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EDITED BY

Patrick Meyfroidt,
Université Catholique de
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REVIEWED BY

Shalander Kumar,
International Crops Research Institute
for the Semi-Arid Tropics
(ICRISAT), India
Ximena Rueda,
University of Los Andes, Colombia

*CORRESPONDENCE

Brigid Aileen Letty
bletty@inr.org.za

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A critical comparative review of evidence on alternative instruments for supporting research and innovation in agri-food systems in the Global South

Brigid Aileen Letty^{1*}, Tim G. B. Hart^{2,3}, Simone Murugan¹,
Theolin Naidoo¹, Sharad Rai⁴, Djibril Thiam⁵, Joshua Zake⁶,
Sershen¹ and Irene Annor-Frempong⁷

¹Institute of Natural Resources, Pietermaritzburg, South Africa, ²Human Sciences Research Council, Pretoria, South Africa, ³Department of Sociology and Social Anthropology, Stellenbosch University, Stellenbosch, South Africa, ⁴Innovations Development Partners, Kathmandu, Nepal, ⁵Agribio Services, Thiés, Senegal, ⁶Consultant, Kampala, Uganda, ⁷Forum for Agricultural Research in Africa (FARA), Accra, Ghana

Financial support is a critical enabling factor for healthy agri-food innovation systems, particularly within resource-limited settings, though additional forms of support are also necessary. This motivated a critical comparative review of evidence in peer-reviewed and gray literature on the range of instruments that support innovation in agri-food systems in the Global South, toward achieving sustainable agriculture intensification. The main aim is to provide recommendations to innovation managers on the choice of different instruments for supporting innovation. The key guiding questions for the comparative analysis were whether the instrument fosters uptake of innovation and whether it promotes inclusive development. A review of the literature was supplemented with a scan of websites for sources of peer-reviewed and gray literature documenting the application of the 12 selected instruments. The study revealed three categories of instruments: (Type A) those that support entrepreneurship; (Type B) those that primarily finance innovation; and (Type C) those that support innovation in real-life contexts. Our analysis indicates that innovation managers and funders need to select instruments that are likely to fit the specific context as well as to address the mandates of their organizations, and in so doing, they must consider how to ensure the sustainability of their investments and meet the needs of their beneficiaries. This review represents one of a handful that have compared the use of multiple instruments across multiple continents in the Global South, and can serve as an important decision-making tool for investors and funders looking to invest in agri-food innovation systems.

KEYWORDS

agriculture, innovation systems, inclusive development, decision support, evidence

Introduction

The human population in the Global South is expected to increase by 2.4 billion by 2050, coupled with a 60% increase in food demand (Fróna et al., 2019). Since smallholder farms (i.e., <5 ha in size) account for 53% of food calories produced globally (Samberg et al., 2016), it is critical that research and innovation processes lead to the development and uptake of new technical and non-technical solutions that are appropriate for these smallholder farmers. However, financial and other forms of support are critical enabling factors for creating healthy agri-food innovation systems, particularly within limited resource settings characteristic of the Global South. The need to further understand the relevance of different instruments, and related factors for their success, motivated this critical comparative review of peer-reviewed and gray literature on the range of instruments that have been used to support innovation in Global South agri-food systems, where an innovation is a new or improved solution to a need or problem (Cooke et al., 2021).

The traditional linear technology transfer model has limitations in terms of its effectiveness in promoting the uptake of technologies and innovations. Linear approaches fail to account for complexity within the agri-food system, do not deliver on outcomes, or result in unsustainable project interventions (Hellin, 2012). Furthermore, they often exclude users from the innovation process and do not address their priorities adequately (Glover et al., 2019). There is, therefore, a need for a more user-centered approach in the form of alternative instruments that support innovation processes based on user needs, resources and priorities. The potential for adopting instruments that include co-development processes involving different development partners is also important in addressing the problem (Kaimowitz, 1990; Kavoi et al., 2014). These processes require the participation of stakeholders to ensure ownership and learning from experience, and should draw on multiple sources of knowledge so that interventions are designed appropriately for a particular context (Butler et al., 2017; Brookfield Institute, 2018; Devaux et al., 2018).

The aim of this study is to provide recommendations to innovation managers about alternative instruments and their effectiveness in ensuring the uptake of innovations, as well as in supporting inclusive development where structural factors such as gender, race, ethnicity and other social categories do not exclude certain groups (van Gent, 2017). We used two key guiding questions for the comparative analysis (relative to the traditional linear transfer model):

- Does the instrument foster the uptake of innovations?
- Does the instrument promote inclusive development?

Methodology

Starting with an extensive list of documented mechanisms that have been used to support innovation in the broad field of agriculture, we eliminated those we perceived to be tools or approaches—*tools* being means to fulfill a task, and *approaches* being paradigms that inform the way that development or research is done (de Koning et al., 2021)—leaving a list of 12 instruments. We developed a data collection framework prior to reviewing literature and gathering information. In gathering data we used a mixed-methods approach that included quantitative and qualitative strategies.

The examination of peer-reviewed material, which focused on agricultural innovation rather than on research and development (to identify innovative approaches), relied largely on searches of various databases of prominent scientific journals for the period 2010 to 2020 using the search engine EBSCOhost and the following search string:

agricultur AND innovat* AND challenge fund OR farmer innovation fund OR innovationgrant OR prize OR award OR insurance OR innovation platform OR innovation hub OR farmer research network OR living lab OR farmer field school OR incubator OR accelerator OR results-based contract OR broker OR intermediar**

This search was supplemented with searches on SAEpublications, Sage, JSTOR and Academia.edu and the original search string was also modified to include the term *research*. The team also made use of forward and backward linkages from literature to expand the body of articles reviewed. It should be highlighted that the selection of sources/information for review was purposive in terms of focusing on the list of pre-selected instruments and thus also included literature as far back as 2003 for some older instruments.

The EBSCOhost search returned 2,105 items, of which 721 were found to relate to innovation support and involved the use of the instruments identified during the inception phase. Additional online articles, gray literature (such as project reports), and peer-reviewed articles were also screened. A total of 115 items comprising peer-reviewed and gray literature were finally included in the review and the project database.

The nature of instruments that support innovation

The review of literature showed that the instruments are very diverse and some had been used across different sectors outside of agriculture, such as water and sanitation services (Trémolet, 2015; McNicholl et al., 2020). To facilitate

a comparative evaluation of the 12 identified instruments and assist with decision-making by potential users, those with similar characteristics and functions were grouped into three types. Type A are instruments that support entrepreneurship; Type B are instruments that primarily finance innovation (this excluded conventional financing instruments such as loans); and Type C are instruments that support innovation in real-life contexts (where users are operating). There are differences within and across instrument types in terms of the extent to which they support inclusive innovation and outscaling of innovations. There are also differences among the types of instruments in terms of where in the agricultural sector and along the innovation continuum they are most relevant, as shown in [Figure 1](#). The innovation continuum is based on the definitions of [Organisation for Economic Cooperation Development/Statistical Office of the European Communities \(OECD/Eurostat\) \(2005\)](#). Brief descriptions of the 12 instruments, as well as some examples of where they have been used, are provided below to support the discussion.

Instruments that support entrepreneurship (type A)

Incubators create, nurture and develop new enterprises, thereby improving their chances of success ([OECD European Commission, 2019](#)). They can also bring new technologies, products and business models to the market by linking universities, research, enterprises and the market ([Hjortso et al., 2017](#)). Two such programs in Africa include BioInnovate Africa and UniBRAIN (Universities, Business and Research in Agricultural Innovation), while the Villgro Incubator is an example from India ([InfoDev, 2011](#)). Accelerators, such as the Grow Impact Accelerator in Singapore, are instruments that provide short-duration support to early-stage ventures to speed up their growth ([Cohen S. et al., 2019](#)). Innovation hubs, such as the Campos dos Goytacazes Innovation Hub in Brazil ([UNESCO, 2019](#)), are generally recognized as physical co-working spaces for entrepreneurs working with technology at an early stage of development ([Jiménez and Zheng, 2021](#)), although most aim to create sustainable enterprises ([Beesabathuni et al., 2021](#)).

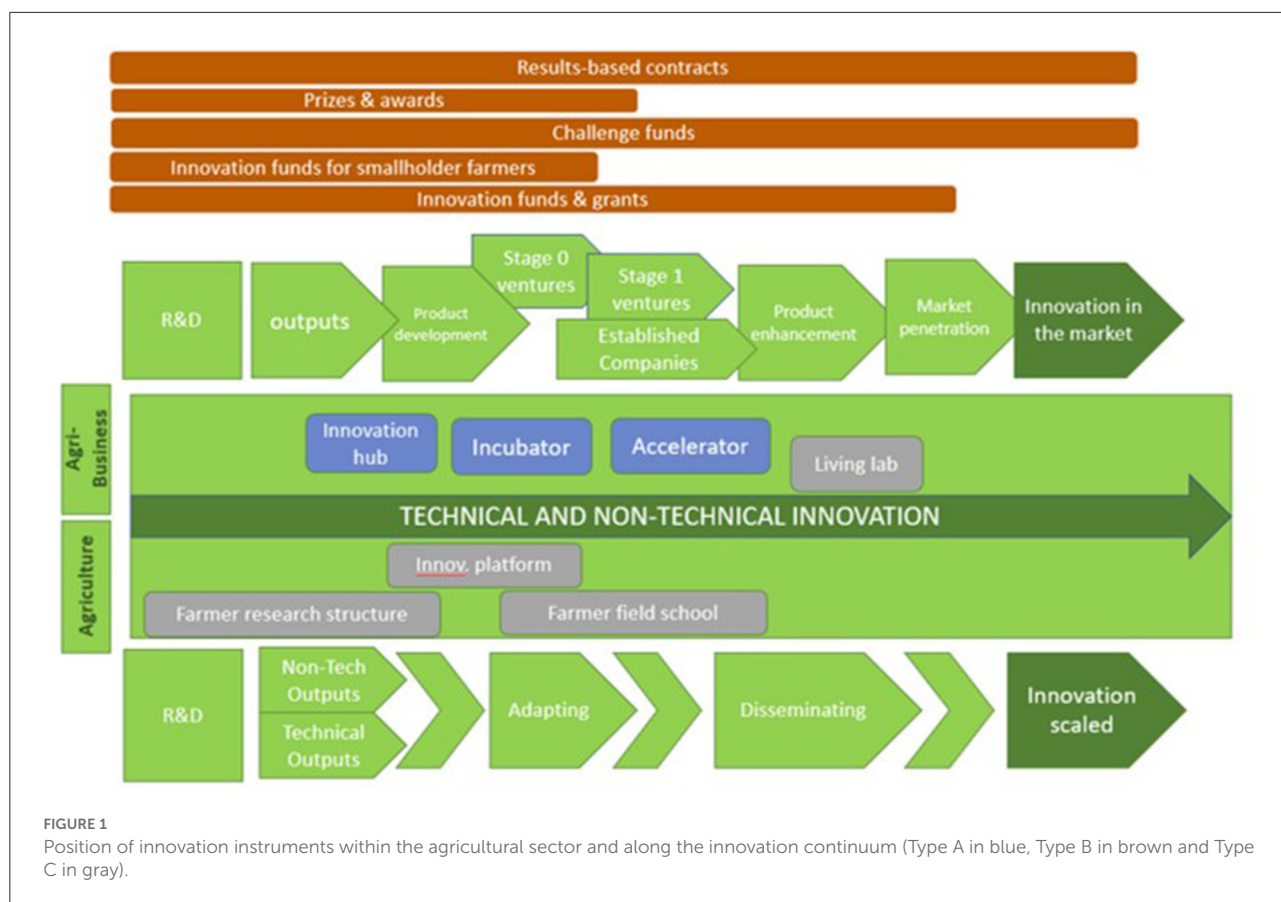
Instruments that primarily finance innovation (type B)

A challenge fund is a mechanism by which a funder can work with non-profit and business organizations to deliver solutions for difficult social problems ([Tjornbo and Westley, 2012](#)). The funder defines the challenge, while the private

sector conceptualizes and designs the solution, provides co-finance, and implements the solution ([UNDP, 2016](#)). One such fund was Innovation Against Poverty (IAP), a pilot challenge fund launched by the Swedish International Development Cooperation Agency (Sida) in 2011 ([Andersson et al., 2014](#)). There are also different forms of innovation funds and grants, including competitive research grants and matching grants. One example is the Groupe Speciale Mobile Association (GSMA) Innovation Fund for Digitization of Agricultural Value Chains. These are increasingly used to stimulate the private sector and farmer engagement in activities related to technology generation, technology dissemination and overall innovation processes. Next, there are several forms of innovation funds for smallholder farmers (IFSFs). These instruments give farmers direct access to resources so that formal research and extension actors do not have complete control over the research agenda ([Friis-Hansen and Egelyng, 2007](#); [Triomphe et al., 2012](#)). Some initiatives use prizes and awards to incentivize participants to solve societal challenges that may lead to major breakthroughs ([Tambo, 2018](#)). The AgResults Program, supported by various multilateral and bilateral donors and foundations, uses pay-for-results prizes to incentivize the private sector to invest in agricultural innovations. Another instrument that offers opportunities for supporting innovation is the results-based contract, which is sometimes called a pay-for-success project. However, the risky nature of agricultural research raises concerns as contractors may not be willing to take the risk unless the risk is priced into the contract ([Deloitt, 2015](#)).

Instruments that support innovation in real-life contexts (type C)

An innovation platform is a network of different actors that set themselves up to collaboratively achieve a joint objective, which may be related to a particular commodity ([Boogard et al., 2013](#); [Homann-Kee Tui et al., 2013](#)). Several organizations and programs have promoted innovation platforms, including the Forum for Agricultural Research in Africa (FARA) and the Platform for African–European Partnership in Agricultural Research for Development (PAEPARD) ([Fatunbi et al., 2016](#)). Living labs can be described as facilities or spaces (e.g., a selected village or group of households) that are user- or citizen-centered and allow for user co-creation. The users are involved in this process from an early stage, which allows for a socio-economic assessment of the innovations ([Robles et al., 2015](#); [Cunningham and Cunningham, 2016](#)). An example from Kenya is the Nakura Living Lab, established through the REFOOTURE project (Food Futures Eastern Africa), which will also establish living labs in Ethiopia and Uganda ([WUR, 2021](#)). Several different farmer research structures exist, including farmer research networks (FRNs), as used by the McKnight Foundation ([Navarette et al.,](#)



2020; Richardson et al., 2021); and local agricultural research committees (CIALs), a farmer-run research service accountable to the local community (Polar et al., 2012). Finally, farmer field schools (FFSs) are a form of adult education, widely used in Africa and Asia, that aims to empower farmers and improve agricultural outcomes through agricultural knowledge exchange (Waddington and White, 2014; SSMP, 2016; Mariyono, 2019). The International Fund for Agricultural Development (IFAD) adapted the approach and introduced Livestock FFSs in East and Southern Africa—integrating active experimentation and *learning by doing* (Jordans, 2021). These instruments all involve users (and could be designed to be more user-driven), with the user generally being a farmer or community member. Most require that innovators have access to financial resources that can support innovation activities because their focus is on strengthening social and human capital.

Comparison of different instruments

The extent to which instruments were found to have contributed to inclusive development and fostered the uptake of research outputs or innovations is documented here. These are key factors that can contribute to supporting the strengthening and sustainability of agri-food systems.

Contribution to inclusive development

If addressed in the design, then many of the instruments can ensure inclusive or equitable development, specifically giving agency to marginalized actors (Mungai et al., 2019). For example, considering language and regional characteristics such as livelihood activities and access to natural resources and technology when designing innovation platforms (Masi, 2016). However, they need to be facilitated to prevent domination by certain groups of actors who wish to dictate the research agenda (Boogard et al., 2013). Some accelerators, innovation hubs, challenge funds, living labs and innovation funds and grants have specifically targeted women and youth, for example with their eligibility criteria (Tjornbo and Westley, 2012; Adekunle and Fatunbi, 2013; Pompa, 2013; Musikoyo et al., 2017; Cohen S. L. et al., 2019; IFAD, 2020). Additionally, there are incubators that monitor their portfolio to ensure that women-founded ventures are represented (InfoDev, 2011). However, open application processes and the costing models adopted by some facilities may still exclude the marginalized (Friederici, 2018). Innovation grants that enable proof-of-concept work by smaller companies (including startups) that would otherwise not be able to garner finance is another way of ensuring inclusive development (Howell, 2017). An

alternative to financing innovation by marginalized groups is to finance innovation or outcomes that benefit marginalized groups—for example, gender-responsive innovation (Tambo, 2018) and results-based contracts that pay for addressing equity issues (Janus and Holzapfel, 2016). A key element that is promoted by a number of programs is to design the instruments to ensure that users are seen as equal to other participants (Nyström et al., 2014).

Several instruments center inclusiveness as a key intention, in particular IFSFs, FFSs and farmer research structures. A number of authors have confirmed that IFSFs can provide resources that allow the rural poor and vulnerable households to pilot their innovations and even patent them (Ashby et al., 2000; Friis-Hansen and Egelyng, 2007; Triomphe et al., 2012). FFSs and farmer research structures are also designed to allow for the participation of smallholder farmers, but may need to be designed to actively target marginalized groups, such as those with low literacy levels (Davis et al., 2010). Sometimes FRNs provide access to production assets that enable them to participate in innovation processes, but approaches such as iterative learning cycles are also important as they build farmers' capacities to engage effectively (Descheemaeker et al., 2021; Richardson et al., 2021).

Contribution to accelerating uptake of innovations and research outputs

Accelerating innovation uptake (i.e., achieving adoption of technologies/innovations) is mentioned in the literature as a key element of a number of instruments, namely incubators, accelerators, innovation hubs, IFSFs, innovation platforms and farmer research structures. Incubators and accelerators create links between innovators/entrepreneurs and companies that may wish to invest in or purchase the innovations (InfoDev, 2014; Hjortsø et al., 2017). Some facilities are linked to educational/research organizations and focus specifically on commercializing research and development outputs (InfoDev, 2011). It is expected that since potential users are involved in vetting applications submitted to IFSFs, they are likely to be addressing real needs, which will foster uptake (Ashby et al., 2000)—even more so if linkages are brokered with the private sector (Friis-Hansen and Egelyng, 2007; Triomphe et al., 2012). The co-development of innovations through innovation platforms generates a sense of ownership of the developed innovations, which has been found to foster research uptake. This can be further supported by non-research actors that disseminate the innovations (Agboton et al., 2018). Besides creating a sense of ownership, field visits, mini-workshops and focus group discussions on the program of a farmer research structure enable continuous evaluation and adaptation of technologies (Descheemaeker et al., 2021), while additional

channels such as community radio and farmer-to-farmer exchanges can be used to disseminate results (and planting material) to other producers (CIAT, 2003; Kanoute et al., 2019).

While there is an expectation that challenge fund outcomes will be commercially viable with additional social and/or economic benefits (UNDP, 2016), there may be factors that prevent immediate uptake, and they may require third-party (such as government) intervention to make them affordable (Tjornbo and Westley, 2012). Sometimes, instruments are designed to improve communication between actors in order to foster uptake, as has been the case with certain innovation funds and grants (Rajalahti and Larson, 2011). Similarly, some programs that make use of prizes and awards (such as AgResults) include a cost-share element to create market stability and reduce costs for the end user, thereby accelerating uptake (Hammond et al., 2021). An important finding from programs using FFSs is that dissemination of information and technologies beyond the participating farmers is not always effective because uptake is strongly linked to experiential learning [ICIMOD (SMMP), 2008; Waddington and White, 2014; Goldstein, 2020]. Furthermore, it should be recognized that while uptake is the intention, technologies often cannot be shared as standardized practices because they may not be appropriate for all farmers, even within the same locality (Bakker et al., 2021).

There was little literature about the contribution of results-based contracts and living labs toward accelerating uptake. However, with living labs, market participation and business development that create linkages between companies and users may allow them to access markets (Masi, 2016; Musikoyo et al., 2017).

Recommendations for selection and use

The choice of instrument must consider the context in which it is to be used—which may or may not be that in which it has previously been used—followed by systematically considering the purpose and desired scale of investment and impact. It is recommended that this process be guided by the following considerations to ensure this and promote inclusive development and sustainability.

Matching the mandate of the program or organization

Some instruments specifically aim to support innovation by entrepreneurs (Type A), while others aim to contribute to broader human wellbeing. For example, challenge funds generally focus on global or societal issues related to human or environmental wellbeing, while some innovation hubs and

incubators focus on translating research outputs into socio-economic impacts.

Positioning within the agricultural sector

An innovation manager may be mandated to target a specific part of the agricultural sector (primary production or processing) or type of farmer. Instruments differ in terms of their application to different parts of the sector. For example, prizes have been awarded to local innovators in rural contexts, small-scale commercial farmers, startup enterprises, large-scale commercial farmers, and even large agribusinesses, whereas FFSs generally focus on small-scale commercial farmers.

Ensuring sustainability

To achieve sustainability, instruments need to be institutionalized within government departments or other organizations' work programs or policies, because their use is often limited to project timeframes—especially projects funded by external donors (Anchala et al., 2005; Seifu et al., 2020). This situation demands changes in terms of organizational mandates and job descriptions. Alternatively, a strong business model is required that considers the capacity of the participants to pay for services, thereby ensuring continuity of these types of instruments.

Understanding the needs of smallholder farmers

The heterogeneity of smallholder farmers must be recognized so that efforts are made to include less literate and poorer segments of the community. It must also be noted that technologies developed with farmers in one locality may not necessarily be appropriate for those in another area, and they may also require new institutional arrangements.

Establishing the right stakeholder mix

With instruments that bring stakeholders together or broker linkages, it is important to have the correct mix of actors. This includes a strong facilitator who can manage power dynamics, and consideration for how the benefits will be felt by all to ensure participation.

Concluding discussion and final remarks

This study represents one of a handful that have recently compared the use of multiple instruments across multiple continents in the Global South, and can thus serve to provide comparative evidence to investors and funders to guide their decision making around, and awareness of, the potential challenges that need to be considered when selecting and designing instruments for use in specific contexts. However, a transition within the research and innovation landscape toward mainstreaming these instruments requires policy changes (e.g., to put funds directly in hands of farmers) and capacity building efforts within relevant organizations (e.g., developing facilitation skills).

While the comparative approach adopted in this study is valuable in terms of surfacing lessons to guide innovation managers and funders, it is extremely challenging because of the high levels of variability with which instruments have been designed, applied and evaluated. There is, therefore, a need for more structured and consistent monitoring and evaluation of the various costs associated with using the different instruments against the benefits that are derived, in order to provide evidence that these instruments are more effective than conventional research and extension instruments in achieving effective uptake and scaling of new innovations. Despite the limitations of this study and evident gaps in the body of literature reviewed, there clearly exists a range of instruments that can support innovation for inclusive development as well as fostering uptake. These simply require substantial thought regarding their design if they are to have the intended impacts.

Author contributions

BL, TH, and S contributed to conception and design of the study. SM and TN reviewed literature and organized the database. SR, JZ, and DT were involved in execution of the study. IA-F provided strategic guidance to the study. BL wrote the first draft of the manuscript. All authors contributed to manuscript revision.

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Conflict of interest

Authors BL, SM, TN, and S were employed by Institute of Natural Resources. Author DT was employed by Agribio Services. Author IA-F was employed by Forum for Agricultural Research in Africa (FARA).

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2022.1013156/full#supplementary-material>

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