Strengthening agricultural innovation capacity: are innovation brokers the answer?

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Abstract: Taking the case of Dutch agriculture as an example, this paper examines the emergence and role of innovation brokers in stimulating agricultural innovation system interaction and innovation capacity building, and reflects upon their potential role in developing and emerging countries' agriculture and how their emergence and functioning can be fostered. It concludes that innovation brokerage is likely to be relevant in developing countries, that public or donor investment may be needed to overcome inherent tensions regarding the legitimacy and funding of such players in the innovation system and that stimulating the emergence of innovation brokers requires a policy that supports institutional learning and experimentation to ensure that the brokers become locally embedded.

Keywords: agricultural innovation systems; innovation capacity; intermediaries; network linkage building; innovation brokers; innovation policy; agricultural extension; agricultural research; The Netherlands; developing countries; emerging countries; Africa; Asia; Latin America.

Reference to this paper should be made as follows: Klerkx, L., Hall, A. and Leeuwis, C. (2009) 'Strengthening agricultural innovation capacity: are innovation brokers the answer?', *Int. J. Agricultural Resources, Governance and Ecology*, Vol. 8, Nos. 5/6, pp.409–438.

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1 Introduction

In the current fast-changing multifunctional agricultural sector, innovation is a central strategy to achieve economic, social and environmental goals. Many countries are attempting to reform and evolve their agricultural innovation support arrangements to develop flexible and responsive capacities to achieve these goals. This is particularly urgent in developing countries as agriculture remains a central element of their economies and innovation is a key to the sustainable agricultural growth needed to reduce poverty (Thomas and Slater, 2006). Central to this reform and evolution process is the shift from a linear approach to innovation in which public sector agricultural research and extension delivers new technology in a pipeline configuration, to a systems approach in which innovation is the result of a process of networking, interactive learning and negotiation among a heterogeneous set of actors (Leeuwis, 2004; World Bank, 2006; Röling, 2009). The systems approach recognises that agricultural innovation is not just about adopting new technologies; it also requires a balance amongst new technical practices and alternative ways of organising, for example, markets, labour, land tenure and distribution of benefits (Dormon et al., 2007; Adjei-Nsiah et al., 2008).

Systems thinking in agricultural innovation has evolved over the years, through several approaches such as agricultural knowledge and information systems (e.g., Engel, 1995; Röling, 2009), Farmer Field Schools (e.g., Tripp et al., 2005), the Australian Landcare movement (e.g., Wilson, 2004) and the Farmer First movement (e.g., Scoones and Thompson, 2009). Recently, a blending of insights from the agricultural innovation literature and industrial innovation literature has resulted in the concept of agricultural innovation systems (AIS) (Hall et al., 2001; Pant and Hambly Odame, 2009; Röling, 2009). A national AIS is defined by World Bank (2006, pp.6–7) 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 the way different agents interact, share, access, exchange and use knowledge". Beyond researchers, extension agents and farmers, an AIS consists of all types of public, private and civil society actors, such as inputs and processing industry actors, agricultural traders, retailers, policymakers, consumers and NGOs. For specific innovation processes, flexible and dynamic innovation networks are formed from the network of actors present in national AIS or across different national AIS. These networks have been referred to as innovation coalitions by Biggs and Smith (1998), multistakeholder platforms by Röling (1994), innovation configurations by Engel (1995) or as public-private partnerships (PPPs) (Spielman and Von Grebmer, 2006; Hartwich and Tola, 2007; Hall, 2006). Besides stressing the fact that innovation requires involvement of many actors and effective interactions amongst these, the AIS approach recognises the influential role of institutions (i.e., laws, regulations, attitudes, habits, practices, incentives) in shaping how actors interact (Hall et al., 2001; World Bank, 2006). Although there is much emphasis on knowledge creation, exchange and use in the above definition of AIS, innovation systems need to fulfil several other functions that are essential for innovation. These functions include fostering entrepreneurial drive and activity, vision development, resource mobilisation (e.g., capital), market formation, building legitimacy for change and overcoming resistance to change by means of advocacy and lobbying (Hekkert et al., 2007).

For AIS to function and enhance *innovation capacity* in developing countries' agricultural sectors, the literature emphasises the need to come to shared visions, have well-established linkages and information flows amongst different public and private actors, conducive institutional incentives that enhance cooperation, adequate market, legislative and policy environments and well-developed human capital (Hall et al., 2001; Biggs, 2007; Spielman et al., 2008). However, creating and fostering effective linkages amongst heterogeneous sets of actors (i.e., the formation of adequate innovation configurations, coalitions, PPPs) is often hindered by different technological, social, economic and cultural divides (Hall, 2006; Pant and Hambly-Odame, 2006; Gijsbers, 2009). Such divides may be caused, for example, by different incentive systems for public and private actors, differences between local indigenous knowledge systems and formal scientific knowledge systems, social differences that cause exclusion of certain actors and ideological differences amongst different NGOs. Moreover, the World Bank (2006) study on AIS found that, even when there were strong market incentives for private actors to collaborate for innovation, linkage formation was still extremely limited. This suggests that public policy should play a role in promoting these linkages, but it is not clear how this should be achieved in practice. The AIS approach has proved its value as a comprehensive framework for analysing strengths and weaknesses in developing

countries' agricultural innovation capacity. However, it still needs to be transformed from an analytical concept into an operational concept with policy options and targeted interventions to improve everyday innovation capacity (Spielman, 2006). In practical terms, this means that questions need to be addressed such as how a production base made up of many farmers can organise its demand for knowledge, technology and organisational change; what mechanism will facilitate the search for information and cooperation partners; and who will coordinate the networks of interaction needed for innovation.

From an innovation systems perspective, the importance of having intermediary organisations that sit between and connect different actors involved in innovation trajectories in developing countries is becoming apparent (Szogs, 2008; Kristjanson et al., 2009). This type of intermediary should not just mediate a one-to-one relationship, but rather be a *systemic intermediary*, an in-between in a many-to-many relationship (Howells, 2006; Hartwich et al., 2007a). These systemic intermediaries act as *innovation brokers*, whose main purpose is to build appropriate linkages in AIS and facilitate multistakeholder interaction in innovation. So far, the agricultural sector has relied mainly on public sector intermediaries such as agricultural extension services, often with questionable effectiveness and a limited mandate to play such a systemic intermediary role (Leeuwis, 2004: Sulaiman et al., 2005; Rivera and Sulaiman, 2009). National governments and development assistance agencies now face the difficult task of identifying appropriate innovation brokerage arrangements in an agricultural scenario in which numerous challenges (e.g., sustainability, climate change, poverty alleviation, food security, agri-industrial development) need to be addressed simultaneously (Hall, 2008; Kiers et al., 2008). To inform policy formulation it is important to understand the effectiveness of different innovation brokerage arrangements (Hall, 2006). It is equally important to understand the process that governs the emergence and evolution of these arrangements in specific settings (Hall, 2005), because past experience shows that efforts to transplant organisational blueprints from one country to another are unlikely to be effective. The purpose of this paper is therefore twofold. Using the case of innovation brokers in the Dutch agricultural sector where considerable experience has been gained with innovation brokerage arrangements, the paper first explains the circumstances that have led to the emergence of these arrangements and discusses the role of policy in facilitating this emergence. Secondly, it outlines how these intermediaries look in practice and discusses the factors that determine their effectiveness. The paper concludes with a wider discussion of the implications of this experience for developing countries. Section 2 provides a brief review of the literature on innovation brokers in order to further clarify and demarcate the area of discourse and provide an analytical lens.

2 The role of innovation brokers as innovation system catalysts

The roles, performance and effects of specialised innovation brokers as facilitators of innovation in the industrial sector in Western countries are quite well-documented (e.g., Winch and Courtney, 2007; Johnson, 2008). Despite the existence of a broad literature on the facilitation of interactive processes and social learning in agriculture (see, e.g., Groot, 2002; Leeuwis and Pyburn, 2002), the literature on embedding this facilitation role as a specialised intermediary function in the AIS is still limited. Although mentioned as a solution to knowledge infrastructure and innovation system fragmentation

and underperformance, and researched in preliminary studies (Clark, 2002; Spielman and Von Grebmer, 2006; Hartwich et al., 2007a; Van Mele, 2008; World Bank, 2008; Kristjanson et al., 2009), the topic appears to have been less systematically investigated in the agricultural sector.

2.1 What is an innovation broker?

Howells (2006, p.720) coined the term *innovation intermediary*, defined as:

> "An organisation or body that acts as an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between, for bodies or organisations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations."

However, the provision of brokerage and mediation functions may often not be the primary role of an innovation intermediary as Howells argues, because these often "also cover more traditional contract research and technical services which involve no third-party type collaboration" (2006, p.726). To distinguish such specialised brokers from organisations that provide some innovation brokerage functions, but not as a core function, Winch and Courtney (2007, p.751) define an innovation broker as "an organisation acting as a member of a network of actors […] that is focused neither on the organisation nor the implementation of innovations, but on enabling other organisations to innovate".

2.2 What are the main functions of innovation brokers?

Innovation brokerage comprises several detailed functions (Howells, 2006) that can be reduced to three generic functions (Van Lente et al., 2003; Klerkx and Leeuwis, 2009a):

- Demand articulation: Articulating innovation needs and visions and corresponding demands in terms of technology, knowledge, funding and policy, achieved through problem diagnosis and foresight exercises.
- Network composition: Facilitation of linkages amongst relevant actors, i.e., scanning, scoping, filtering and matchmaking of possible cooperation partners (Howells, 2006).
- Innovation process management: Enhancing alignment in heterogeneous networks constituted by actors with different institutional reference frames related to norms, values, incentive and reward systems. This requires continuous 'interface management' (Smits and Kuhlmann, 2004) in which there is a 'translation' amongst the different actor domains, described as 'boundary work' (Kristjanson et al., 2009). Furthermore, it includes a host of facilitation tasks that ensure that networks are sustained and become productive, e.g., through the building of trust, establishing working procedures, fostering learning, managing conflict and intellectual property management (Leeuwis, 2004).

Innovation processes generally do not develop in a straightforward planned manner but are a result of self-organising networks [i.e., they are characterised by irregular progression and regression, and influenced by serendipity and events that lie outside of the direct sphere of innovation projects – see, e.g., Hekkert et al. (2007) and Sherwood (2009)]. Consequently, it is essential that these innovation brokerage functions are applied flexibly depending on the evolution of the innovation process.

2.3 Reported risks and drawbacks

Despite the potentially important role that innovation brokers can play, a number of risks and possible drawbacks have been identified with regard to their functioning.

Legitimacy tensions

A key factor for the legitimacy and credibility of innovation brokers is that they must have a trusted position as a relatively neutral 'honest broker' (Spielman and Von Grebmer, 2006). Such neutrality should not be seen as absolute because brokers always exercise a certain degree of steering (Laschewski et al., 2002). The degree of steering should however be acceptable for those actors amongst whom the broker is positioned. Innovation brokers should not become so involved with projects that they take over detailed management and take away ownership from the innovation network partners, and they should give equal attention to the goals and interests of each of the partners (Kuada and Sørensen, 2005). This is complicated because innovation brokers generally operate in an environment which to a greater or lesser degree is characterised by diverging and conflicting interests. Stakeholders (e.g., financiers of the innovation broker or participants in the innovation network) may exercise pressure to compose and facilitate networks in a way that fits their objectives (Isaksen and Remøe, 2001). Furthermore, innovation generally challenges existing practices with its corresponding role divisions, power relations and profit distribution. As innovation is about breaking out of current practices, sometimes innovation brokers need actively to help 'destroy' existing systems to be able to bring about new networks and new ways of thinking (Smits and Kuhlmann, 2004). This means that, in order to be able to build productive innovation networks, they may sometimes need to temporarily bypass parties with vested interests (Wagemans, 2005).

Function ambiguity

This tension plays out at the level of inter-organisational relationships in the innovation system as a whole and at the innovation process level. In inter-organisational relationships, the fact that innovation brokerage can be both a side activity of, for example, research institutes or extension service providers and the core business of a dedicated organisation (Howells, 2006) can cause tensions. It may imply that brokers' functions overlap with those of parties for which they intend to broker; and hence, they may be seen as a competitor rather than a facilitator. Also, there may be a lack of clarity about the actual benefit of having a mediating agent (Candemir and Van Lente, 2007). As a result of competing functions and perceptions about benefits, innovation brokers may alienate themselves from players in the existing knowledge infrastructure (e.g., research and extension providers), who nevertheless can be important as possible partners in the

network to be formed. At the process level, there is the tension of having a substantive involvement in the process versus having a role as a mere catalyst that just facilitates the cooperation process amongst actors without getting into the technical details (Kuada and Sørensen, 2005). In this sense, Williams (2002) discusses the dilemma in brokerage roles whereby, on one hand, technical knowledge about a certain subject can serve as a 'passport of legitimacy' because of the associated power and status. However, on the other hand, being a 'jack of all trades and master of none' may give a broker more ability to think holistically and freely associate because there is no 'mental lock-in', and to be less threatening to other network participants as they do not challenge them in their professional status (e.g., as experts in a particular field).

Invisible effects/willingness to pay

Assessing the impact of innovation brokers is considered difficult, given their indirect and sometimes invisible impact (Howells, 2006), although they may have had a determining role in achieving success instead of failure (Johnson, 2008). Main tensions include:

- Value assessment difficulties: difficulties in ex-ante evaluation of service value and low ex-ante identifiability of benefits may affect willingness-to-pay amongst private parties.
- Funding impatience: public funding is provided for too short a period and this impedes the innovation broker from becoming well-established (Rosenfeld, 1996), enhanced by the fact that innovation brokers' impact is hard to make visible with current evaluation methods aimed at 'hard' indicators such as patents (Rasmussen, 2008).

The following section explores whether the Dutch experience with agricultural innovation brokers can throw more light on the policy challenges faced by those seeking to reform national agricultural research and extension systems and strengthen agricultural innovation capacity in developing and emerging countries.

3 The emergence and role of innovation brokers in the Dutch AIS

3.1 The rise and fall of the research-extension-education triangle

Historically, the Dutch AIS was seen as synonymous with the formal knowledge infrastructure of public agricultural research, extension and education establishments, generally referred to as a *knowledge triangle* (Rivera and Sulaiman, 2009). This so-called research-extension-education triangle (REE-triangle) has been credited as a key factor in the development of innovative capacity within Dutch agriculture, making it an important global player (Roseboom and Rutten, 1998; Wielinga, 2001). This, however, could only be achieved because the REE-triangle was embedded within a broader institutional setting in which there was clear land-tenure legislation, a well-organised and strong influence of farmers on agricultural policymaking, a large number of farmer cooperative owned processing enterprises, cooperative farmer banks for credit provision, and a favourable subsidy regime for agricultural produce (Röling, 2009). The REE-triangle was

characterised by a high degree of interconnections and continuous alignment among farmers, agri-industry, research and extension establishments, and government. It was instrumental in the post-World War II policy on food security, and its focus on productivity increase and efficiency gains worked well until the 1970s (Wielinga, 2001). However, in the 1980s it became less successful. Increasing health and environmental awareness triggered a major rethink of agricultural production in the Netherlands and how the knowledge infrastructure should support that. As policy shifted towards reducing the environmental constraints, the interests of policymakers and farmers, that had once been aligned, started to become increasingly divergent. The policy view became that the REE-triangle needed to open up to new societal players (e.g., consumers, nature conservationists, the environmental movement) to deal with the new societal concerns, options and priorities. The agricultural sector (including the REE-triangle) responded slowly to the redefined public interest and became viewed as an obstacle to desirable change (Wielinga, 2001).

Furthermore, as part of a wider wave of reform and privatisation of public services, the government responded to these problems in the REE-triangle by embarking from 1990 onwards on a trajectory of privatisation of research and extension establishments (Roseboom and Rutten, 1998). Its aim was to make room for new providers of research and extension services, and to change the service delivery culture (of providers) and the expectations (of clients) from supply-driven to demand-driven approaches. This also led to increased competition and the shielding-off of information among research and extension organisations in an emerging knowledge market setting. Whereas in the public knowledge infrastructure, information was freely shared between research and extension, the fact that it became a commodity meant that information needed to be purchased from research and extension providers who had no commercial interest in giving it away (Wielinga, 2001).

These policy and institutional changes weakened the once strong linkages amongst agricultural research, extension, farmers, agri-industry and government, which were seen as key factors in the success of the REE-triangle.

3.2 Different types of innovation brokers emerge

The ‘collapse’ of the REE-triangle induced fragmentation of the knowledge infrastructure and also brought about the recognition – central to innovation systems thinking – that all types of public, private and civil society actors are relevant and should be connected in innovation processes. As a response to the need to counteract knowledge infrastructure fragmentation and connect heterogeneous sets of actors, intermediary organisations with the function of agricultural innovation brokers came to prominence. These emerged both as a policy intervention and as a pragmatic response on the part of civil society, farmers’ organisations and the private sector to social and economic challenges and opportunities. An initial attempt by the government to establish a central innovation broker proved non-viable. It was viewed as having a biased agenda (i.e., that the broker represented purely the government’s interest, which did not correspond with farmers’ interests) and could not cope with the increasingly dispersed and autonomous set of networks that emerged after reform (Wielinga, 2001). At the same time, various types of innovation brokers emerged in a more self-organised manner at regional and subsectoral levels, with the goal to restore and optimise the linkages in the Dutch AIS. Such innovation brokers

were generally established in a concerted effort by private (research and extension providers, farmers' organisations) and public parties (municipalities, provinces, the ministry of agriculture). These parties either subsidised these organisations or participated as shareholders. However, the motivations of individual founders were not always altruistic, as goals such as profit seeking and policy realisation were reasons to invest. Following the function-based typology of Klerkx and Leeuwis (2009a), we now give examples of the seven distinct types of agricultural innovation brokers that can currently be seen in the Netherlands.

Types 1 and 2 Innovation consultants

These organisations focus either on the individual farmer (Type 1), or on a collective of farmers with a common interest, who wish to jointly develop or implement an innovation (Type 2). They focus mostly on incremental innovations. They make an innovation strengths, weaknesses, opportunities and threats (SWOT) analysis of a farm, define an innovation strategy with the farmer and help to find and guide interaction among cooperation partners. Most often, the SWOT-type analysis and the identification of cooperation partners and information sources are initially provided free of charge. Innovation consultants can have different organisational formats: for-profit private firms, government agencies and non-profit foundations. These organisations often have a regional coverage, attending different types of farms. An example is the Agricultural Knowledge Centre North Holland (AKC-NH), which emerged out of concern about the closure of a regional experimental station. It was jointly funded by provincial and local government, privatised research and extension providers, regional agricultural colleges and the regional farmers' organisation. An example of its services is the guidance it provided in the search for a flower bulb disease detector to automate disease detection and reduce labour costs. Instead of ending up at the 'default', formerly public agricultural research institutes, in its role of a neutral broker the AKC-NH searched for available knowledge in public and private, agricultural and non-agricultural, research institutes and R&D departments of large companies. Having found a candidate technology, AKC-NH then searched for subsidies to conduct feasibility studies as the investment risk for farmers was too high. Furthermore, it helped maintain energy and stamina in the process, mediated between the different cultural worlds of the actors involved and guided the process of intellectual property protection.

Type 3 Peer network brokers

These organisations usually have a subsectoral focus (such as horticulture, pig farming). They concentrate on the formation of peer networks concerned with informal knowledge exchange amongst farmers. In the Dutch agricultural sector, so-called study clubs, which resemble concepts such as Farmer Field Schools, traditionally had this function. Because of diversification of farmer interests, a decreasing number of farmers, and the fact that free of charge facilitation from the public agricultural extension service is no longer available, the original study club concept has been considerably weakened. The peer network brokers are an attempt to revitalise the study club concept, and besides a small participation fee paid by farmers they are generally supported with public funding. An example is the Dairy Farming Academy (DFA), whose goal is to set up new farmer

networks on the basis of shared interests (Klerkx and Leeuwis, 2009b). Networking activities include information exchange through an online databank, network members' farms being used as demonstration farms, experienced farmers acting as business coaches for less experienced farmers, best practice meetings in which farmers discuss a theme of common interest and master classes by non-agricultural entrepreneurs. To be able to closely identify with farmers' life worlds, facilitators themselves are dairy farmers.

Type 4 Systemic instruments

The main difference in the systemic broker compared to the previous three is that it goes beyond individual firms or networks of firms. It targets higher level innovation architectures that involve complex constellations of business, government and societal actors, dealing with complex problems and radical innovations (i.e., those that require a considerable reordering of social and economic routines and relationships). This type of innovation broker is often a civil society organisation (but with public funding), reflecting its interests in innovation and policy issues that go beyond the conventional domain of government or the private sector. A Dutch example is the Innovation Network Rural Areas and Agricultural Systems (INRAAS), described by Smits and Kuhlmann (2004). It was established in mid 2000 to address challenges such as reducing the detrimental effects of agriculture on the environment and the need to shift from bulk production to multifunctional agriculture. This complex agricultural agenda required intermediation between a diverse set of agricultural and non-agricultural actors. INRAAS aims to manage a collective systemic approach to agricultural innovation, through foresight exercises, network building and initiating experiments to jointly identify, develop and implement innovative opportunities. Beyond participating actors, INRAAS also aims to bring about change in underlying policies, rules, habits, standards, procedures and laws. Following INRAAS, a number of subsectoral instruments have been set up such as SIGN (Dutch Greenhouse Horticulture Innovation Foundation). An example of the radical innovations this type of organisation facilitates is SIGN's facilitation of a project on the greenhouse as an energy source instead of as a major energy user. At the conception of the idea eight years ago, it was seen as a ridiculous idea, but now there is a working prototype. This did, however, require reorganisations; for example, in the way the electricity grid can be used. This involved energy companies and regulatory government bodies, and thus transcends the level of the individual greenhouse owner.

Type 5 Internet portals

A large variety of internet portals have developed in the Dutch agricultural sector and display relevant information, such as agricultural news, market information, and 'yellow pages' of service providers, the function of which is to connect farmers with these information sources. These portals may be stand-alone efforts or part of a research project. They are sometimes operated commercially, or are paid for by subsidies from government or commodity boards. Examples include the agri-logistics knowledge portal for linking actors and knowledge developed in several projects relating to agri-logistics (Van Baalen et al., 2005) and the web-based question-answer databank integrated in the previously described DFA.

Type 6 Research councils with innovation agency

Although in the Netherlands, farmer-driven research planning mechanisms have traditionally existed, these do not always forge broader linkages in the innovation system (Klerkx and Leeuwis, 2008a). A new sort of research council has recently emerged, called Bioconnect. Through Bioconnect, all relevant actors in the organic agriculture value chain [organised in product workgroups (PWGs)] have been granted decision-making authority in research funding, utilising public funds of the Ministry of Agriculture (Klerkx and Leeuwis, 2008b). PWGs are expected to propose topics based on a broadly shared demand from their constituencies, which they discuss and prioritise with research coordinators in order to make research fit with sector needs. Within PWGs, a so-called knowledge manager fulfils the role of facilitator, streamlining the flows of information and mediating between the different actor groups involved. Bioconnect also facilitates the participatory research that results from the agenda setting process and links research with legislative and market developments. It thus tries to ensure that research results have impact and are accompanied by a broader set of changes needed for innovation.

Type 7 Education brokers

Because the Dutch Ministry of Agriculture continues to fund agricultural education, basic research and research that supports policymaking, it has responded to a perceived lack of interaction amongst agricultural (vocational) education establishments, research institutes and practice by supporting the set-up of the so-called Green Knowledge Cooperative (Kupper et al., 2006). Besides linking the several education establishments, it aims to position the agricultural schools as regional knowledge centres that respond to innovation queries from the agricultural sector, involving teachers and students. Another example is the so-called content broker, which helps to find material for teachers to use in their classes, such as journal articles, educative computer models and manuals.

3.3 The observed contribution of innovation brokers

Several studies have looked at the contribution of the Dutch agricultural innovation brokers (Klerkx and Leeuwis, 2008b, 2008c, 2008d, 2009a, 2009b; Batterink et al., 2010) in terms of their influence on the way innovation arrangements are organised (roles, responsibilities and patterns of interaction) and how routine working practices and policies (institutional setting) have changed. No studies have been carried out so far on the economic efficiency of innovation brokers. Such a study is not easy to carry out given their rather intangible and behind the scenes mode of operating. This is further illustrated in Section 3.4. Below, we discuss the main findings in terms of whether innovation brokerage mechanisms have, or have not, fulfilled the functions, outlined in Section 2, that are needed to establish dynamic, responsive AIS.

In the sphere of demand articulation, they have helped farmers and other agri-food stakeholders to think about new possibilities to sustain their businesses. Because of their unbiased position, innovation brokers appear to provide a fresh look at diagnosing the constraints and opportunities of farmers or, at a higher level, production chains, regions

or subsectors. Because innovation brokers are critical and provide a mirror for self-reflection, they tend to force their clients to look towards the possibilities beyond their current situation and constraints.

In the sphere of network building, there are numerous examples where innovation brokers have helped farmers, and others that want to initiate innovation projects (innovation champions), to get in touch and negotiate with project partners and other relevant stakeholders from the policy, market and civil society domain, as well as with the most suitable research and extension providers who could assist them in orienting towards new activities. They hence make a variety of knowledge sources and cooperation partners available; this is essential for developing the new combinations that are central to innovation. At a higher system level, they have contributed to the development of innovation agendas, and radical and/or systems innovations to meet future challenges, by performing foresight exercises and initiating innovation projects that bear a high risk of failure. This has resulted in several new concepts, some of which where initially regarded with suspicion and disbelief, but now have become viable new development strategies.

Finally, it has been confirmed that innovation process management is an important function that can be performed by innovation brokers. Innovation processes tend to involve different groups of actors, with different expectations and interests determined by their institutional background. For example, farmers often want instant access to applicable knowledge and quick results, research providers have an interest in undertaking (publishable) research, policymakers want to realise their policy goals and see the results of public investments. The interested parties thus differ with regard to the time horizons of projects and the desired output. Innovation brokers have clearly facilitated cooperation and managed to synchronise expectations of different actor groups during a number of innovation processes. They have reportedly made the different project partners aware of their institutional backgrounds and expectations and of the role they can fruitfully play in the innovation process. Moreover, they have been successful in making transparent the risks and benefits that are attached to engagement in the innovation process, reducing uncertainty in the early stages of innovation processes that would preclude private parties from innovating (see Johnson, 2008). In addition, they act as a 'translator' between the different cultural worlds and perform mediating roles in the event of conflict about; for example, the attribution of intellectual property rights, strongly diverging goals and visions or the division of funds. The involvement of innovation brokers in innovation processes hence avoids inertia and accelerates the process by helping project members maintain their focus and energy during the process. Beyond the level of the single project, innovation brokers fulfil a catalyst role (to bring about change and stimulate cooperation), a liaison role (e.g., to inform policy) within the AIS, and also an innovation capacity building role.

3.4 Observations regarding the inherent vulnerabilities of innovation brokers

Not surprisingly, the vulnerabilities that are reported in the general literature on the structural embedding of innovation brokers in the innovation system also seem to play a role in the Dutch AIS. Below, we indicate how these have expressed themselves and what lessons can be learned.

Legitimacy tensions

Besides the recognition that total neutrality is hard to achieve and sometimes also counterproductive in facilitating innovation processes, there are several pressures on innovation brokers that may impair their legitimacy. As stated earlier, to restore knowledge infrastructure linkages and optimise innovation system interaction, several parties in the Dutch agricultural sector supported the set-up of innovation brokers through concerted action. However, a social dilemma situation manifested itself in that the benefits for the collective were recognised (enhancing innovation systems performance by facilitating the formation of linkages amongst system components), but parties also wanted to realise conflicting individual goals through an innovation broker as a condition for (financial) support. For example, the providers of research and extension that contributed financially as shareholders or financiers of several Types 1 and 2 innovation brokers (e.g., the previously mentioned AKC-NH), explicitly or implicitly expected some form of return on investment. They wanted to be seen as 'preferred supplier' and showed unwillingness to cooperate with other (competing) knowledge providing parties, hence, forcing innovation brokers into the role of procurement instruments. Although most innovation brokers did not adhere to such preferred suppliership, it had negative effects on their perceived impartiality as regards partner selection and matchmaking (especially amongst other research and extension providers) and thus had the potential to hamper collaboration.

Innovation brokers also risk becoming, or being seen as, vehicles to realise policy objectives of financiers. Externally imposed goals may inhibit, or destroy, (informal) interactional patterns conducive to innovation. For example, a government-funded innovation broker that aimed to stimulate multistakeholder interaction and learning on nutrient management was perceived by farmers as having a direct link with the realisation of undesired government policy (Klerkx et al., 2006). It hence never gained credibility and quickly disappeared. Contrasting objectives may also cause loyalty conflicts with financiers and clients. In the case of DFA, the ministry of agriculture as financier wanted DFA to focus on advanced in-depth learning activities, whereas farmers preferred to have casual knowledge exchange on day-to-day experiences. Being driven by both farmer demand and financier demand produced a dilemma for the innovation broker as to whose demands to favour (Klerkx and Leeuwis, 2009b). These tensions indicate that, as a basic condition for effectiveness, innovation brokers should be given the freedom to operate independently.

Function ambiguity tensions

As regards function ambiguity, independent innovation brokerage is not always fully understood and accepted. This is partly due to the response from established players (i.e., the established research institutes and extension providers) to the revitalisation and innovation catalyst mission of the Dutch innovation brokers – which is about breaking with old structures, establishing new partnerships – and partly due to the overlap with existing or new functions from traditional research and extension providers.

For example, in the case of KnowHouse, a Type 1/2 innovation broker (see Klerkx and Leeuwis, 2008d), research and extension organisations welcomed its demand articulation and network composition functions, but saw it as a competitor in the

provision of certain services during the innovation process (innovation process management). They felt that KnowHouse forced itself in between them without adding value, but taking up project money. Farmers' representatives positively evaluated KnowHouse's contribution to innovation, but saw KnowHouse's role as opinion leader as a threat. There was, hence, vagueness about the different roles that KnowHouse was desired to play. The result of this is that, despite the innovation broker having a positive influence on network formation and on the effectiveness of cooperation in the innovation process, parties may lose confidence in the innovation broker as they are not sure what it actually does and represents. This indicates that the role of innovation brokers should be made clear to the parties with whom they work, that parties should be made aware of what they can expect from the innovation broker and what activities are undertaken by the innovation broker and by the network participants themselves.

Tensions regarding funding and willingness to pay

Tensions such as low private willingness to pay and public funding impatience appear to be felt in the Netherlands particularly by innovation consultants and peer network brokers (Types 1, 2 and 3) who offer services to optimise innovation at the level of the individual farmer, such as AKC-NH, KnowHouse and DFA. Types 4, 6 and 7 appear to receive more continuous funding as the radicality of the innovations they wish to support is of such a nature that it is commonly accepted that private investment will be initially low or they align with public concerns of government.

Either way, the Dutch innovation brokers have to continuously struggle to prove their usefulness because their process-oriented services take place in the early phases of the innovation process of which the course is unpredictable and they are highly intangible and invisible. Innovation brokerage is thus non-compatible with specific, measurable, agreed, realistic and time-bound (SMART) criteria. Innovation brokers often choose to operate in the background, or their contribution cannot be easily distilled as they operate in multi-actor networks. Their contribution to a successful innovation is thus in hindsight often taken for granted by clients. If this work is done on a fee-for-service basis, there is often little initial incentive to pay for such a service and for-profit organisations experience difficulties charging for it: their income is often largely derived from public funds through the innovation subsidies that they channel. Publicly financed organisations do not have this complication as the cost of their activities is covered, but the difficulty of showing the effect of activities on the end result may undeservedly negatively influence impact evaluations.

As a response to these funding tensions and changes in funding schemes (i.e., the gradual withdrawal of public funding to make innovation brokers self-financing), innovation broker organisations may also simply cease to exist because they cannot make innovation brokerage activities profitable. Another possibility is that they become a 'content-providing' consultant rather than a facilitator; this may hamper the demand articulation and network composition function, as brokers are no longer seen as neutral and credible in their function of referral service and matchmakers.

The problem of unstable public policy and the difficulty in showing innovation brokers' impact in evaluations is illustrated in the case of Innovation Supportpoint Wageningen (ISW). Government-funded ISW had high client satisfaction but was nevertheless discontinued. However, one year after dissolving ISW, the Ministry of Agriculture decided to co-invest in a pilot project aimed at including the agricultural

sector within the service provision of Syntens (a non-agricultural innovation broker financed by the Ministry of Economic Affairs). Syntens essentially provided the same services as ISW. Despite this vicious circle of short-term funding – disappearance of the innovation broker – and renewed funding of a similar innovation broker, it is specific policy to publicly support innovation brokers only temporarily (exceptions include the systemic instruments of which there is more acceptance that facilitating radical innovation costs time and that failure is inherent in radical innovation) and that they should become self-sufficient. Such a short-term vision is symptomatic of the current market-based Dutch agricultural knowledge infrastructure in which there is an emphasis on short projects that have to compete in competitive grant schemes to secure continued funding and have to serve specific policy objectives that may radically change. From the Dutch cases, it is clear that the demand articulation and network composition activities need continued public funding. However, the innovation process management function, if added value is recognised, could be funded by means of private payments from network participants. This function could then also be fulfilled by research and extension service parties who have facilitation as a new activity, and thus the perceived function ambiguity could be resolved.

3.5 Overall lessons from the Dutch experience

After 15 years of experimenting, there appears to be a growing recognition of the value of innovation brokers in the new AIS in the Netherlands. The fact that they have become more accepted is shown by the increase in the number of innovation brokers of all types, with the result that there is now a complete palette of innovation brokers for different subsectors (see Klerkx and Leeuwis, 2009a). This is not the result of coordinated policy, however, but generally of regional or subsectoral initiatives, as most innovation brokers emerged and continue to emerge in a bottom-up fashion. It remains a fundamental challenge to sustainably embed the innovation broker function in the AIS. A policy implication is hence that a considerable incubation period is required to change attitudes towards supporting the intangible and invisible services provided by innovation brokers. Without this period of incubation, neither policy nor private support will emerge to sustain them.

A related point is that the effectiveness of these mechanisms also rests on a much wider set of institutional settings than might be imagined, for example, the perceptions of the role and, most importantly, the value of brokers in society. These perceptions and accepted ways of working are themselves changing over time as a result of experimentation with brokerage. In other words, the incorporation of innovation brokers into the AIS of a country, and hence their effectiveness, is truly dependent on a contextual process of institutional and policy learning, and this is likely to be a long-term process. This of course raises a larger question. If the effectiveness of brokerage mechanisms is determined by institutional and policy learning at a macro level, how can this be accelerated? This question in turn points to the fact that public policy may have to assume a new role and approach in its efforts to promote innovation because of the systemic and evolutionary nature of the capacities involved, as the Dutch case has shown.

The following sections chalk out some of the practical implications of the Dutch case for developing countries looking to strengthen their agricultural innovation capacity.

4 Innovation brokers in developing and emerging countries – observations and options

A key question is whether the Dutch experience bears relevance to AIS in developing countries and emerging economies, or is uniquely determined by the Dutch institutional setting. In this section, we discuss the emerging experience with innovation brokers in developing and emerging countries and reflect upon what the Dutch experience implies for policy to foster their emergence and functioning.

4.1 Conditions for innovation brokers' emergence and functioning may differ

The Dutch AIS used to be characterised by great cohesion and the supporting knowledge infrastructure has been fully privatised, but the situation may be different elsewhere. In many developing and emerging countries, the knowledge infrastructure is still largely public [see, e.g., Rivera and Alex (2004a, 2004b) for an overview)]. Also, many countries are characterised by 'immature' AISs (Chaminade et al., 2009) that lack a functioning knowledge infrastructure and are characterised by inadequate institutional frameworks (in terms of well-functioning legislation, markets and interaction patterns). It should be kept in mind that different cultures of collaboration elsewhere may affect the potential effectiveness of innovation brokers (for example, in terms of building trust, achieving a collective goal) because of the cultural organisation of interaction amongst actors at different social and economic positions and issues like clientelism, social exclusion, nepotism and corruption (Lenné, 2008; Pant, 2009). The problems and challenges that need to be tackled may also be different. Although not exclusive to developing and emerging countries, but maybe even more severe and pressing in light of rural poverty and natural resource scarcity and degradation, problems that need to be addressed include: dealing with competing claims on natural resources, inclusion of the poor and giving them a voice in the development process, equitably integrating smallholder farmers in global value chains. Hence, differentiated approaches are needed in broker design depending on asset positions, favourable or unfavourable production environments, gender issues and power distribution (Berdegué and Escobar, 2002; Van Mele, 2008; Pant, 2009; Kristjanson et al., 2009). But whereas the problems and challenges in agriculture and the circumstances in which these need to be tackled may differ from those in the Netherlands, there is a similar need to enhance effective networking in a fragmented AIS to deal with the challenges of multifunctional sustainable agriculture (Clark, 2002; Sulaiman et al., 2005; Hall, 2006; Spielman et al., 2008; Rivera and Sulaiman, 2009). Hence, a relevant question here is: Who are the innovation brokers in developing and emerging countries' agriculture?

4.2 Recent experience of innovation broker functioning in developing and emerging countries

A review of the literature shows that there are already many parties fulfilling innovation brokerage roles adapted to the problems and challenges of developing and emerging countries. It is beyond the scope of this paper to give an in-depth analysis of all these initiatives. Nonetheless, the review already shows a great diversity of organisational structures, issues tackled and approaches used. Examples include:

- *National NGOs.* Goldberger (2008) describes the way Kenyan NGOs have brought together several actors in Kenyan agriculture to facilitate the transition to organic agriculture in export horticulture production, assisting farmers to connect with scientists to acquire scientific legitimacy for organic practices and, hence, get increasing support from the Kenyan state and donors. As a result, socially and geographically disparate social worlds (NGOs, foreign donors, agricultural researchers, self-help groups and individual farmers) have united to challenge the environmentally destructive and inequitable Green Revolution technological package regime through the promotion of organic agriculture among Kenyan smallholders. An example of an international network of national NGOs is the PROLINNOVA initiative (Waters-Bayer et al., 2009), which comprises several national NGOs in African and Asian countries that act as facilitators of pro-poor innovations. PROLINNOVA focuses on the development and scaling-up of local innovations of farmers by linking these with other farmers, traders, craftspeople, researchers and extensionists, through what it calls *participatory innovation development* (PID). Apart from stimulating developments at the local level, PROLINNOVA tries to bring about institutional change among research managers, development administrators and policymakers by raising awareness of local innovation processes. They thus aim to establish a coordinated country programme. They do this, for example, by means of field visits by policymakers to local farmers, bringing farmer innovators to workshops, or by organising 'farmer innovation markets' in which local innovators share experiences. PID processes can be supported by a local innovation support fund set up by PROLINNOVA. Similar to PROLINNOVA's PID approach, the International Centre for development oriented Research in Agriculture (ICRA) aims to build Agricultural Research for Development (ARD) partnerships in sub-Saharan Africa and Latin America (ICRA, 2008; Hawkins et al., 2009). ICRA either acts as innovation broker itself or builds local innovation brokerage capacity to support collective innovation approaches based on multi-stakeholder participation and interactive learning.
- *International NGOs.* Clark et al. (2003) and Hall et al. (2007) document the activities of an international NGO, International Development Enterprises (IDE), in managing, respectively, packing technology and low cost irrigation pump innovations in India and Bangladesh. As regards the latter, IDE facilitated and coordinated not only interaction amongst actors in the irrigation pump supply chain, but also with policy actors. Because of IDE's intervention, the focus was not just on development of a particular technology, but more broadly on how to realise the vision of effective irrigation water provision to the poor. This called for institutional innovations, such as changes in incentive mechanisms for public and private actors, and creating effective demand for this kind of technology to enable the emergence of a self-sustaining market. The Latin American Grupo Chorlaví (Ramirez and Pino, 2008) uses the concept of social learning as a way to bring about dialogue and cooperation among to the diverse set of public, private and civil society actors in the rural areas of Latin America. The aim of Grupo Chorlaví is to facilitate capacity building and institutional change by enabling the exchange of experiences on creating sustainable natural resource management practices and the improvement of rural livelihoods. This is done by organising multi-organisational exchange of

experiences through internet-based platforms, with an average of 300 active and 4,000 passive participants.

- *International donor agencies.* Kuada and Sørensen (2005) describe the role of the Danish development agency, Danida, in fulfilling the role of broker in inter-firm collaboration in Ghana. From a third party perspective, Danida tried to bridge the cultural differences between Danish firms and Ghanaian firms in agri-food related industries as diverse as fishnet manufacturing and juice extraction. By doing so, they helped to build trust and establish clear expectations about the nature of the cooperation. Van Leeuwen et al. (2007) describe the activities in several Latin American countries of the Dutch development organisation, SNV, which acts as an intra-organisational broker for its advisors. SNV connects its own advisors to each other, as well as to advisors from other organisations. In this way, thematic networks on, for example, the theme 'linking the poor to markets' have been established, ranging from 25 to 90 advisors. Because of the experience sharing in these thematic networks, advisors have been able to better serve their clients (e.g., local groups of farmers), and these networks have enabled advisors to find relevant additional experience and expertise for specific problems faster. Experience sharing was supported by installing internet-based knowledge sharing sites and information repositories.
- *Farmer and industry organisations.* Heemskerk and Wennink (2004) describe the role of farmers' organisations in bonding African farmers into farmer groups, connecting these with other organisations and linking them to formalised agricultural research and extension to influence research and extension agenda setting and execution. In the Colombian cut flower industry, the Ceniflores innovation centre was set up by producers' associations to act as an independent broker between the industry and research institutes. It supports demand articulation to set adequate research priorities to address the sector's needs through an information and communications technology (ICT) platform connecting the demand side (the growers) and the supply side (the researchers) (Lee and González, 2006).
- *Experiments in (inter) national research programmes.* The National Agricultural Innovation Programme of the Indian Council of Agricultural Research focuses on the establishment of what it calls 'consortia' of public research organisations in partnership with farmers' groups, the private sector, civil society organisations and other stakeholders around agricultural development themes (NAIP, 2009) The Sub-Saharan Africa Challenge Programme (SSA-CP) hosted by the Forum for Agricultural Research in Africa applies the Integrated Agricultural Research for Development (IAR4D), which is based on innovation systems thinking. The programme has set up several so-called innovation platforms in eight African countries including a wide array of stakeholders (farmers, farmer organisations, NGOs, input suppliers, traders, national and international research organisations, extension services) and aims to stimulate both technological developments and the necessary institutional innovations that need to accompany it (FARA, 2009). Similar objectives are held by the Convergences of Science (CoS) programme. The first programme (2001–2006) in Ghana and Benin was aimed at joint diagnostic studies by farmers and scientists. Because of the observed importance of establishing wider stakeholder networks and promoting institutional change (see Nederlof et al., 2007),

the second so-called CoS-SIS programme (2008–2013) has a broader scope aimed at enhancing overall AIS interaction in Benin, Ghana and Mali on themes such as cocoa production, co-existence between humans and crocodiles in freshwater basins and food security. This includes the involvement of specifically trained 'innovation coaches' who act as innovation brokers (Gildemacher and Pyburn, 2009) and facilitate what are called multistakeholder consultation and innovation groups. The Research into Use (RIU) programme of the UK Department for International Development (DFID) is currently experimenting with and facilitating multistakeholder innovation platforms similar to those in the SSA challenge and COS programmes. This is coupled with an innovation fund to which organisations in the African and Asian countries where RIU works submit proposals for adapting and using research results. Those that are funded should set up coalitions or other partnerships with end-user groups and intermediaries such as farmer organisations, extension agents, NGO networks and policymakers.

- *Descendants of special projects.* Bentley et al. (2007) describe the Bolivian Innova project that acted as a demand articulator for farm technology, with subsequent network formation. The project defined farmers' explicit and implicit expectations about several types of technologies (e.g., soil conservation, integrated pest management, animal traction), and set up a dialogue with researchers who adapted and developed these technologies accordingly, which were then again tested and adapted again. This was done by means of stratified surveys and so-called technology fairs in which farmers could see and react to new versions of technologies. In this way, demand-driven research was institutionalised. Clark et al. (2002) documented the evolution of the Andhra Pradesh-Netherlands Biotechnology Programme (APNLBP) into a self-financed broker of research and development projects focused on using biotechnology to address smallholder agriculture. Initially, this concerned traditional biotechnology (tissue culture, microbial inoculants and bio-control of pest) and later advanced biotechnology (including genetic transformation, for example, Bt castor). APNLBP established a local Indian steering committee and programme office that acted as innovation broker. Through what was called an integrated bottom-up approach, APNLBP facilitated that NGOs rather than research organisations (as scientists usually dominate the debate and research agenda), conducted needs assessment with farmers and facilitated their involvement in the further research programme. Thus, conventional laboratory-centred research was combined with farm-centred research, and this allowed both scientists and development workers to create and experience the institutional innovations necessary to allow biotechnology to be adapted to the problems of poor farmers (Hall, 2005). Main achievements include scientists having direct contact with the lifeworlds of farmers (which is uncommon in the strongly hierarchical Indian society) and getting a better idea what is needed for uptake and use of their research findings, and the building of linkages and trust between researchers and NGOs to provide a basis for future collaborations.
- *Research organisations or affiliates.* Van Mele (2008) suggests that the innovation broker role could be a new role for the institutes from the Consultative Group on International Agricultural Research (CGIAR), and there is growing experience on

this. Spielman et al. (2007) describe the AGRONATURA Science Park at the International Centre for Tropical Agriculture in Colombia, hosting private companies and research and development organisations, and aiming at building public-private relationships. Devaux et al. (2009) describe the role of the International Potato Centre (CIP) in Peru as innovation broker in the context of value chain innovations ('linking farmers to markets') in Peru, Bolivia and Ecuador through the Papa Andina network. By applying a so-called participatory market chain approach, relevant market chain actors were connected to each other to discuss possible innovations and trust was built amongst organisations as diverse as agricultural research organisations, NGOs, farmer groups and traders, which usually keep at a distance from each other. These actors were brought together on stakeholder platforms, both at a local level amongst potato providers, local authorities and a range of service providers (e.g., inputs), and also at a market chain level, including traders, processors, supermarkets, researchers and extension agents. As a result, new products have been created with greater added value for small farmers. An example are potato chips marketed in Peru under the Lay's label owned by multinational corporation Pepsico, made from indigenous potato varieties produced by smallholders (Thiele et al., 2009). In a similar vein, Kristjanson et al. (2009) describe several efforts of the International Livestock Research Institute (ILRI) to facilitate pro-poor livestock husbandry-related innovations. Here, the 'Innovation Works' unit created several so-called learning platforms of public and private stakeholders, mediated by local facilitators hired by the different projects. Such platforms often also took the form of 'safe places', creating environments outside each of the organisations involved, thus establishing a more neutral space conducive to creativity and co-creation (i.e., bypassing distorting dominant groups committed to maintaining the status quo). A concrete example of this was the facilitation of the inclusion of local pastoral Kenyan Maasai communities as equal partners in the drawing up of a land-use master plan, in which local and scientific knowledge was combined. This enabled the Maasai to have a voice in the policy debate from which they had been so far excluded. A major achievement in this regard was that the facilitators tackled the huge power imbalances across their multi-partner project team, such as the often unrecognised power of scientific experts. It pursued multiple strategies (e.g., hiring local community members as members of the core project research team, joint creation of knowledge by a hybrid community-scientist team) to build trust and demonstrate respect for the knowledge of all partners in the project. However, in other cases, power imbalances could not be overcome by projects.

- *Specialist intellectual property rights brokers*. Hall (2005) describes the International Organisation for the Acquisition of Agri-Biotechnology Applications (ISAAA), a non-profit organisation established to broker access for developing country research institutes to technologies, genes and protocols owned by the private sector or held in public laboratories in developed countries. An example is the partnership it brokered between the Kenyan Agricultural Research Institute and Monsanto in the development of virus resistant sweet potato. Monsanto had the virus resistant gene and trained Kenyan scientists in genetic transformation techniques. The gene was then transferred into Kenyan sweet potato germplasm. However, the relevant network was confined to research organisations and, consequently, the limitations of this partnership meant that it was hard to get the technology to the fields because of

weak links with extension organisation. Even more worrying in this case is the fact that the lack of connection with farm reality may have been responsible for the selection of a gene conferring resistance to the wrong virus: it appears that the gene does not give protection against the commonly occurring sweet potato virus in Kenya. Omanya et al. (2009) describe a similar role of the African Agricultural Technology Foundation, a non-profit organisation that negotiated a royalty-free licence with Monsanto to develop a transgenic cowpea variety resisting the pod-boring insect, *Maruca vitrata*, a serious field pest of cowpea that is estimated to cause significant grain yield losses. In contrast to the virus resistant sweet potato, local adaptations are being made to fit local conditions.

- *Government organisations or affiliates.* Hartwich et al. (2007b) and Gandarillas et al. (2007) describe the development of the Bolivian Sistema Boliviano de Tecnología Agropecuaria (SIBTA), a joint government-NGO supported initiative combining a fund for applied technical innovation projects and a knowledge management (KM) scheme based on the idea of markets for local knowledge. Implicitly, this scheme permitted networking among a range of agents (i.e., farmers, researchers, policymakers, development organisations) in the Bolivian AIS. Vera-Cruz et al. (2008) describe a similar development of the Mexican Produce Foundations, which established a link between the demands of farmers and the funding of agricultural research. It gave farmers the opportunity to establish the research priorities, hence, making research more demand-driven; and the better performing Produce Foundations also had an active manager who facilitated broader innovation systems interaction. Bell and Juma (2007) and Nelson (2007) describe the respective role of the Fundación Chile and Corporación de Fomento de la Producción (CORFO). These organisations boosted the networking with foreign technology sources (through country visits, facilitating intellectual property rights purchase, cooperation with multinational corporations, facilitating foreign investment) and provided seed capital for new ventures that co-enabled Chile's agricultural development (in tandem with features such as a stable and conducive regulatory environment). An example of this is Chile's development as an important player in farmed salmon – despite salmon being an exogenous species to Chilean waters – that involved the setting up of a completely new salmon farming infrastructure. This occurred for example through cooperation with Norwegian salmon farming firms and their establishment in Chile (Aslesen et al., 2009). However, as Aslesen et al. (2009) note, a downside of this technology networking has recently manifested itself in the form of a lack of innovation capacity to tackle the severe occurrence of biological problems (salmon diseases), so the reliance on foreign technology has hindered the development of a strong national Chilean salmon farming innovation system with adequate linkages.
- *ICT-based brokers*. Although often on a more operational level (market/production information) than for strategic (innovation) purposes, a range of ICT-based brokerage instruments act as 'infomediaries' (Rao, 2007; Ballantyne, 2009), such as information kiosks in India through which smallholder farmers with difficult access to computers and the internet may access cattle health information (Ramkumar et al., 2007). Another example is the recent CGIAR attempt to improve access to its research outputs by means of the use of ICT and KM structures in its ICT-KM programme (ICTKM, 2009). This programme intends to use ICT applications

> (e.g., Web 2.0 tools like wikis and blogs, social media like micro blogging, photos and document sharing and online learning resources) to improve knowledge flows amongst actors, support the opening up of the research process to stakeholder interactions, voices and knowledge and more cost-effectively widen the participation of stakeholders in the research process (Manning-Thomas, 2009).

This review shows that, in the context of developing and emerging countries, in contrast to the Dutch innovation brokers which are mainly new and specialised organisations, many existing parties take up an innovation broker role in addition to their existing roles as advocates, representatives, funding agencies and research organisations. Such new roles have either purposefully or serendipitously emerged. Although not all innovation brokerage efforts are successful or their impact is still unclear, they appear to have similar beneficial effects on innovation as those reported for the Dutch innovation brokers (Clark et al., 2003; Bentley et al., 2007; Kristjanson et al., 2009; Devaux et al., 2009). However, some still have a quite limited scope in that they merely establish links between research and research users without addressing the wider stakeholder network.

4.3 Considerations on fostering the emergence of innovation brokers as a specialised organisation in the AIS in developing and emerging countries

From our review in Section 4.2 it emerges that many organisations in developing and emerging countries that fulfil innovation brokerage tasks are strictly speaking innovation intermediaries that have innovation brokerage as a side-activity, as opposed to their being specialised innovation brokers as defined by Winch and Courtney (2007). We do not suggest that one approach is necessarily better than the other: the experience so far in developing countries suggests that each approach has its own strengths and weaknesses. For example, on one hand, a strong advocacy orientation may be needed in situations in which weaker actors need to be given a position in AIS; this would favour innovation brokerage being undertaken by an organisation with a strong normative orientation (see, e.g., Goldberger, 2008). On the other hand, however, this may have negative effects on the organisational and institutional manoeuvring space that is given, or can be created, to execute the innovation brokerage role (Hulsebosch et al., 2006). It may also be hard to sustainably embed the innovation brokerage role in an organisation for which it is not (yet) its core-business (Clark et al., 2003; Spielman et al., 2007; Kristjanson et al., 2009; Devaux et al., 2009). 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. In relation to the problem of function ambiguity, Sherwood (2009) found that researchers, as facilitators of farmer field schools, after a while fell back into their role of technical experts. Hocdé et al. (2009) found that researchers in the role of innovation broker constantly had to defend this position and negotiate their status in their organisations as their colleagues saw this work as lacking scientific legitimacy. Although there remains significant scope for existing agricultural research and extension organisations (such as the CGIAR institutes, national public extension organisations) to retool or reinvent themselves in order to play innovation brokerage roles as several authors state (World Bank, 2008; Hocdé et al., 2009; Van Mele, 2008; Devaux et al., 2009; Rivera and Sulaiman, 2009), this may be a far from easy process. Kristjanson et al. (2009), who refer to this role as 'boundary spanning', note

that the institutionalisation of the innovation broker role is problematic. On basis of a broad review of experiences at ILRI they note that:

> "Boundary spanning may be institutionalised by creating a new organisation or by making it a function of part of an existing organisation. Existing institutions, however, are often disinclined to invest in boundary-spanning activities that appear extrinsic rather than central to their core mission, whereas government and private funding agencies have proved reluctant to invest in the creation of new organisations aiming to serve as 'go-betweens'." (2009, p.6)

As the Dutch case shows, positioning innovation brokers as new organisations, detached from existing organisations, may be an option to prevent some legitimacy tensions and to provide more freedom to act as an innovation catalyst and bring about institutional change. Nonetheless, it also bears its own tensions with regard to legitimacy, function overlap and funding, as the analysis in Section 3.4 has shown. There are several indications that these independent brokerage agents need some form of continued support from a public funding agency, or through collective funds such as farmer levies. Given the fact that in the case of developing countries also it has been noted that innovation brokers have difficulties in securing funding (Spielman et al., 2007; Kristjanson et al., 2009) and that there is a need for public-sector promoting agents or system coordinators (Hartwich et al., 2007a), public or donor funding may be justified. Reasons in favour of this include:

1 it appears inherently difficult to make especially the demand articulation and network composition functions self-sufficient

2 innovation brokers contribute to systemic interaction and, hence, mitigate innovation system failure [indicated as a principal role of government – see Smith (2000)]

3 innovation brokers can more impartially fulfil the role of facilitator than parties that have a substantive stake in the subsequent research or innovation process, or that have a very strong business, political or advocacy interest.

Nevertheless, some challenges also emerge in this regard, including:

1 the difficulty of assessing the contribution of innovation brokers through conventional forms of impact evaluation

2 the proper demarcation of the mandate of publicly financed innovation brokers, as activities that go beyond demand articulation and network composition are sometimes perceived as competition

3 the risk that due to resource dependencies the innovation broker may nevertheless become a more or less 'hidden messenger' for government or another party – a perception that may be detrimental to its impartiality, credibility and, hence, longevity.

5 Conclusions and implications for policy

We have argued that it is plausible that public or donor investment in innovation brokers in developing and emerging countries' AIS may be sensible. In fact, we have seen that

existing organisations have expanded their mandate and are already taking up innovation brokerage roles. Whether such organisations are ideally placed to play these roles is a subject for further study. More research is needed on the implications of the organisational connection of innovation brokerage with other roles (such as research and extension, advocacy and representation and funding). Also, further enquiry is needed to get more systematic insights on the different types of innovation brokers in different developing and emerging countries. Such an analysis may serve to substantiate and/or adapt the function-based typology developed in the Dutch context and to shed more light on their effectiveness.

Besides the question of *who* should perform innovation brokerage roles, an important question is *how* to foster their emergence. First of all, it must be recognised that the AIS perspective is about fostering inclusive networking amongst sets of heterogeneous actors – thus going beyond the linear technology transfer model that is still adhered to by many – and that effective networking needs to be supported by systemic intermediaries. This calls for a fundamental reorientation of many organisations working in the field of science and technology on the development of what constitutes innovation and the embracing of an innovation systems model. Secondly, a striking feature of the Dutch case is that centrally designed blueprints to establish innovation brokers failed, and that successful innovation brokers (even if eventually subsidised) emerged in a self-organised manner, resulting in a very diverse landscape of innovation brokers adapted to specific (sub)sectors and regions. Moreover, we have seen that the current configuration has evolved over time, required considerable experimentation and institutional adaptation and continues to be dynamic. Combined with the generally bad experiences with the wholesale transfer of institutional innovations from one country to another, such as the fallacy of universal agricultural extension models (Rivera and Sulaiman, 2009), this leads to the conclusion that we need a policy approach that encourages institutional learning and experimentation.

In order to allow innovation brokers to emerge and become embedded, we think it important to raise several points that require attention during such a process. First, we feel that it is essential to adequately map and diagnose the strengths and weaknesses of the relevant innovation system (see e.g. Gildemacher et al., 2009) in order to develop a clear vision about which weaknesses to tackle, at which system aggregation level, and with what kind of innovation ambition (radical or incremental innovation). In doing so, it should also become clear whether some parties already fulfil an innovation brokerage role and the extent to which these may complement or overlap with the envisioned task of the proposed innovation broker. Once established, an innovation broker should be given considerable freedom to explore new options and establish new linkages, and not be tied to prescribe input-output schemes and log-frame-determined performance indicators. It should be recognised that the primary work of innovation brokers is to improve the quality of interactions and processes during innovation trajectories, and that this includes many intangible contributions to making interdependent actors and networks collaborate effectively. In performing such roles, innovation brokers mediate between actors who have different goals, interests and incentives, and they are accountable to several parties. Innovation brokers will thus always have to perform a balancing act.

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