ‘Level A’-type indicator development, even if there existed a convincing argument for it. Instead, as illustrated in Figure 7.1, the main tasks are concerned with building up through Levels C and B in the iceberg structure discussed earlier in Section 2. That involves dealing with indicator development as an integral part of undertaking various kinds of case-study and survey analysis. Within that the initial primary challenge is probably at the case study level – Level C.

⁴¹ In very large organizations (for example the CGIAR as a whole or its larger associated institutes) the inside/outside distinction may not be clearly linked to the distinction between resource allocation and the management of organizational arrangements and methods.

Figure 7.1 Grassroots-Participatory Innovation in Agriculture: Some Steps in the Further development of Innovation Indicators



Source: Bell (unpublished)

Task 1 – Case studies and small surveys (Level C)

The main requirement here is to develop ways of undertaking these kinds of study so that their results are much more consistent and comparable than in the past, and hence capable of being cumulated and aggregated to allow increasingly generalizable observations and understanding. Moving horizontally to the right across the iceberg in Figure 7.1, work could then be undertaken to develop sets of indicators to reflect important features of grassroots-participatory innovation activities. That horizontal path across Figure 7.1 has conceptual and organizational dimensions.

The conceptual dimension is concerned with developing a consensus around core frameworks or models that capture what are thought to be the more important features of grassroots-participatory modes of innovation. These frameworks would need to be extended to include impact pathways within which evaluative studies could be focused along common lines. At the most basic level, a framework for case studies might be no more than a list of topics along the lines of, but probably not the same as, the headings used earlier in the case study descriptions in Section 5. More usefully, that would be developed to provide a basis for exploration and experiments with different forms of indicators. In principle it would probably be important to build up a portfolio of indicators that are consistent with the basic components of indicator systems already used elsewhere for other kinds of innovation in other contexts – e.g. along the lines of the categories used earlier in Table 2.1: *inputs* to innovation, the *actors* involved, the innovation *process*, the *outputs* from that process, and the wider *impacts and consequences*; and perhaps adding *initial conditions* and their *history*.

The organizational dimension is concerned with how one would arrive at consensus around such frameworks, models, categories and specific indicators. These need not constitute restrictive straightjackets.⁴² But to be useful they do need to be reasonably widely accepted as minimum cores for a substantial body of case study work, with variations *around* them being not merely possible but desirable as a necessary part of continuing experimentation. Arriving at such accepted cores requires at an early stage some kind of forum within which as many as possible of the main current funders, implementers and analytical observers of grassroots-participatory modes of innovation can work to build a consensus.

Questions about organization, and also about research design, are raised by two of the large gaps in the current body of case-study work in this area. One of these gaps arises because some of the important impacts of grassroots-participatory innovation, especially the more empowerment-centred approaches, only evolve over relatively long periods of time, requiring impacts to be observed over correspondingly long periods. That in turn requires ways of designing, organising and funding studies that differ from most of the arrangements currently used. For example, aspects of the methodology of cohort studies used in other fields might be useful – involving intermittent (rather than continuous) longitudinal studies of the same subjects over long time periods.

The second gap has been left by the dominant (or exclusive) focus of past studies on grassroots-participatory innovation activities that have been embedded in projects undertaken by research institutes, NGOs and other bodies. This leaves a gap in understanding about the characteristics of innovation at the right hand end of the typological framework discussed earlier in Section 3 – the fully decentralized ‘farmer only’ type of innovation. Case studies of innovation in such situations will be invaluable in understanding the potential and the ‘added value’ of projects designed to move to the left across the typology towards empowerment-centred grassroots modes of innovation – and also about the constraints they face. Again, discontinuous longitudinal (cohort) study designs might be invaluable in this area.

Task 2 – Larger surveys (Level B)

It will also be important to develop surveys designed to illuminate general features of grassroots-participatory innovation on the basis of much simpler and selective sets of variables. These are likely to be particularly useful in two areas. The first is about mapping the resource *inputs* to these modes of innovation more extensively than can be achieved by the accumulation of case studies - even if these are designed to be much more compatible and comparable than in the past. This mapping would be a supplement to existing surveys of ‘formal’ R&D (and extension) inputs to ‘conventional’ modes of innovation. In effect the aim would be to bring resource inputs to ‘informal’ innovation (both grassroots-participatory and ‘farmer-only’) within the same kind of framework as the Frascati Manual has provided for ‘formal’ agricultural R&D. This should then allow the relative scales of resource allocation to ‘conventional’ and ‘non-conventional’ modes to be identified and publicized.

⁴² Also, the development of common frameworks does not imply homogeneity in the purposes and scope of studies. For example, not all case-study work will be designed to address the whole spectrum of issues at similar depths, or even at any depth – for example, covering *initial conditions, inputs, actors, innovation processes, outputs, and wider impacts and consequences*. In particular, it is likely that evaluation and impact assessing types of study are likely to deal with outputs and impacts in much more detail than other kinds of case study.

But, although that kind of comparative aim would be important, such surveys could not conceivably be conducted initially on anything like the same scale as conventional R&D surveys. There are considerable difficulties about definitions and operational feasibility to be resolved before anything like that that can be considered. The requirements are consequently for small-scale exploratory and experimental surveys; and these might focus, for example, on particular agricultural R&D organizations, particular programmes. One might then move on to examine more comprehensive R&D and extension systems, not at the national level but at the level, for instance, of individual provinces.

The second possible area for survey-centred work within Task 2 would be about aspects of the innovation *process* – in particular on the innovators, their knowledge sources and their innovation outputs. These are the main types of data collected under the Oslo Manual framework for surveys of innovation in manufacturing and service industries, and would therefore be able to serve similar purposes. For example, they could shed light on the incidence of different kinds of innovators and different types of innovation, and their distribution across different contexts; and they could illuminate the types of knowledge sources and networks used in innovation in different situations. In principle also, in the same way that Oslo-type data have been used to distinguish different modes of innovation and situations where they appear to be more and less effective in industry and services, data about these characteristics of grassroots-participatory and also conventional modes of innovation could be synthesized and grouped to discriminate broadly between different modes of agricultural innovation and the circumstances in which they appear to be more and less effective – either individually or in playing complementary roles.

In other words, just as the first type of survey work would seek to bring ‘informal’ agricultural *R&D* within a Frascati-type framework, so this second type would seek to bring informal agricultural *innovation* within an Oslo-type framework. But again, this second type of survey work could not conceivably be conducted initially on anything like the same scale as conventional Oslo-type innovation surveys. Explorations and experiments focused on samples of much smaller populations of farming ‘entities’ would be needed – not least to identify what kind of farming entity would be the most appropriate survey unit.

Task 3 - Official government surveys (level C)

As suggested above, before any activity can usefully be developed at this level, it will be necessary to build a solid base of understanding and tested practice at Levels B and C in the iceberg structure. Nevertheless there is perhaps one area of experiment and exploration that might be opened up. This starts from a view that it may never be feasible to conduct Oslo-type surveys systematically across total national populations of farming ‘entities’. The costs might be prohibitive until farming has been consolidated into a very much smaller number of larger enterprises. Reliance would therefore have to be placed on surveys of samples of selected sub-national populations (e.g. in districts or different agro-ecological zones).

It might therefore be worth exploring whether *highly simplified* mini-surveys of agricultural innovation could be added to existing widespread surveys such as Household or Labour Force surveys. Aspects of the feasibility of such ‘piggy-back’ approaches could be explored and tested on a standalone basis in *very* small experiments – very small in both sample sizes and numbers of questions.

While, of course, questions arise about funding and organizational support for pursuing these three kinds of tasks, attempting to answer them lies beyond the scope of this paper. However,

there are several reasons for thinking that such an approach should be pursued in South Africa: the key one is perhaps the social, economic and political significance of the smallholder sector in the country, and the need to find effective ways to improve the livelihoods of rural communities, which can be achieved at least partially through participatory-grassroots innovation processes.

ACKNOWLEDGMENTS

The authors thank the UNU-MERIT project team, Martin Bell, Fred Gault, Michael Kahn, Mammo Muchie and Watu Wamae for their support and comments.

The Institute of Natural Resources (INR), in partnership with the Farmer Support Group (FSG), the outreach arm of the University of KwaZulu-Natal, explored the cases of grassroots innovation in agriculture that were supported by a sub-programme of ProInnova, an international network that promotes local innovativeness in overcoming challenges faced by smallholder farmers and rural communities.

REFERENCES

Alene, A., Y. Yigezu, J. Ndjeunga, R. Labarta, E. Andrade, A. Diagne, R. Muthoni, F. Simtowe and T. Walker (2011), Measuring the effectiveness of agricultural R&D in Sub-Saharan Africa from the perspectives of the varietal output and adoption: Initial results from the diffusion of improved varieties in Africa Project, Conference Working Paper 7, ASTI/IFPRI-FARA Conference, Accra, Ghana.

Aliber, M. and T.G.B. Hart (2009), Should subsistence agriculture be supported as a strategy to address rural food insecurity?, *Agrekon*, Vol.48 (4), pp. 434 – 458.

Anderson, J.R. (2007), Agricultural advisory services. Background paper for the World Development Report 2008.

http://siteresources.worldbank.org/INTWDR2008/Resources/2795087-1191427986785/Anderson_AdvisoryServices.pdf, Accessed March 13, 2012.

Ashby, J. (2009a), Fostering Farmer First methodological innovation: organizational learning and change in international agricultural research, in I. Scoones and J. Thompson (eds) (2009) *Farmer first revisited: Innovation for agricultural research and development*, Rugby: Practical Action Publishing.

Ashby, J. (2009b), The impact of participatory plant breeding; Chapter 25 in S. Ceccarelli, E.P. Guimarães and E. Weltzien (eds) (2009), *Plant breeding and farmer participation*, Rome: UN Food and Agriculture Organization.

Ashby, J. A. and N. Lilja (2004), Participatory Research: Does it work? Evidence from Participatory Plant breeding in Proceedings of the 4th International Crop Science Congress: 'New directions for a diverse planet'; 26 Sept – 1 Oct, Brisbane Australia, www.cropscience.org.au. Accessed March 13, 2012.

ASTI (2009), Agricultural Science and Technology Indicators (ASTI) Initiative: Summary report of the consultation workshop on identifying supplementary indicators, Entebbe, Uganda. Agricultural Science and Technology Indicators, Washington, DC: International Food Policy Research Institute.

Baldwin, C., C. Hienerth and E. von Hippel (2006), How user innovations become commercial products: A theoretical investigation and case study, *Research Policy*, Vol. 35, (9): 1291-1313.

Beintema, N. and G-J Stads (2011), African Agricultural R&D in the new millennium: Progress for some, challenges for many, Washington DC: International Food Policy Research Institute.

Bell, M. (1979), The exploitation of indigenous knowledge, or the indigenous exploitation of knowledge: What use of what for what? *IDS Bulletin*, Vol. 10 (2), 44-50.

Belshaw, D. G. T and N. Hall (1972), The analysis and use of agricultural experimental data in Tropical Africa, *East African Journal of Rural Development*, 5, Vol. 5, pp. 39-71.

Biggs, S. D. (1980), Informal R&D, *Ceres*, July-August 1980, 23-26.

Biggs, S. D. and E.J. Clay (1981), Sources of innovation in agricultural technology, *World Development*, Vol. 9 (4), 321-336.

Biggs, S. D. (1989), *Resource-poor farmer participation in research: A synthesis of experiences from nine national agricultural research systems*; International Service for National Agricultural Research, On-Farm-Client-Oriented Research, OFCOR-Comparative Study paper No. 3; The Hague, Netherlands: OFCOR [Later incorporated in IFPRI].

Biggs, S. (2008), The lost 1990? Personal reflections on a history of participatory technology development, *Development and Practice*, Vol. 18, (4-5), pp. 489-505.

Biggs, S. and Farrington, J. (1991), *Agricultural research and the rural poor: A review of social science analysis*, Ottawa: International Development Research Centre.

Brammer, H. (1980), Some innovations don't wait for experts: A report on applied research by Bangladeshi peasants, *Ceres*, Vol. 13 (2), pp. 24-26.

Botha, C. A. J. (1999), Democratising South African agricultural extension services. Chapter 14 in J. Kirsten J. van Zyl and N. Vink, *Agricultural democratisation in South Africa*, Cape Town, South Africa: African Institute for Policy Analysis and Economic Integration.

Brooks, S., J. Thompson, H. Odame, B. Kibaara, S. Nderitu, F. Karin and E. Millstone (2009), *Environmental change and maize innovation in Kenya: Exploring pathways in and out of Maize*; STEPS Working Paper 36, Brighton: STEPS Centre.

Burns, T. and G.M. Stalker (1961), *The management of innovation*, London: Tavistock Publications.

Ceccarelli, S., E.P. Guimarães and E. Weltzien (2009), *Plant breeding and farmer participation*, Rome: UN Food and Agriculture Organization.

Ceccarelli, S., S. Grandio, M. Singh, M. Michael, A. Shikho, M. Al Issa, A. Al Saleh, G. Kaleonjy, S.M. Al Ghanem, A.L. Al Hasana, H. Dalla, S. Basha and T. Basha (2003), A methodological study on participatory barley breeding II. Response to Selection, *Euphytica*, 133: 185-200.

Chambers, R. (ed.) (1979), Rural Development: Whose knowledge counts? *IDS Bulletin*, Vol. 10(2).

Chambers, R., A. Pacey and L.A. Thrupp (eds) (1989), *Farmer first: Farmer innovation and agricultural research*, London: Intermediate Technology Publications.

Chambers, R. (2009), Foreword; in I. Scoones and J. Thompson (eds) (2009) *Farmer first revisited: Innovation for agricultural research and development*; Practical Action Publishing, Rugby.

Chipeta, S. (2006), *Demand-driven agricultural advisory services*, Lindau, Switzerland: Neuchâtel Group, (Swiss Center for Agricultural Extension and Rural Development).

Clark, N. (2002), Innovation systems, institutional change and the new knowledge market: Implications for Third World agricultural development, *Economics of Innovation and New Technologies*, Vol. 11 (4-5), 353-368.

Collier, P. (2008), The politics of hunger, *Foreign Affairs*, Vol. 87 (6): 67-80.

Daane, J., J. Feancis, O. Oliveros and M. Bolo (2009), Performance indicators for agricultural innovation systems in the ACP region: Synthesis report, Wageningen, The Netherlands: The Technical Centre for Agricultural Innovation System Performance.

DAEARD (2010). KwaZulu-Natal COMBUD budgets for horticultural crops 2009 / 2010, Pietermaritzburg: KwaZulu-Natal Department of Agriculture, Environmental Affairs and Rural Development.

Department of Agriculture (2008), *National Agricultural Research and Development Strategy*, Pretoria, South Africa: National Department of Agriculture.

Douthwaite, B. (2002), *Enabling innovation: A practical guide to understanding and fostering technological change*, London: ZED Books.

Douthwaite, B., J.D.H. Keatinge and J.R. Park (2001), Why promising technologies fail: the neglected role of user innovation during adoption; *Research Policy*, Vol. 30, (5): 819-836.

Drimie, S., T. Ggermishuyse, L. Rademeyer and C. Schwabe (2009), Agricultural production in Greater Sekhukhune: The future for food security in a poverty node of South Africa?; *Agrekon*, Vol. 48 (3), pp. 245 – 275.

Feder, G., J.R. Anderson, R. Birner and K. Deininger (2010), Promises and Realities of Community-Based Agricultural Extension, IFPRI Discussion Paper 00959, Washington DC:

International Food Policy Research Institute.

Franke, N. and S. Shah (2003), How communities support innovative activities: an exploration of assistance and sharing among end-users; *Research Policy*, Vol. 32, (1): 157-178.

Franke, N. and E. von Hippel (2003), Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software; *Research Policy*, Vol. 32 (7): 1199-1215

Freeman, C. (1988), Japan, a new national system of innovation, in G. Dosi, C. Freeman, R. Nelson, G. Silverberg and L. Soete (eds), *Technical Change and Economic Theory*, London: Pinter Publishers.

Gault, F. (2010), *Innovation Strategies for a Global Economy: Development, Implementation, Measurement and Management*, Cheltenham: Edward Elgar and Ottawa: IDRC.

Hall, A. (2009), Challenges to strengthening agricultural innovation systems: Where do we go from here? In I. Scoones and J. Thompson (eds) (2009) *Farmer first revisited: Innovation for agricultural research and development*; Rugby: Practical Action Publishing.

Hall, A., R.V. Sulaiman, N. Clark and B. Yoganand (2003), From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research, *Agricultural Systems*, Vol. 78, 213-241.

Haverkort, B. J. van der Kamp and A. Waters-Bayer (eds) (1991), *Joining Farmers' experiments: Experiences in participatory technology development*, London: Intermediate Technology Publications.

Hayami, Y. and S. Yamada (1991), *The Agricultural development of Japan: A century's perspective*, Tokyo: University of Tokyo Press.

Hazell, P., C. Poulton, S. Wiggins and A. Dorward (2007), *The future of small farms for poverty reduction and growth*. 2020 Discussion paper No. 42; Washington DC: International Food Policy Research Institute.

Hazell, P., C. Poulton, S. Wiggins and A. Dorward (2010), The future of small farms: Trajectories and policy priorities, *World Development*, 38 (10), pp. 1349-1361.

IFPRI (2005), *The future of small farms: Proceedings of a research workshop*; Washington, DC: International Food Policy Research Institute.

Jayne, T. S., D. Mather and M. Mghenyi (2010), Principal challenges confronting Smallholder Agriculture in Sub-Saharan Africa, *World Development* Vol. 38, (10), pp. 1384-1398.

Jensen, M. B., B. Johnson, E. Lorenz and B-A Lundvall (2007), Forms of knowledge and modes of innovation, *Research Policy*, Volume 36, (5), pp.680-693.

Johnson, N., N. Lilja and J.A. Ashby (2001), Characterising and measuring the effects of incorporating stakeholder participation in natural resource management research: analysis of

research benefits and costs in three case studies. Participatory Research and Gender Analysis (PRGA), Working Document No. 17, Cali, Columbia: PRGA-Centro Internacional de Agricultura Tropical (CIAT).

Johnson, N., N. Lilja and J.A. Ashby (2003), Measuring the impact of user participation in agricultural and natural resource management research, *Agricultural Systems*, 78: 287-306.

Kirsten, J. and W. Moldenhauer (2006), Measurement and analysis of rural household income in a dualist economy: The case of South Africa, *Agrekon*, Vol. 45 (1), pp. 60 – 77.

Klerkx, L. and C. Leeuwis (2008), Institutionalizing end-user demand steering in agricultural R&D: Farmer levy funding of R&D in The Netherlands; *Research Policy*, Vol. 37, (3): 460-472.

Kongo, V. M., J.R. Kosgei, G.P.W. Jewitt and S. A. Lorentz (2010), Establishment of a catchment monitoring network through a participatory approach in a rural community in South Africa, *Hydrology and Earth System Sciences*, 14, 2507-2525.

Labrada, H. R. (2009), Participatory seed diffusion: experiences from the field, in S. Ceccarelli, E.P. Guimarães and E. Weltzien (2009), *Plant breeding and farmer participation*, Rome: UN Food and Agriculture Organization.

Leakey, C. L. A. (1970), Heterogeneous agricultural populations, *Agricultural Progress*, 45, Vol. 45, pp. 34-42.

Liebenberg, F. (2011), South African Agricultural Production and Investment Patterns, in E. Ball and K. Fuglie, *Proceedings of the ERS-Farm Foundation Conference on “The Causes and Consequences of Global Agricultural Productivity,”*, May 12-13, 2010, Washington, DC: CABI.

Liebenberg, F., N.M. Beintema and J.F. Kirsten (2004), South Africa, ASTI Country Brief No. 4; Agricultural Science and Technology Indicators Initiative, Washington, DC: International Food Policy Research Institute, Washington.

Liebenberg, F., P.G. Pardey and M. Kahn (2011), South African agricultural R&D investments: Sources, structure, and trends, 1910-2007, *Agrekon*, Vol. 50 (2), pp. 1-26.

Lilja, N. and J.A. Ashby (1999), Types of participatory research based on locus of decision making. Participatory Research and Gender Analysis (PRGA) Working Document No. 6. Cali, Columbia: PRGA-Centro Internacional de Agricultura Tropical (CIAT).

Lilja, N. and M. Bellon (2006), Analysis of participatory research projects in the International Maize and Wheat Improvement Center. Mexico, D. F.: CIMMYT.

Lilja, N. and J. Dixon (2008), Responding to the challenges of impact assessment of participatory research and gender analysis, *Experimental Agriculture*, 44: 3-19.

Lipton, M. (2010), From policy aims and small-farm characteristics to farm science needs, *World Development*, Vol. 38 (10): 1399-1412.

Lundvall, B.-Å. (ed.) (1992), *National systems of innovation: Towards a theory of innovation and interactive learning*, London: Pinter Publishers.

Lüthje, C., C. Herstatt, and E. von Hippel (2005), User-innovators and “local” information: The case of mountain biking; *Research Policy*, Vol. 34, (6): 951-965.

Malinga, M., T. Madondo, E. Kruger and B. Letty (2010), Farmer’s own and joint research on alternative ways to grow potatoes in South Africa, in C. Wettasinha and A. Waters-Bayer (eds), *Farmer-led Joint Research Experiences of ProInnova Partners*, Silang, Cavite, Philippines: IIRR / Leusden: ProInnova International Secretariat, ETC EcoCulture, pp. 13-21.

Matlon, P. J. (2009), Foreword; in P.C. Sanginga, A. Waters-Bayer, J.N. Kaaria and C. Wettasinha (eds) (2009), *Innovation Africa: Enriching farmers’ livelihoods*; London: Earthscan.

Nelson, R. R. (ed.) (1993), *National innovation systems: A comparative analysis*, New York and Oxford: Oxford University Press.

Nelson, R. (2008), What enables rapid economic progress: What are the needed institutions? *Research Policy*, vol. 37, 1-11.

Nelson, R. and B.N. Sampat (2001), Making sense of institutions as a factor shaping economic performance, *Journal of Economic Behaviour and Organisation*, Vol. 44, 31-54.

NEPAD (2006), African Science, Technology and innovation Indicators (ASTII) – Towards African Indicator Manuals: A Discussion Document, Pretoria: New Partnership for Africa’s Development, www.nepadst.org/doclibrary/pdfs/iastii_jun2006.pdf. Accessed March 13, 2012

Norman, D. W. (1974), Rationalising mixed cropping under indigenous conditions: The example of Northern Nigeria, *Journal of Development Studies*, 11 (1), 3-21.

OECD (1963,) *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Development*, Paris: Organisation for Economic Cooperation and Development.

OECD (1992), *OECD Proposed Guidelines for Collecting and Interpreting Technological Innovation Data: Oslo Manual*, Paris: Organisation for Economic Cooperation and Development, Paris.

OECD/Eurostat (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, Paris: Organisation for Economic Cooperation and Development.

Okali, C., J. Sumberg and J. Farrington (1994), *Farmer participatory research: Rhetoric and reality*; London: Intermediate Technology Publications.

Oliveira, P. and E. von Hippel (2011), Users as service innovators: The case of banking services; *Research Policy*, Vol. 40, (6): 806-818.

- Ortmann, G. F. and R.P. King (2011), Research on agri-food supply chains in Southern Africa involving small-scale farmers current status and future possibilities. *Agrekon*, Vol. 49 (4), pp. 397 – 417.
- Pauw, K. W. (2007), Agriculture and poverty: Farming for food or farming for money?; *Agrekon*, Vol. 46 (2), pp. 195 – 218.
- Pavitt, K. (1984), Sectoral patterns of technical change: Towards a taxonomy and a theory; *Research Policy*, Volume 13 (6), pp. 343-373.
- Probst, K. and J. Hagmann, J. (2003), Understanding participatory research in the context of natural resource management – Paradigms, approaches and typologies, Network Paper No. 130, London: Agricultural Research and extension network, Overseas Development Institute.
- Raitzer, D. A. and T.G. Kelley (2008), Assessing the contribution of impact assessment to donor decisions for international agricultural research; *Research Evaluation*, Vol. 17 (3), pp. 187-199.
- Reij, C. and A. Waters-Bayer (eds) (2001), *Farmer innovation in Africa: A source of inspiration for agricultural development*, London: Earthscan Publications.
- Richards, P. (1985), *Indigenous agricultural revolution: Ecology and food production in West Africa*, London: Hutchinson.
- Rockström, J., C. Folke, L. Gordon, N. Hatibu, G. Jewitt, F. Penning de Vries, F. Rwehumbiza, H. Sally, H. Savenije, R. Schulze (2004), A watershed approach to upgrade rainfed agriculture in water scarce regions through Water System Innovations: an integrated research initiative on water for food and rural livelihoods in balance with ecosystem functions; *Physics and Chemistry of the Earth*, Vol. 29: 1109-1118.
- Sandrey, R. and N. Vink (2008), Trade and innovation project – Case study 4: Deregulation, Trade reform, and innovation in the South African Agriculture Sector; Trade and Agriculture Directorate, Trade Committee Working Party, Paris: Organisation for Economic Cooperation and Development.
- Sanginga, P. C., A. Waters-Bayer, J.N. Kaaria and C. Wettasinha (eds) (2009a), *Innovation Africa: Enriching farmers' livelihoods*; Earthscan, London.
- Sanginga, P. C., A. Waters-Bayer, J.N. Kaaria and C. Wettasinha (2009b), Innovation Africa: Beyond rhetoric to praxis, in P.C. Sanginga, A. Waters-Bayer, J.N. Kaaria and C. Wettasinha (eds) (2009a) *Innovation Africa: Enriching farmers' livelihoods*, London: Earthscan.
- Scoones, I. and J. Thompson (eds) (1994), *Beyond farmer first: Rural people's knowledge, agricultural research and extension practice*, London: Intermediate Technology Publications.
- Scoones, I. and J. Thompson (eds) (2009), *Farmer first revisited: Innovation for agricultural research and development*, Rugby: Practical Action Publishing.
- Slaughter, S. (1993), Innovation and learning during implementation: a comparison of user and manufacturer innovations; *Research Policy*, Vol. 22, (1): 81-95.

Spielman, D. J. and R. Birner (2008), How innovative is your agriculture? Using innovation indicators and benchmarks to strengthen national agricultural innovation systems; Agriculture and Rural Development Discussion Paper 41, Washington, DC: The World Bank.

Spielman, D. J. and D. Kelemework (2009), Measuring agricultural innovation system properties and performance: Illustrations from Ethiopia and Vietnam; IFPRI Discussion paper 00851, Washington, DC: International Food Policy Research Institute.

Sturdy, J. D., G.P.W. Jewitt and S.A. Lorentz (2008), Building an understanding of water use innovation adoption processes through farmer-driven experimentation; *Physics and Chemistry of the Earth*, Vol. 33: 859-872.

Sulaiman, V. R (2009), Farmer first or still last? Uneven institutional development in the Indian agricultural innovation system, in I. Scoones and J. Thompson (eds) (2009) *Farmer first revisited: Innovation for agricultural research and development*; Rugby: Practical Action Publishing.

Tether, B. S. and A. Tajar (2008), The organisational-cooperation mode of innovation and its prominence amongst European service firms, *Research Policy*, Vol. 37 (4), pp. 720-739.

Thompson, J. and I. Scoones (1994), Challenging the populist perspective: Eural people's knowledge, agricultural research, and extension practice, *Agriculture and Human Values*, Vol. 11, (2-3), pp. 58-76.

Vink, N. and J. van Zyl (1999), Black disempowerment in South African Agriculture: A historical perspective, in J. Kirsten, J. van Zyl and N. Vink, *Agricultural democratisation in South Africa*, Cape Town, South Africa: African Institute for Policy Analysis and Economic Integration.

Vink, N. and J. van Rooyen (2009), *The economic performance of agriculture in South Africa since 1994: Implications for food security*; Development Planning Division Working paper Series No. 17, Midrand, South Africa: Development Bank of South Africa.

von Hippel, E. (1976), The dominant role of users in the scientific instrument innovation process, *Research Policy*, Vol. 5, (3): 212-239.

Wettasinha, C and A. Waters-Bayer (2010), Introduction, in C. Wettasinha and A. Waters-Bayer (eds) *Farmer-led Joint Research Experiences of Prolinnova Partners*, Silang, Cavite, Philippines: IIRR / Leusden: Prolinnova International Secretariat, ETC EcoCulture, pp. 1-4.

Wiggins, S., J. Kirsten and L. Llambí (2010a), The future of small farms, *World Development*, Vol. 38 (10): 1341-1348.

Wiggins, S., J. Kirsten, L. Llambi, T. Walker, J. Ryan and T. Kelley, T. (eds) (2010b), The Future of Small Farms, Including Special Section: Impact Assessment of Policy-Oriented International Agricultural Research; Special Issue, *World Development*; Vol. 38, (10): 1453–1526.

World Bank (2007), *World Development Report 2008: Agriculture for development*; Washington, DC: International Bank for Reconstruction and Development/The World Bank.

The UNU-MERIT WORKING Paper Series

- 2012-01 *Maastricht reflections on innovation* by Luc Soete
- 2012-02 *A methodological survey of dynamic microsimulation models* by Jinjing Li and Cathal O'Donoghue
- 2012-03 *Evaluating binary alignment methods in microsimulation models* by Jinjing Li and Cathal O'Donoghue
- 2012-04 *Estimates of the value of patent rights in China* by Can Huang
- 2012-05 *The impact of malnutrition and post traumatic stress disorder on the performance of working memory in children* by Elise de Neubourg and Chris de Neubourg
- 2012-06 *Cross-national trends in permanent earnings inequality and earnings instability in Europe 1994-2001* by Denisa Maria Sologon and Cathal O'Donoghue
- 2012-07 *Foreign aid transaction costs* by Frieda Vandeninden
- 2012-08 *A simulation of social pensions in Europe* by Frieda Vandeninden
- 2012-09 *The informal ICT sector and innovation processes in Senegal* by Almamy Konté and Mariama Ndong
- 2012-10 *The monkey on your back?! Hierarchical positions and their influence on participants' behaviour within communities of learning* by Martin Rehm, Wim Gijsselaers and Mien Segers
- 2012-11 *Do Ak models really lack transitional dynamics?* by Yoseph Yilma Getachew
- 2012-12 *The co-evolution of organizational performance and emotional contagion* by R. Cowan, N. Jonard, and R. Weehuizen
- 2012-13 *"Surfeiting, the appetite may sicken": Entrepreneurship and the happiness of nations* by Wim Naudé, José Ernesto Amorós and Oscar Cristi
- 2012-14 *Social interactions and complex networks* by Daniel C. Opolot
- 2012-15 *New firm creation and failure: A matching approach* by Thomas Gries, Stefan Jungblut and Wim Naudé
- 2012-16 *Gains from child-centred Early Childhood Education: Evidence from a Dutch pilot programme* by Robert Bauchmüller
- 2012-17 *Highly skilled temporary return, technological change and Innovation: The Case of the TRQN Project in Afghanistan* by Melissa Siegel and Katie Kuschminder
- 2012-18 *New Technologies in remittances sending: Opportunities for mobile remittances in Africa* Melissa Siegel and Sonja Fransen
- 2012-19 *Implementation of cross-country migration surveys in conflict-affected settings: Lessons from the IS Academy survey in Burundi and Ethiopia* by Sonja Fransen, Katie Kuschminder and Melissa Siegel
- 2012-20 *International entrepreneurship and technological capabilities in the Middle East and North Africa* by Juliane Brach and Wim Naudé
- 2012-21 *Entrepreneurship, stages of development, and industrialization* by Zoltan J. Ács and Wim Naudé
- 2012-22 *Innovation strategies and employment in Latin American firms* by Gustavo Crespi and Pluvia Zuniga
- 2012-23 *An exploration of agricultural grassroots innovation in South Africa and implications for innovation indicator development* by Brigid Letty, Zanele Shezi and Maxwell Mudhara