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Catalysing innovation: from theory to action

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Feeding a growing population and responding to changing markets requires innovation in agriculture. The expectations of the contribution of agricultural research to innovation are high. This paper looks at the process of agricultural innovation and the realistic contribution agricultural research can make. To be able to analyse the process of agricultural innovation, three elements are distinguished: 1) opportunity assessment to identify 'entry points for change'; 2) experimentation, leading to 'tested and tried promising new practices'; and 3) bringing into routine use, for 'impact at scale'. Any intervention aiming at impact at scale would do well to work on these three elements simultaneously. Attention should be given to building the 'capacity to innovate' to contribute to future results. Based on the analysis of the agricultural innovation process, a number of recommendations are formulated on how agricultural research can contribute to impact at scale.

Keywords: agricultural innovation; research; rural development; impact at scale

Photo: Peter Gildemacher

Wholesale fruit market, Nakuru, Kenya

Introduction

The purpose of this paper is two-fold. In a general sense it is meant to feed the discussion on how to enhance collaboration between agricultural research for development and development practitioners in order to achieve improved development outcomes. In addition, it is meant to inspire new initiatives aiming at bringing agricultural innovation to scale.

Initially, this paper was prepared specifically to inform GIZ's *(Gesellschaft für Internationale Zusammenarbeit)* Innovation Transfer into Agriculture/Adaptation to Climate Change (ITAACC) project.

To feed the debate, this paper will first clarify the issue by discussing the 'problem statement'. Next, the paper will use innovation system thinking to reflect on how to achieve impact at scale in the agricultural sector by:

1. Discussing what we understand by agricultural innovation.
2. Identifying the principal actors in agricultural innovation.
3. Dissecting the process of agricultural innovation.
4. Analysing the possible roles of agricultural research in the process of agricultural innovation.
5. Reflecting on how the capacity to innovate can be improved.

Finally, the paper will discuss what this could mean in practice for research for development initiatives.

Problem statement

Increasing need to innovate in the agricultural sector

The agricultural sector has as important mandate and function to feed a growing population. At the same time however, it provides jobs, income and livelihoods to a very large proportion of the population in developing countries. The agricultural sector needs to change continuously to adapt to a changing world. This need to adapt and change, or to 'innovate', is increasing.

To start with, there is an urgent need to innovate to mitigate the effects of a changing climate. Though the effects of climate change will be seen worldwide, it will be those closely depending on agriculture that will bear most of its associated risks. This is particularly true for smallholder farmers, who often have little scope to deal with the associated changes to the extent needed to maintain – let alone increase – their income and food supply (Hachigonta et al., 2013).

Changing demography, which is characterised in most of sub-Saharan Africa by rapid population growth (UNFPA, 2011), necessitates agricultural innovation. Pressure on land and natural resources is mounting fast, requires increased land and resource use efficiency to feed the population.

A parallel, and highly significant, related development is that agriculture is becoming much more market-oriented. As a result of rapid urbanisation the market demand for food and agriculture derived products is even outpacing the speed of population growth, making agriculture a fast growing economic sector. State involvement in food markets in Africa has declined, giving way to the market as the mechanism to coordinate supply and demand. International trade in agricultural produce is becoming more dynamic. This provides unprecedented economic opportunities for agricultural producers and agri-business enterprises (IFAD, 2010; UNECA, 2011) provided that agricultural systems manage to continuously adapt to the demands of the local, national and international market.

Consequences for agricultural support services

The need for faster agricultural sector innovation has consequences for producers but also for agricultural support services, which at the same time are going through major developments and changes in their own right. A change in thinking and policy about the role of the public sector in agricultural extension led to reductions in public spending. As a result, many extension services, once purely government-run, have been partly or wholly privatised. Operators from the private sector have arisen to complement the shrinking government services and take advantage of the new opportunities in the sector. But this has happened only to a limited extent and certainly not everywhere, typically not in remote areas with cash-strapped farmers and consumers (Wongtschowski et al., 2013).

Importantly, the expectations of the contribution of agricultural research in solving the above mentioned issues are also changing. Once seen only as the source of new ideas and technologies, which then should be disseminated by extensionists, researchers are more and more often requested to 'work closer' with their final clients (the farmers). Once happy to fund research without requesting proof of final impact of such research, donors currently put great pressure on research organisations to deliver an entirely different product: impact at scale. Research organisations have answered this call by promising more, often without knowing exactly how to deliver it.

The international agricultural research system has gone through a process of reflection and change to respond to these new requirements and expectation (among other reasons). Once focused on the 'production of knowledge' the international agricultural research system now puts added emphasis on ensuring that this knowledge is useful and taken up. There is a consensus, within the CGIAR management, that the expected system level outcomes (SLOs) and their respective intermediate development outcomes (IDOs) cannot be achieved by CGIAR centres alone. Effective partnerships are essential in the design of the research, and the processes that lead to research outputs and research outcomes, to ensure that results are suitable for being put into use at scale and have the best chance of delivering the desired outcomes

Photo: Peter Gildemacher

(CGIAR, 2011). Effective partnerships, nevertheless, are only able come into being if the different partners understand and respect each other's role and expertise, combining their (different) ideas, knowledge and world views to work together.

In this paper, we use concepts from agricultural innovation theory to look at the role of the different actors in the sector, and their potential role in stimulating impact at scale, with an emphasis on the role of research in this process. We will investigate what is the realistic contribution that agricultural research is able to make to achieve impact at scale, and how this contribution can be optimised.

Agricultural innovation

'Innovation' makes for a difficult subject to discuss. People have very different interpretations of what 'innovation' is, and it is furthermore considered as something abstract and complex. By 'innovation' we mean simply 'putting into practice a new way of doing things'. As such, agricultural innovation is the process of creating and putting into use agricultural practices, new to a particular environment.

There are some important things to consider when discussing agricultural innovation:

1. Innovation may take place at different scales, from the individual to, for example, national scale when an entire sub-sector is changing practices. If an individual farmer starts practicing something which is new to them, but well known elsewhere, beyond their farm, we consider this 'innovation' from their point of view. In the case of new local milk collection systems being adopted across an entire country, we consider this innovation at country-scale.
2. Innovation includes 'putting into use'. A research result showing the potential of a new practice is not innovation per se.
3. In the minds of some, 'innovation' is only associated with 'new technology'. However, we consider innovation a change in 'practices', which goes beyond technology, and can also relate to changing ways of working together, organising, marketing, providing services or communicating.
4. The word 'innovation' refers to both a process and an end product/practice. 'An innovation' is in our reasoning synonymous with 'a new practice'. To avoid too much confusion however, we will use the term 'innovation' exclusively as a process, i.e. the 'process of changing agricultural practices'.

Actors in agricultural innovation

A frequently used term, which often makes the discussion slightly more confusing, is 'agricultural innovation system' (AIS). An innovation system can be defined as a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect their behaviour and performance (Hall et al., 2006). In other words, the agricultural innovation system is the arena in which all the actors that play a role in changing agricultural practices interact.

A core understanding in AIS thinking is that a multitude of actors (farmers, extensionists, input suppliers, researchers, etc.) contribute to agricultural innovation, and that it is a combination of the quality and skills of the individual actors, but also importantly, the quality of their interaction, which determines the capacity to innovate. From the point of view of assessing the role of agricultural research in innovation, this means that agricultural research is not the single most important driver, initiator or owner of the process of agricultural innovation. It is more helpful to see agricultural research as a significant service provider to the process of agricultural innovation, next to other actors (see Table 1).

The process of agricultural innovation

When reflecting on the process of agricultural innovation, it is often a simple process that comes to mind: innovators appear as first adopters of new ideas, often originating from research, followed later by masses of peers, as described extensively by Rogers (2003). This has long been applied rather non-critically to the role of research and extension, resulting in a linear model of technology transfer , in which research develops new technology, which is transferred to producers through agricultural extension, and then widely adopted through farmer-to-farmer dissemination: **Research ➔ Extension ➔ Farmer.**

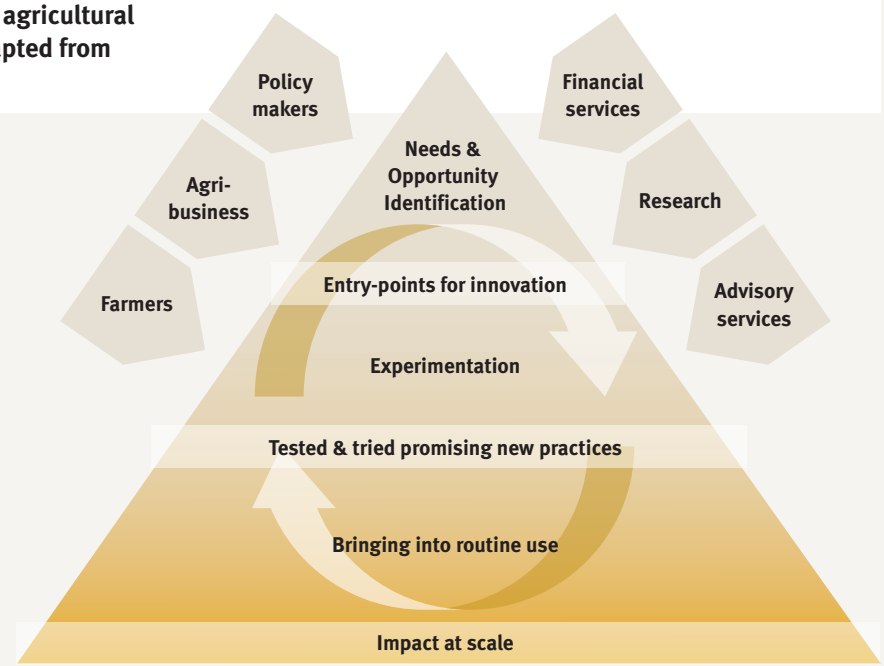
This linear manner of looking at agricultural innovation has been dismissed (Arnold and Bell, 2001; Leeuwis and Aarts, 2011) and many have advocated for a shift towards innovation system thinking, which focuses on the interaction between diverse actors as key to innovation, including the private sector (Biggs, 2007; Hall et al., 2006).

Innovation system theory takes the principal point of view that taking a new 'practice' from one place to the next requires, by default, the re-creation of the innovation process, to ensure local fit and the re-ordering of actor relations

Table 1: Roles of a number of actors in AIS. Source: Posthumus, and Kahan, 2013

Actor	Role in AIS
Family farmers	• Creating, testing and adapting new technologies to field conditions. • Coming up with, and implementing, innovative practices to increase agricultural productivity and market access.
Farmer organisations	• Represent family farmers (needs, opportunities, interests) in value chains and/or in policy arenas. • Brokerage of knowledge between farmers and other actors. • Facilitating access to agricultural inputs, credit and markets.
Advisory services (both private, non-governmental and public)	• Brokerage of knowledge and practices between farmers and other actors. • Bringing new knowledge to farmers and other local actors. • Developing networks and supporting organisation of producers. • Facilitating access to credit, inputs and output services. • Promoting gender equality.
Agro-dealers	• Providing (new) agricultural inputs. • Identifying, piloting and mainstreaming new market opportunities.
Agro-food processors, buyers	• Providing (new) output markets. • Defining quality standards of agricultural products. • Developing and applying technologies. • Identifying, piloting and mainstreaming new market opportunities.
Researchers	• Developing and improving technologies, practices and processes. • (Joint) Testing of locally developed (indigenous) technologies and processes. • Documenting the way new practices and technologies are adapted and further innovated with (for both men and women, poor and rich), to feed into other agricultural research efforts and policy decisions.
Tertiary education institutes	• Education and training of professionals in the agricultural sector.
Policy makers	• Creation of an enabling environment and public sector that accommodates innovation. • Provide incentives to innovate and collaborate. • Enabling networks and partnerships.

Figure 1: The deliberate process of agricultural innovation for impact at scale (adapted from Gildemacher and Mur, 2013)



required for its success. So a new practice (keeping crop residue in the soil as mulch in conservation agriculture, for example) needs to be adapted further at local level and actors need to re-organise themselves around the new practice (e.g. by achieving new agreements on the extent to which livestock keepers can/cannot use crop residues). Keeping crop residue as soil cover is more than just an agronomic issue, it has social, gender, economic and environmental repercussions that are important and must be re-determined locally (Beuchelt and Badstue, 2013)

The dismissal of the linear model, therefore, leaves us with a rather ambiguous term, innovation, applied to widely different types of changing practices, sets of actors and institutional set-ups. This does not make the thinking about how to influence and actually catalyse or accelerate the process of agricultural innovation easy, nor does it provide much hands-on guidance as to how impact at scale can be realised. A compromise has to be found somewhere between the contrasting, but over-simplistic, ideas that a similarly intensive innovation process is required in every new context versus the notion that a successful new practice can simply be copied and transferred.

Gildemacher and Mur (2013) created some opening for thinking about agricultural innovation and the mechanisms for reaching impact at scale, which resulted in a schematic picture of the process of agricultural innovation (see Figure 1). The idea is by no means to revert back to linear thinking about relations between research and agricultural innovation. And furthermore, it is important that a figure is – by definition – a gross simplification of complex reality. Such representation is only meant to aide in thinking about the processes related to deliberate efforts to catalyse agricultural innovation. Having said that, bringing 'proved' technologies into routine use by a wider public is something that, in principle, makes sense, provided that we do not fall back into a linear process of blind and rigid 'transfer of technology', and ample space, support and incentive to further experimentation and adaptation is provided.

In efforts to catalyse agricultural innovation, the model distinguishes three actions, leading to three types of results:

1. Opportunity and needs identification, leading to the identification of 'entry points for change'.
2. Experimentation, leading to 'tried and tested promising new practices'.
3. Bringing into routine use, potentially leading to 'impact at scale'.

Opportunity and needs identification

The objective of a needs and opportunity assessment is to identify entry points for innovation, or, in other words, bright ideas to put to the test. There is no single best source of ideas or entry-points for innovation (Biggs, 1990). Needs and opportunities can be identified from/by multiple sources: farmers, private entrepreneurs, researchers or others. It is often said that the best chance for new ideas to emerge is to stimulate discussion or bring together people with widely diverging world-views, interests and experiences. Having said that, sometimes ideas or entry points for innovation come from individual farmers, scientists, extension workers or traders (see Box 1).

Box 1: Farmers as source of ideas and entry points for action: Local Innovation Support Funds, Prolinnova. Based on Gebremichael et al., 2011

Since 2005, the Prolinnova (Promoting local innovation in ecologically-oriented agriculture and natural resources management) network has set in place Local Innovation Support Funds: funds managed by communities which can be drawn upon to support farmer-led experimentation.

A good example is that of a local farmer, Jifara Workineh, from Ambo, Ethiopia. Jifara resolved the long-standing problem of propagating Podocarpus, a tree with high economic value because of its good-quality timber. As its seed has a very long dormancy period, few farmers were interested in planting it. In 2007, Jifara started experimenting with ways to break the seed dormancy and induce germination. The local innovation fund provided him with the funds to experiment systematically with three germination approaches he thought most feasible. The successful completion of this experiment increased his visibility (an award received from the Ethiopian Government) and encouraged him to sign an agreement with an investor in July 2010 to produce 2,000 Podocarpus seedlings. Farmers in the area have been encouraged by his success and have started growing these trees on marginal land.

Experimentation

The second element of agricultural innovation is experimentation. During this process entry points are tested and adapted. Experimentation may focus on farming technologies, but also on new market relations, services or collaboration models. As such, experimentation here has to be understood differently from experimentation by researchers under controlled conditions to confirm or falsify theories. Here we mean experimentation under realistic circumstances to arrive at locally tried and tested promising new practices. Practices can be related to agronomic practices, but can just as well relate to trying out different manners of farmer organisation, bulking, marketing or processing under realistic circumstances. It is precisely because experimentation is carried out at local level, in the context in which the new practices have been tried and tested, which leads to change/results. To ensure that the experience of this experimentation is put to use beyond the context of its testing, additional efforts are almost invariably required, which brings us to the third element of agricultural innovation: 'bringing into routine use'. The distinction between experimentation and 'bringing into routine use' is not always clear-cut, because in a new context testing and adaptation is often required (see Box 2).

Box 2: Experimenting with intensive commercial smallholder banana production in Zimbabwe

The Dutch development organisation SNV supported smallholder banana producers and a banana marketing company, Matanuska, in Honde valley, Zimbabwe, to experiment in ways of collaborating to supply the Zimbabwean market. Previously, the banana supply had been assured exclusively by large plantations. Smallholder plantation establishment, training on plantation management, continued access to finance and inputs, as well as quality control, collection and transport logistics were piloted, which resulted in a functional contract farming model, in which smallholder producers managed irrigated banana plantations to supply the banana marketing company. This can be considered an example of 'experimentation' under realistic circumstances. Matanuska, as well as the farmers took risks in piloting, which were partly covered by resources from SNV.

Currently the same model is being brought into routine use. Building on the first experiences gained in the pilot, more buyers are developing supply relations with smallholder producers in the valley, more commercial financial service providers are interested in providing credit for plantation establishment and management, more smallholder farmers are planting commercial plantations, and other development organisations are brokering between producers and buyers. The changing circumstances of competing buyers, increasing demand for irrigation water, and the increasing supply of high quality bananas in the valley requires adaptation of the pilot model. Still, as a result of the proof of concept from the initial pilot, risks are manageable and more companies are willing to invest in building smallholder sourcing strategies. Similarly, more farmers are willing to risk investing in intensive banana farming, and financial service providers are offering routine services to banana growers.

One characteristic which distinguishes experimentation from 'bringing into routine use' is that the process of experimentation is often 'pre-competitive'. The experimentation serves a wider public interest than the interest of the economic actors involved alone, provides information and experience to a wider audience, and largely takes place in the public arena, with the input of a multitude of different actors. Impartial process facilitation and public resources are also important, and only partial investment by the private sector – whether producers or agribusiness – are to be expected, as the results do not exclusively benefit a few, but are of public benefit to many.

A second important distinction is that experimentation includes room for failure and consequently carries higher risk. In experimentation, risks must be taken to put untested assumptions and ideas to the test of reality. Without the willingness to recognise and accept the possible failure of practices and approaches being tested, no adaptation and selection is able to take place. High risk and failure are easier to accept in a pre-competitive setting, in which risks are shared among stakeholders, and which offers an important role for public funding (see Box 2).

Bringing into routine use

'Bringing into routine use' is the process that moves promising new practices to impact at scale. Underestimating the importance of this process has been a pitfall, hampering learning from, and replicating, successful experiences. It should be recognised that this process also requires experimentation, risk-taking and local adaptation, much like the experimentation phase, but it differs in the levels of risks that need to be taken and the amount of room for failure.

With 'bringing into routine use', there is much less emphasis on developing new practices and approaches for the public good. The focus is on assuring sustainable and lasting, cost-effective or – in the case of private sector involvement – profitable service delivery and production.

As stated previously, 'bringing into routine use' almost invariably requires local adaptation. There may be a need for policy changes, training or organisation of producers, traders or service providers, or adaptation of the technology or practice itself, to ensure it is able to exert its potential effect (without negative unintended results) in an environment for which it was not initially developed during the experimentation process. When relating this to the case of bananas in Box 2, it means that the approaches used for smallholder banana sourcing applied after the pilot phase is being adapted to the specific needs of different companies and the capacities of different producers.

The difference with experimentation lays in the fact that, as 'bringing into routine use' happens within a competitive arena, participation of all stakeholders in initiatives should not be expected – especially if they are competing against each other. In the case of smallholder banana production and marketing (Box 2), different companies are currently competing against each other, in different partnerships with producers, NGOs and other support organisations.

Innovation is not a predictable linear process

Figure 1 assists in understanding agricultural innovation, and in thinking about how interventions can support agricultural innovation. However, the figure may give a false idea of how much the process of agricultural innovation is able to be planned, predicted and influenced. Agricultural innovation is a process of discovery, and as such outcomes are unable to be predicted. Although there is a chronological and hierarchical logic, from needs and opportunity assessment to impact at scale, steps will not always be taken in this logical order (Van der Fliert and Brown, 2002). Experimentation may lead to a need to identify new opportunities, and opportunities may be identified which do not require experimentation with room for failure. Also, as previously stated, the border between experimentation and 'bringing into routine use' is not clearly defined and is amorphous. During 'bringing into routine use', a degree of experimentation and adaptation is required. Experimentation may be implemented at different scales, and also directly lead to impact. In short, the process of agricultural innovation is much messier than depicted.

An important consequence of this is that it is not realistic to expect smooth sailing from opportunity identification to impact at scale. This has consequences for the role of agricultural research, and the expectations one can have of agricultural research activities. The role agricultural research may play in agricultural innovation is discussed in more detail below.

Role of research in agricultural innovation

Figure 1 provides a helpful framework to consider the contribution of agricultural research in catalysing innovation. It is essential, however, to realise that research is not the unique initiator or driver of the process of agricultural innovation (Hawkins et al., 2009; Hall, 2006). Also without researchers, innovation takes place, and without researchers, experimentation happens (Biggs, 1990; Chambers, 1983). Research, as an actor, is able to add much value to the process of innovation and increase the likelihood of impact at scale, and research has a role to play in each of the three elements of the agricultural innovation process, depicted in Figure 1.

Opportunity and needs identification

Through more fundamental research efforts new entry points for innovation are discovered, which feed into the process of needs and opportunity identification. Through analysis of farmer practices, it is also important that research is able to contribute to the identification of entry points for innovation. In addition, researchers could contribute to the selection of

those 'best-bet' ideas with most potential. It is important to recognise that research is able to contribute to the latter, but should do so in consultation with other stakeholders in the system, such as producers, service providers and (other) private actors (traders, processors, etc.).

Experimentation

An important added value of researchers is the ability to design experimentation such that relatively objective choices are able to be made based on reliable data collection and comparison between options. Whatever the experimentation is about, research may also contribute by documenting and analysing the process in a structured manner. Process and documentation analysis is important:

- As an input into the adaptation of the new practice being tested for local conditions.
- To derive new entry-points for innovation. By understanding the socio-economic and physical reality better, multidisciplinary researchers or research teams are able to come to new entry points for innovation.
- To provide input for the step of 'bringing into routine use', beyond the environment in which it is being tested. Analysis of the process of experimentation, and the context in which 'experimentation' was successful, is important to consider how it can be successful on a wider scale outside the pilot context. This requires the identification of 'essential principles' of the process for successful, and importantly, more efficient, re-creation of the success elsewhere.

Bringing into routine use

'Bringing into routine use' by definition takes place at a larger scale. As researchers are few, and are unable to be everywhere, they will need to take a more modest role.

Nevertheless, as mentioned above, well documented and synthesised experiences from experimentation are valuable for the design and implementation of efforts to promote the wider use of new practices. Researchers are well positioned to play a role in this.

Also at this step, analysis of the processes taking place is essential, which assists in improving the approach taken to promote the wider use of a new practice by understanding what changes are made to the initial innovation and how successful these were. In addition, participating in, and analysing, 'bringing into routine use', allows for the provision of feedback and input into parallel experimentation, and provides new entry points for innovation.

Innovation process facilitation

Researchers may, in certain situations, be the actors that best understand the wider agricultural sector context. In these cases, they can potentially facilitate functional interaction between different actors, in opportunity identification and experimentation. However, researchers need to have particular competencies related to facilitation of stakeholder interaction.

While in the experimentation phase an applied researcher may well take up roles as a broker and facilitator, in other phases the brokering, facilitation, and, eventually, the advocacy should fall beyond the researchers scope (Maatman et al., 2011).

Capacity to innovate

Here we understand the 'capacity to innovate' first and foremost as the capacity of the entire 'system' to ensure agricultural innovation takes place continuously. To a large extent, this means that the three elements distinguished in Figure 1 happen continuously and effectively. Agricultural innovation does not happen on its own, but is driven by actors, such as producers, advisors, agri-business entrepreneurs, financial service providers, researchers and policy makers.

For the three elements (Figure 1) to function effectively, the different actors that contribute to innovation require the capacities to do so effectively. If the important actors have poor capacities, such as researchers not having a system overview, or knowing how to set-up participatory research initiatives, or producers not being organised so that they can articulate opinions, innovation will still happen, but at a slower pace.

The broad features of 'capacity to innovate' include a combination of: (1) scientific, entrepreneurial, managerial, and other skills and knowledge; (2) partnerships, alliances, and networks linking different sources of knowledge and different economic sectors; (3) routines, organisational culture, and traditional practices that pattern the propensity to innovate; (4) an ability to learn continuously and use knowledge effectively; and (5) clusters of supportive policies and other incentives, governance structures, and the nature of the policy process (Hall and Dijkman, 2009; Watson, 2006).

To strengthen the capacity for innovation, it is therefore necessary to invest in learning and skills development while ensuring that incentives are in place to encourage people to put these skills into use and nurture the desired attitudes and practices (Rajalahti et al., 2008).

The capacity to innovate can be improved through three areas of focus:

1. Upgrading the skills, expertise, competencies and confidence of individual actors.
2. Improving the organisation, processes and incentives within organisations, businesses and actor groups to get involved.
3. Creating a an environment in which actors actively interact, exchange new ideas and expertise, and collaborate.

Box 3: Working in the three innovation processes: the example of MasAgro (KIT, 2013)

MasAgro is a Mexican-government funded project that engages research, development and knowledge transfer to support farmers in Mexico to sustainably increase their productivity of maize and wheat by offering them training, technical support (mainly promoting Conservation Agriculture), and high-yielding maize and wheat seeds. The International Maize and Wheat Improvement Center (CIMMYT) initiated and coordinates the project, acting as an independent network broker to build up links between stakeholders. MasAgro has more than 150 partners from the public and private sector who contribute with technical support, training, and research, amongst others. MasAgro has four components: Seeds of discovery, the International Maize Improvement Consortium for Latin America (IMIC), the Wheat Yield Consortium, and Take it to the Farmer (TTF).

MasAgro in general, but in particular TTF, works in the three processes of innovation simultaneously. Farmers experiment – with the support of researchers and local service providers – with new seeds, practices and ideas. Farmers come up with their own suggestions on what further research should be carried out. These suggestions are taken into consideration when establishing experimentation fields managed by researchers, but placed at 'local level', closer to farmers. Researchers also have a say on what is to be experimented on – by drawing on the new seeds and practices being experimented on by CIMMYT and other research partners.

By working with a large number of farmers and experimentation fields, in several parts of the country, CIMMYT aims at 'bringing into routine use' (elements of) Conservation Agriculture and farm management. It does so by continuously experimenting and adapting these practices, together with other actors. As with any project, there are many challenges to tend to, such as, for example, ensuring that there is a link between these different elements as the project grows larger, and strengthening capacity of project staff to deal with institutional problems faced by farmers. Despite the challenges, MasAgro has quickly become a flagship project for CIMMYT, and an inspiration for policy makers in the region.

Table 2 presents a list of actors in the innovation system, and what individual and organisational capacities they need to build to be able to effectively contribute to agricultural innovation.

Consequences for interventions aimed at catalysing agricultural innovation

In the agricultural development sector, there is a tendency to think in terms of 'interventions' which have a beginning and an end, and at the end lays an achieved result. In reality however, the process of agricultural innovation is an autonomous process, which does not start and end with deliberate interventions, but takes place continuously and can at best be catalysed by temporary deliberate action. Any deliberate intervention will have to recognize that the three elements of the process (needs and opportunities identification, experimentation, 'bringing into routine use') are occurring continuously.

Any intervention to catalyse agricultural innovation would do well to consider working on two levels of results at the same time:

1 **Catalysing innovation**: Stimulating, facilitating and directing the three elements of the agricultural innovation process, resulting in 'impact at scale'
2 **Building capacity to innovate**: Improve the capacity of actors in the agricultural innovation system to play their role and be able to effectively interact.

To achieve the first point, interventions do well by investing simultaneously in all three elements of agricultural innovation. Opportunity assessment, experimentation and 'bringing into routine use' can take place simultaneously. It would be an error to think that one could start with opportunity assessment, identify three good opportunities, test and adapt them and bring them into routine use. A more likely positive contribution to impact at scale would be made by simultaneously supporting processes of identification of entry-points, experimentation and 'bringing into routine use' of tested and tried promising new practices. For an interesting example of a project designed to do that, see Box 3.

At the same time, to build capacity to innovate, interventions to catalyse agricultural innovation should work to build the capacities of the different actors involved. This may be achieved by getting those actors involved in needs and opportunities identification, experimentation and bringing to scale. Strengthening innovative capacities may also be achieved by more general investments in agricultural education, for example. Importantly, the actors' capacities must not be assumed to be in place; this holds for researchers, farmers, advisory service providers and other actors alike.

Table 2: Capacities required of actors in the agricultural system to effectively contribute to innovation. Adapted from Posthumus and Kahan, 2013.

Actor	Capacities
Farmers	• Entrepreneurial skills. • Ability to adapt and innovate. • Functional organisation. • Ability to identify and articulate common constraints and opportunities.
Advisory services (private, public, NGOs)	• Group facilitation skills. • Ability to 'translate' between actors. • Technical knowledge. • Knowledge brokerage skills. • Training skills in agricultural technologies, management and entrepreneurship. • Skills in ICT. • Problem-solving skills. • Network of peers and support.
Researchers	• Technical knowledge. • Ability to interpret practice. • Link theory with practice and vice versa. • Skills in participatory research. • Engagement with other actors. • 'Soft' skills (communication, teamwork, networking facilitation). • Interdisciplinary skills. • System overview.
Agri-business	• Entrepreneurial skills. • Ability to adapt and innovate. • Access to knowledge and information. • Ability to identify and articulate common constraints and opportunities. • Access to credit. • Ability to relate to other actors. • Willingness to take (calculated) risks.

Consequences for initiatives aimed at bringing research outputs to scale

Based on the above discussion about agricultural innovation processes, this paper presents a number of (provocative) points for discussion about the role and ambition of projects aimed at bringing agricultural innovation to scale.

Commonly, the pitfall of such projects is to expect linear cause-effect relations between agricultural research and impact at scale. In previous sections we suggest that the idea of linear 'transfer of technology' has to give way to an dynamic understanding of the system, in which new ideas and practices are again (and again) experimented on and adapted by farmers, researchers, (private and public) extensionists, input suppliers, traders and other actors in the system.

To promote agricultural innovation effectively, with good chances of success, we propose that the following recommendations are considered:

- Avoid the notion of 'research results ready to use'. Research results are to be seen as one possible 'entry points for innovation' which, by definition, requires additional effort to test and adapt under realistic circumstances ('experimentation') with room for failure.
- Be open to good ideas from as many diverse sources as possible. Avoid narrowing down to only a few sources of good ideas, such as only research-derived ideas, or only ideas emerging from specific efforts.
- If 'pre-intervention' choices need to be made, such as choosing regions, countries or promising commodities, make them quickly. After these 'pre-intervention' choices, be open to good ideas from all possible directions.
- Distinguish what the main objective of each project is:
  - Projects aiming to experiment with one or more 'entry points for innovation', with the objective to develop 'tried and tested new practices'. Such a project needs to be allowed a risk of failure.
  - Projects taking already 'tried and tested promising new practices' and aiming to bring these into routine use, with the objective to achieve impact at scale.
- When assessing what opportunities are 'promising', do not rely on the judgement of one specific actor alone. Instead, draw on the expertise and opinions of many actors (farmers, traders, input suppliers, extension workers, researchers, etc.).
- Realise that even 'tried and tested promising new practices' may still need further joint experimentation for context-adaptation before one is able to expect success at scale. Support for context adaptation and 're-ordering' of actor relations may well be needed.

- Documentation, analysis and synthesis of experiences in the process provide benefits for all agricultural development partners. It may provide new entry-points for innovation, but also insight into effective approaches for 'bringing into routine use'.
- Be open for failure throughout. A lack of room for failure easily results in over-protection and nursing, which will yield non-scalable artificially successful new practices. Learning from what has gone wrong is just as – or more – important than learning from what has gone well.
- Take into consideration six types of results when assessing the results from support to agricultural innovation:

Direct:

1. Entry-points for innovation.
2. Tried and tested promising new practices.
3. Impact at scale.

Indirect:

4. Improved individual capacity to contribute to agricultural innovation.
5. Improved capacity of actor organisations to contribute to innovation.
6. Improved collaboration between actors for agricultural innovation.

Photo: Peter Gildemacher

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