1 Introduction
Recently, interest in enhancing the uptake, use and impact of research in policy and practice has increased considerably. This interest has emerged in various fields such as medical and health science, environmental science, and development (Lavis et al. 2006; Michaels 2009; Fisher and Vogel 2008). An increasingly popular approach to enhance research uptake and use, moving beyond mere diffusion of research results through reviews, leaflets, and summaries, is ‘knowledge brokering’ (Bielak et al. 2008). Although several definitions and modalities of knowledge brokering exist (see Michaels 2009; Meyer 2010; Fisher 2011), knowledge brokering is broadly about filtering relevant research, advocating the use of research in policy and practice, translating research into plain language and helping people to make sense of and apply information, and establishing a connection between research producers and users during research processes (Lomas 2007; Neef and Neubert 2011). This implies that knowledge brokering is not only about enhancing ‘research push’, but also about enhancing ‘research pull’ and facilitating collaboration between researchers and stakeholders to foster a process of joint knowledge construction, which often enhances research impact. While researchers can engage in knowledge brokering activities (Ward et al. 2010), these activities are often executed by specialised actors or organisations who are then called ‘knowledge brokers’ (Bielak et al. 2008; Lomas 2007; Meyer 2010).

While the knowledge brokering literature from the medical and health science field as well as the environmental science field has increasingly recognised research pull and participatory or collaborative research models, there remains a strong focus on ‘research’ and ‘knowledge’ (often explained as research evidence), which obscures the fact that to effectuate change and innovation there are several other influential factors...
(Best and Holmes 2010; Hounkonnou et al. 2012; Millstone et al. 2010). The latter has become increasingly recognised in the agricultural sector. We believe that the work from this sector on agricultural extension (the common term for knowledge brokering) is relevant and interesting to review. While the goal and audience of extension may be different (initially it was stimulating productivity of farmers) than bringing research to policy, it applies similar principles and therefore provides valuable lessons on knowledge brokering for research, policy and practice. The body of literature on extension describes over 50 years of experience (Leeuwis and Aarts 2011; Röling 2009) and other sectors may benefit from such cumulative learning. However, we do not intend to present the case of extension as best practice, but rather to provide reflection.

The article continues with an overview of developments in thinking on innovation and change in the agricultural sector and the role of research and knowledge brokering herein. Subsequently, we focus on the implications of the changing and new roles of knowledge brokers. The article concludes with a reflection upon the implications of the experience from the agricultural sector for thinking on knowledge brokering in other fields.

2 Changing paradigms on change and innovation in the agricultural sector: implications for knowledge brokering

2.1 The evolution from linear to systemic models thinking

Agricultural extension was founded with the objective of enlightening farmers with insights from science to enhance agricultural productivity (Leeuwis 2004). In many countries, public sector extension services were and still are explicitly connected to the national agricultural science system. However, the interpretation of the concept of extension, and the mandate it has or should have, evolved with changing views on agricultural development and innovation, and the role of science in this process (see Table 1). The main reason for these changing views was that the first, ‘diffusions of innovation’ or ‘transfer of technology’ approach to extension could not explain the complex social processes surrounding innovation. Moreover, the research push approach did not address well issues like heterogeneity in production context and farming styles, and complex natural resource management conflicts. Given these shortcomings, participatory research approaches emerged (based on research pull and collaboration), such as Farmer First (see Scoones and Thompson 2009 for an overview) and participatory technology development (see Neef and Neubert 2011 for an overview). The key objective of these participatory approaches was to enhance research uptake and impact, by adapting research to specific contexts and creating ownership of the research. This participatory research perspective considered the broader knowledge systems in which farmers were embedded, and evolved into the so-called Agricultural Knowledge and Information Systems (AKIS) perspective. However, AKIS mainly considered farmers, researchers and extensionists, but did not explicitly focus on the broader network of actors and institutional factors that impact agricultural innovation.

The importance of addressing the multiplicity of actors and institutional factors has become recognised in the Agricultural Innovation Systems (AIS) perspective. The AIS perspective moves beyond research and technology development as main ingredients for innovation and recognises that agricultural innovation is not just about adopting new technologies invented by research and transferred to farmers; it also requires a balance amongst new technical practices and alternative ways of organising, for example markets, labour, land tenure and distribution of benefits (Brooks and Loevinsohn 2011; Dormon et al. 2004). Innovation does not only involve adaptation to prevailing contextual conditions, but also the active influencing, redesign, or destruction of pre-existing conditions and institutional frameworks (Hounkonnou et al. 2012; Klerkx et al. 2010; Woodhill 2010). Such change is affected by complex interdependencies between actors, organisations and artefacts, unintended and unforeseen developments, and coincidence and dynamics of conflicts that challenge linear approaches and reductionist understanding (Woodhill 2010). This perspective implies that innovation depends on coordinated action in a network of actors, and that it is not very useful to merely look at the degree to which research outcomes are adopted or used as an indicator of successful innovation processes. Research is no longer considered as external and static, but rather as an integral and dynamic part of innovation.

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From knowledge brokering towards systemic facilitation

The above signalled changes in thinking about the role of extension and research in agricultural innovation have certain implications for how the contribution of knowledge brokering is seen. The innovation systems perspective acknowledges that research does not equal innovation, but that innovation happens in society, and involves the re-ordering of relations and institutions in multiple social networks. Communication obviously plays a role in such re-ordering, but can no longer be thought of only in terms of merely brokering research knowledge to policy and practice in a research push or research pull mode. Also, it is not just about enhancing dialogue and direct collaboration between research producers and research users, considering the many factors that influence change and innovation. Rather, innovation needs

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Diffusion of innovations/transfer of technology</th>
<th>Agricultural Knowledge and Information Systems (AKIS)</th>
<th>Agricultural Innovation Systems (AIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Era</td>
<td>Central since 1960s</td>
<td>From 1990s</td>
<td>From 2000s</td>
</tr>
<tr>
<td>Mental model and activities</td>
<td>Supply technologies through pipeline</td>
<td>Collaborate in research (participatory research) and extension</td>
<td>Co-develop innovation involving multi-actor processes and partnerships</td>
</tr>
<tr>
<td>Knowledge and disciplines</td>
<td>Single disciple driven (e.g. breeding)</td>
<td>Interdisciplinary (e.g. plus sociology and farmer experts)</td>
<td>Transdisciplinary, holistic systems perspective</td>
</tr>
<tr>
<td>Scope</td>
<td>Productivity increase</td>
<td>Farm-based livelihoods</td>
<td>Value chains, institutional change</td>
</tr>
<tr>
<td>Core elements</td>
<td>Technology packages</td>
<td>Joint production of knowledge and technologies</td>
<td>Shared learning and change, politics of demand, social networks of innovators</td>
</tr>
<tr>
<td>Drivers</td>
<td>Supply-push from research</td>
<td>Demand-pull from farmers</td>
<td>Responsiveness to changing contexts, complex patterns of interaction</td>
</tr>
<tr>
<td>Relation with policy and institutional environment</td>
<td>Science and technology are relatively independent of political and other social partners – institutional factors as external conditioners of the adoption process</td>
<td>Science and technology develop and are embedded within a historically defined social, political, economic and agro-ecological context</td>
<td>Besides contextually embedded science and technology, institutional change is considered a sine-qua-non for innovation</td>
</tr>
<tr>
<td>Innovators</td>
<td>Scientists</td>
<td>Farmers, scientists and extensionists together</td>
<td>Multiple actors, innovation platforms and networks</td>
</tr>
<tr>
<td>Role of farmers</td>
<td>Adopters or laggards</td>
<td>Experimenters</td>
<td>Partners, entrepreneurs, innovators exerting demands</td>
</tr>
<tr>
<td>Role of scientists</td>
<td>Innovators</td>
<td>Collaborators</td>
<td>Partners, one of many responding to demands</td>
</tr>
<tr>
<td>Key changes sought</td>
<td>Farmer’s behaviour change</td>
<td>Empowering farmers</td>
<td>Institutional change, innovation capacity</td>
</tr>
<tr>
<td>Intended outcomes</td>
<td>Technology adoption and uptake</td>
<td>Co-evolved technologies with better fit to livelihood systems</td>
<td>Capacities to innovate, learn and change</td>
</tr>
</tbody>
</table>

Source: Adapted and integrated from Hall et al. (2006); Pant and Hambly-Odame (2009); Sanginga et al. 2009.1
<table>
<thead>
<tr>
<th>Articulation of problems and possibilities</th>
<th>Network building</th>
<th>Supporting negotiation and learning in networks – dealing with dynamics of power and conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate and visualise interdependencies among stakeholder practices</td>
<td>Make an inventory of existing initiatives, complemented with stakeholder analysis</td>
<td>Identify and propose process facilitators who are credible and trusted by the stakeholders involved</td>
</tr>
<tr>
<td>Explore and exchange stakeholder perspectives (values, problems, aspirations, context, etc.) through discussion, role playing, dramatisation, visits, filmed interviews, informality, humour, fun, etc.</td>
<td>Build on existing initiatives for change and the networks around these</td>
<td>Work towards process agreements, including dealing with media, mandates, etc.</td>
</tr>
<tr>
<td>Visualise invisible biophysical processes with the help of discovery learning tools or simulation</td>
<td>Arrange contact between disconnected networks who may have compatible interests (e.g. Chinese consumers and African farmers)</td>
<td>Probe to explicate the interests and fears that underlie mobilised arguments and counter-arguments</td>
</tr>
<tr>
<td>Explore past and current trends and likely futures if nothing changes</td>
<td>Mobilise pressures from outside (carrots and sticks) to enhance feelings of interdependence</td>
<td>Steer collaborative research activities to questions relevant to less resourceful stakeholders</td>
</tr>
<tr>
<td>Use visioning tools and scenario analysis to imagine (and find common ground on) possible futures</td>
<td>Forge/broker contact between existing networks and outsiders and/or outside expertise</td>
<td>Make stakeholders talk in terms of proposals and counter-proposals</td>
</tr>
<tr>
<td>Discuss institutional and other influences that reinforce existing patterns/problems</td>
<td></td>
<td>Ensure regular communication with constituents to take them along in the process</td>
</tr>
<tr>
<td>Organise contact with others who have encountered and managed similar problems</td>
<td></td>
<td>Translate agreed-upon problems and solutions into storylines and symbols that are likely to resonate in society</td>
</tr>
<tr>
<td>Elicit uncertainties that hinder change, and design collaborative investigation and experimentation to develop common starting points</td>
<td></td>
<td>Use media and lobby tactics to influence societal agendas and advocate solutions (with the help of storylines/symbols)</td>
</tr>
<tr>
<td>Articulate knowledge and resource needs (e.g. funding, lobbying support) as well as where to get knowledge and resources</td>
<td></td>
<td>Use practical actions and experiments as source of reflection and learning, rather than organising discussion and reflection only</td>
</tr>
</tbody>
</table>

*The table shows a repertoire of innovation brokering roles which can be applied depending on the situation at hand, but not necessarily in a chronological order. Source: Adapted from Leeuwis and Aarts (2011).*
to be thought of in terms of a process that takes place in the context of the building, designing, and/or evolution of relations among multiple actors and institutions.

With regard to the role of extensionists, there is a shift towards – or rather the emergence of – an additional and complementary role as systemic facilitator (Clark 2002; Millstone et al. 2010; Rivera and Sulaiman 2009). Terms such as ‘innovation intermediary’ or ‘innovation broker’ have been coined to indicate this role (Klerkx and Leeuwis 2009; Kilelu et al. 2011). While these innovation brokers also aim to resolve communication problems between groups, instead of merely aiming at bridging a knowledge gap between science and practice/policy, they aim to bridge several other divides among groups involved in innovation and development. Such divides may be caused, for example, by different incentive and value systems for public and private actors hindering smooth collaboration, differences between local indigenous knowledge systems and formal scientific knowledge systems and ideological differences amongst different non-governmental organisations (NGOs) (Pant and Hambly-Odame 2006). Furthermore, innovation brokers help to get access to several other resources essential for innovation, such as capital, political support, business development services and material resources.

Leeuwis and Aarts have summarised the implications for extensionists or researchers of moving beyond a linear transfer of technology role and a mere focus on research, to becoming an innovation broker or systemic facilitator (see Table 2).

The role of innovation brokers may take shape in different ways, and may be executed by individual researchers (Schut et al. 2011), by research or extension organisations, NGOs, government agencies (Kilelu et al. 2011;
Performing innovation brokering roles in addition to ‘classical’ research and extension roles is challenging. It has been found hard to sustainably embed the innovation brokering role in a person or an organisation for which it is not (yet) the core-business. For example, as Rivera and Sulaiman (2009) argue, although extension organisations are pressed to develop into facilitating organisations that connect farmers with different sets of service providers, many still adhere to a linear transfer-of-technology paradigm. Hocdé et al. (2008) found that action researchers in the role of innovation brokers constantly had to defend this role and negotiate their status in their organisations as their colleagues saw this work as lacking scientific legitimacy (see also Schut et al. 2011). This calls for alternative reward and incentive structures that pay more attention and attribute more value to fulfilling an innovation broker role within the research process and building bridges between research, policy and practice (cf Schut 2012).

However, also when being an independent intermediary (i.e. not linked to a ‘classical’ organisation), fulfilling the innovation broker role is challenging. Even more than knowledge brokers who actively ‘pass on’ research knowledge (see e.g. Fisher and Vogel 2008; Shaxson and Gwyn 2010), the intangibility of the activities of innovation brokers make it hard to show to stakeholders what is the value of innovation brokering. Furthermore, the need to maintain a neutral position as an ‘honest broker’ (Pielke 2007) who connects different actors but does not have a strong normative orientation, requires careful manoeuvring in terms of positioning between multiple actors. It requires balancing between taking too much credit, and not having one’s contribution recognised; between steering processes too much and being too laissez-faire; between having sufficient expert knowledge to obtain a legitimate position in a network and acting too much as an expert and overruling contributions of the network partners; between empowering non-powerful actors in the network and starting to act as a spokesperson for these.

3 Conclusion: implications for thinking on knowledge brokering
As stated in the introduction, the goal of this article was not to present developments in the field of agricultural extension as an universal best-practice. However, it does offer a starting point for reflection on knowledge brokering. What the experience from agriculture shows, is that there is a need to move beyond narrow and simplistic ideas and strategies for enhancing the contribution of research to policy processes and development practice, and linking research producers to research users. Although a legitimate goal, and not denying that research makes important contributions to innovation and change processes, experience from the agricultural sector show that research is just one of many elements that influence the course and outcome of innovation and change processes. Following the innovation systems perspective, innovation requires work on changing relationships and institutions at different levels and the goes far beyond the focus on interfaces between research producers and research users.

The literature on knowledge brokering in a wide range of fields acknowledges that ‘producer’ and ‘user’ of knowledge are not rigid categories and that interactivity is required; moving from transfer, dissemination and consulting to engagement and collaboration (Bielak et al. 2008; Lavis et al. 2006; Lomas 2007; Meyer 2010; Michaels 2009). Nonetheless, the main focus appears to remain at the level of better inserting research into policy and practice. In that sense—and to use the examples presented in Table 1—it seems to have arrived at knowledge systems thinking as embodied in the AKIS perspective. However, given the similar complexity in which change and innovation in other sectors (e.g. health, development assistance, etc.) takes place, an innovation systems perspective could be useful as framework for analysis and action.

From an innovation systems perspective, a broader range of brokering tasks to support coordinated action in networks that are connected to innovation, policy and development processes are needed. Research uptake is important, and knowledge brokering is an essential function, but should be accompanied by or integrated within the function of innovation brokering (see also Fisher 2011: 6), which more broadly focuses on rearranging all technical, social and institutional relationships needed for...
innovation and change. Such a broad focus can contribute to creating an enabling environment for effective policy formulation and implementation, development and innovation. This appears not yet to be explicitly recognised and considered in many studies on knowledge brokering. Moving towards such an innovation broker role would require that ideas from innovation systems thinking are considered in and adapted to different fields. Additionally, awareness should be created as to what such an innovation broker role implies in terms of identity, capacities and mandate of those who intend to fulfil this role, and how it differs from a knowledge broker role. Also in the field of agriculture, this remains a great challenge.

Notes
1 Section 2 of this article draws heavily on a number of earlier publications by the authors (Leeuwis and Aarts 2011; Klerkx et al. 2012; Kilelu et al. 2011; Schut et al. 2011).

References


