A SYSTEMIC INNOVATION POLICY FRAMEWORK: THE CASES OF SCOTTISH AND DUTCH AGRIFOOD INNOVATION SYSTEMS

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A Systemic Policy Framework: The cases of Scottish and Dutch Agrifood Innovation Systems –Preliminary results

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Annotation: Innovation and knowledge exchange are receiving increased attention among policy makers as a means to address sustainable economic development challenges (European Commission, 2011). However, a range of factors such as inappropriate structures and institutional or capabilities barriers may negatively influence the spread or direction of processes of innovation and knowledge exchange (Klein-Woolthuis et al., 2005). These problems are often referred to as systemic weaknesses or failures, and highlight the need to focus on the innovation system (IS) as a whole (Smiths and Kuhlmann, 2004; Raven et al., 2010).

The purpose of the paper, using a comprehensive innovation systems failure framework, is to assess and he performance of agrifood innovation systems of Scotland and the Netherlands, through analysis of the key innovation actors (organisations, networks or influential individuals), and their key functions (research provider, intermediary etc), and those mechanisms that either facilitate or hinder the operation of the IS (known as inducing and blocking mechanisms, respectively). This framework was drawn up based on literature research and a series of semi-structured interviews and/or workshops with experts involved in the agrifood innovation systems in the two countries.

The findings confirm the appropriateness of considering actors, functions, inducing or blocking mechanisms and governance instruments as analytical tools to evaluate the performance of agrifood innovation systems. In both countries, blocking mechanisms in terms of actors' interactions and competencies as well as market and incentive structure were revealed. The proposed mix of governance mechanisms in each country offers actors a better chance to influence the direction and speed of innovation in agrifood systems.

Key words: national innovation system, IS failure matrix, Dutch, Scottish, agrifood

1 Introduction

It is argued that current pathways of economic development in the agricultural and rural sectors fail to serve balanced development in terms of competitiveness, sustainability and social-territorial cohesion (European Commission, 2011). Innovation and knowledge exchange are receiving increased attention among policy makers as a means to address this challenge, and develop an economy capable of mitigating climate change, whilst responding to the pressures arising from a growing demand for food, increasing energy-costs and resource scarcity (European Commission, 2011).

A systems approach to innovation has been recognised amongst academic researchers and policy makers as one of the most promising tools to understand and support processes underlying innovation, knowledge exchange and transformation of agricultural and food sectors (Spielman and Birner, 2008; World Bank, 2012). It indicates a paradigm shift in the justification of innovation policy intervention away from market failures towards system failures (Chaminade and Edquist, 2006; Jacobsson and Johnson, 2000; Smith, 2000). The strength of this approach is derived from rejecting the simplistic 'linear' or 'pipeline' model of technological knowledge transfer from research through extension services to farmers (Clark, 2002). The new interpretation recognises that (agricultural) innovation is the outcome of an interactive and co-evolutionary process (Smits and Kuhlmann, 2004), where a wider network of actors are engaged, with the speed and direction of innovation processes dramatically affected by the institutional and policy environment (Hall *et al*., 2006). Consequently, innovation combines not only technological but also social, organisational, economic and institutional changes (Klerkx et al., 2012; World Bank, 2006).

In line with this systemic approach to innovation, a need emerges for developing policy instruments that operate at the system level, instead of supporting the individual components of the system (which may be described as the neoclassical approach), and for going beyond traditional command-and-control measures (Jacob *et al*., 2006, OECD, 2001; Metcalfe, 1995). For example, the long-term and complex character of sustainability problems calls for systemic, integrative and participatory instruments for stimulating transition to sustainability-oriented innovation systems (Raven et al., 2010; Hekkert *et al.,* 2007). The innovation systems (ISs) approach has been instrumental in legitimising and designing research and policy interventions that enhance iterative and interactive learning processes among innovation agents, and their capacity to learn, change and innovate (Spielman and Birner, 2008; OECD, 2002; Lundvall, 1992). The focus is on the functionality of the whole system as an entity, rather than on its specific components (i.e. particular actors or institutions etc., Wieczorek and Hekkert, 2012), offering a better insight into coordination and alignment of system components e.g. whether institutions are complementary or conflicting.

The literature in the agricultural innovation domain is rich in empirical studies using the innovation systems approach, at different levels e.g. national, regional, sectoral or technological innovation systems. Yet, surprisingly very few studies (Amankwah *et al*., 2012; Gildermacher *et al.,* 2009) apply comprehensive frameworks to assess systemic failures. This paper aims to address this gap, by undertaking a comparative system analysis of the Dutch and Scottish Agri-food sector. The paper is organised as follows. In Section 2, a conceptual framework is presented, clarifying the particular analytical tools used describe the dynamics and performance

of the the Scottish and Dutch agrifood innovation systems. Section 3 outlines the goal and research methods, and Section 4 focuses on presenting the results of the cross–country comparison analysis, and the paper closes with some concluding remarks summarised in Section 5.

2 Conceptual/Analytical framework

In innovation systems literature, both structural and functional analyses have been used to identify the determinants of varying rates of innovation, and to develop systemic innovation policies (Wieczorek and Hekkert, 2012). Originally, as suggested by its name, structural analysis served to study structural elements of innovation systems, including the actors, institutions (in terms of the 'rules of the game') and infrastructures (see for example Crawford and Ostrom, 1995; Edquist, 1997; Smith, 1997), but mostly it was used to analyse national innovation systems (Schmoch *et al.,* 2006; Nelson, 1993). Functional analysis emerged to replace the structural focus with a process-oriented analysis, identifying different functions within an IS (such as funding research, knowledge creation etc.) and assessing the performance of the system on whether all the functions were being performed properly (Hekkert, *et al.,* 2007; Bergek, 2002; Johnson, 2001).

Regarding structural analysis, there has been a focus on identifying difficulties within innovation systems and different classifications of these systemic problems can be found in the literature. These are alternatively called systemic failures, weaknesses or blocking mechanisms (Chaminade and Edquist, 2010; Jacobsson and Johnson, 2000; Smith, 2000; OECD, 1997). Within this context Klein-Woolthuis et al. (2005), van Mierlo et al., (2010) and Weber and Rohracher (2012), propose an innovation system failure matrix, This places different actors against systemic failure categories. The initial work by Klein-Woolthuis et al. (2005) listed four categories, namely (physical, knowledge and financial) infrastructure, (formal/hard and informal/soft) institutions, interactions and problems with capabilities Van Mierlo et al., (2010) extended the matrix, by introducing the market structure failure. Weber and Rohracher (2012) advanced Klein-Woolthuis' work, and the policy framework's potential to deal with the strategic challenges of transformative change in systems of innovation, production and consumption (see Table 1 for details). They added failures of directionality, policy coordination, demand articulation and reflexivity.

Regarding functions, the most advanced typologies in literature are provided by Hekkert *et al*., (2007) and Bergek *et al*., (2008), with slight differences in their phrasing. For the purpose of this research, a list of functions is formed, based on combining insights from these two sources, and satisfying the purpose of being meaningful to interviewees. Nine processes are identified as important for innovation systems to perform well, and presented in Table 2.

Recent literature however, has argued that neither of these two separately-developed approaches (structural and functional) alone constitute a sufficient basis for analysis of ISs (Bergek et al., 2008). Wieczorek and Hekkert (2012) explain that structures make functions meaningful and vice versa, and argue that alteration of a structural element is always necessary for policies to enable or strengthen functions. Arguably, an integrated functional-structural analysis could provide a much more comprehensive overview of systems' operation and determinants in shaping innovation trajectories (Bergek et al., 2008; Wieczorek and Hekkert, 2012).

Table 1. Overview of innovation system failures

Categories of failures	Type of failure	Failure mechanism
Market failures	Information asymmetries	Uncertainty about outcomes and short time horizon of private investors lead to undersupply of funding for R&D.
	Knowledge spill-over	Public good character of knowledge and leakage of knowledge lead to socially sub-optimal investment in (basic) research and development.
	Externalization of costs	The possibility to externalize costs leads to innovations that can damage the environment or other social agents.
	Over-exploitation of commons	Public resources are over-used in the absence of institutional rules that limit their exploitation (tragedy of the commons).
Structural system failures	Infrastructural failure	Lack of physical and knowledge infrastructures due to large scale, long time horizon of operation and ultimately too low return on investment for private investors.
	Institutional failures	Hard institutional failure: Absence, excess or shortcomings of formal institutions such as laws, regulations, and standards (in particular regarding IPR and investment) create an unfavourable environment for innovation. Soft institutional failure: Informal institutions (e.g. social norms and values, culture, entrepreneurial spirit, trust, risk-taking) that hinder innovation.
	Interaction or network failure	Strong network failure: Intensive cooperation in closely tied networks leads to lock-in into established trajectories and a lack of infusion of new ideas, due to too inward-looking behaviour, lack of weak ties to third actors and dependence on dominant partners. Weak network failure: too limited interaction and knowledge exchange with other actors inhibits exploitation of complementary sources of knowledge and processes of interactive learning.
	Capabilities failure	Lack of appropriate competencies and resources at actor and firm level prevent the access to new knowledge, and lead to an inability to adapt to changing circumstances, to open up novel opportunities, and to switch from an old to a new technological trajectory.
Transformational system failures	Directionality failure	Lack of shared vision regarding the goal and direction of the transformation process; Inability of collective coordination of distributed agents involved in shaping systemic change; Insufficient regulation or standards to guide and consolidate the direction of change; Lack of targeted funding for research, development and demonstration projects and infrastructures to establish corridors of acceptable development paths.
	Demand articulation failure	Insufficient spaces for anticipating and learning about user needs to enable the uptake of innovations by users. Absence of orienting and stimulating signals from public demand. Lack of demand-articulating competencies.
	Policy coordination failure	Lack of multi-level policy coordination across different systemic levels (e.g. regional–national–European or between technological and sectoral systems; Lack of horizontal coordination between research, technology and innovation policies on the one hand and sectoral policies (e.g. transport, energy, agriculture) on the other; Lack of vertical coordination between ministries and implementing agencies leads to a deviation between strategic intentions and operational implementation of policies; No coherence between public policies and private sector institutions; No temporal coordination resulting in mismatches related to the timing of interventions by different actors.
	Reflexivity failure	Insufficient ability of the system to monitor, anticipate and involve actors in processes of self-governance; Lack of distributed reflexive arrangements to connect different discursive spheres, provide spaces for experimentation and learning; No adaptive policy portfolios to keep options open and deal with uncertainty.

Source: Weber and Rohracherb (2012)

Table 2. Functions of innovation systems

Function type
Knowledge development (either through research or learning-by-doing)
Commercial experimentation (i.e. commercial trails)
Knowledge diffusion/transfer
Funding
Mobilising (non-monetary) resources (e.g. in-kind contributions, supply human capital)
Market formation (i.e. commercialisation of innovative products/services)
Guidance of the search (i.e. identifying problems, recognising the potential for change, and showing the direction of search for new technologies, markets, partners)
Creation of legitimacy (i.e. counteract resistance to change and legitimate technologies)
Pure innovation brokering (i.e. focusing on networking, trust building and management of innovation processes)

An illustration of how the coupled structural-functional approach works is provided by Wieczorek and Hekkert (2012 see Table 3 for details), where for each system structural elements are defined and possible problems identified. These authors have therefore attempted to incorporate structural elements into the functional analysis of the systems. In the view of Wieczorek and Hekkert (2012) this should provide the necessary analytical blocks of a policy framework, aiming to identify systemic problems and propose systemic instruments to fix them. The first version of systems failure matrix by Klein Woolthuis et al. (2005) has been incorporated into Wieczorek and Hekkert's (2012) coupled functional-structural analysis framework mentioned above. By combining the four additional types of transformational failures with market and structural failures, the new integrated framework presented by Weber and Rohracher (2012) together with the coupled functional-structural approach taken by Wieczorek and Hekkert, (2012) are two very powerful analytical tools of innovation systems.

Table 3. Table description

System function	Structural element	Systemic problem	(Type of)Aim of Solutions	
Knowledge development etc.	Actors	Actors problems	Presence?	Stimulate and organise the participation of relevant actors (1)
			Capabilities?	Create space for actors capability development (2)
	Interactions	Interaction problems	Presence?	Stimulate occurrence of interactions (3)
			Capacity?	Prevent too strong and too weak ties (4)
	Institutions	Institutional problems	Presence?	Secure presence of hard and soft institutions (5)
			Intensity?	Prevent too weak and too stringent institutions (6)
	Infrastructure	Infrastructural problems	Presence?	Stimulate physical, financial and knowledge infrastructure (7)
			Quality?	Ensure adequate quality of infrastructure (8)
(move to next function)	Actors etc.	Actors problems etc.	Presence?	Stimulate and organise the participation of relevant actors (1)
			Capabilities?	Create space for actors capability development (2)

Source: Wieczorek and Hekkert (2012)

3 Goal and Methods

This paper aims to apply the two complementary tools of Weber and Rohracher (2012) and Wieczorek and Hekkert (2012) in the context of the Scottish and Dutch agrifood innovation systems with the aim of revealing what happens in the systems, and in particular where particular strengths and weaknesses exist and the reasons for these

To achieve this the paper first attempts to map the national agrifood innovation systems of Scotland and the Netherlands, and assess their performance, through analysis of both their function and structural elements (i.e. structures' presence and attributes such as intensity, quality, capabilities). This is in line with Wieczorek and Hekkert's (2012) perspective. Second, it aims to explore those mechanisms that either facilitate or hinder the operation of the IS (the so-called inducing and blocking mechanisms, respectively). This follows the steps of Klein-Woolthuis *et al*. (2005), van Mierlo *et al*., (2010) and Weber and Rohracher (2012). Overall, the contribution of this paper is that it empirically applies methodologies that combine analyses of systemic structures, functions, strengths and weaknesses.

To identify key innovation agents in each of the two national agrifood ISs, Arnold and Bell's (2001) typology of actors in innovation systems was useful. This typology classifies actors into four broad categories, namely research domain, direct and indirect demand for innovation domains and innovation intermediary domain. In particular, the research domain includes universities and research institutes or private R&D departments (e.g. companies or NGOs) producing basic or applied research and primarily codified knowledge. The direct demand for innovation or enterprise domain involves the supply chain actors i.e. input suppliers, farmers, food manufactures or retailers who typically use codified and tacit knowledge, and produce tacit knowledge. The indirect demand for innovation refers to more distant actors demanding innovation, including final consumers, policymakers, social interest groups (e.g. charities and NGOs) and complementary markets to agrifood sector such as energy or pharmaceutical markets. Finally, innovation intermediary domain considers organisations that may not necessarily involve in knowledge creation or usage, but are playing a catalytic role in joining fragmented IS actors and facilitating knowledge/innovation flows. These organisations typically are education and extension services, actively-supporting levy or trade industry boards, consulting services or pure innovation brokers whose primary task is building bridges between knowledge/innovation providers and users. These categories are not mutually exclusive, due to actors' multiple roles, and evolving roles over time (World Bank, 2006). But it served us as an analytical tool, helping to identify important organisations to include in interviews and workshops. Another critical issue is that whilst the innovation systems concept may suggest collective and coordinated action, the system under investigation may not be recognised by its actors in its full entirety, due to weak interactions (Bergek *et al.*, 2008).

The aim was to fill the extended matrix of innovation system failures provided by Van Mierlo *et al*., (2010). In this matrix the various systemic failures (e.g. infrastructure failure, institutions failure, etc.) are set against the various categories of actors (e.g. researchers, farmers, government, innovation intermediaries etc.) However, it was deemed proper to avoid narrowing our perspective into capturing only systemic weaknesses, and instead to allow also inducing systemic mechanisms to be captured in the matrix. Following the lines of Weber and Rohracher (2012), the discussion in interviews or workshops explored whether structural elements have prevented or caused other systemic failures related to more transformative changes, with regards to directionality, policy coordination, demand articulation and reflexivity.

More than 15 semi-structured interviews and a workshop were held with experts at the national agrifood innovation system, holding a variety of position within the IS in each country. Therefore, researchers, consultants, multiple retailers, representatives of farmer unions, levy boards, governmental agencies and other innovation brokering or intermediary organisations were included in the list of interviewees or workshop participants. Although the focus was primarily kept at national level, interviewees were allowed to use examples of sub-agrifood sectors, or specific technologies to illustrate better their arguments, and make the discussion more precise and meaningful.

4 Analysis

4.1 Overall functional performance of the Agrifood Innovation Systems

In the Scottish Agrifood innovation system there is a paradox where knowledge generation through universities and research institutes is well developed, with some consistently ranking

among the most productive in Europe. However this knowledge fails to generate new innovation and agrifood business opportunities. In the Netherlands, however, whilst the same is true for many industrial sectors, the AIS is considered to be performing quite well, and serves as an example for innovation policies. Table 4 summarises findings about IS actors' performance in different functions.

Table 4. Functions of Dutch and Scottish agrifood innovation system actors

Domain type	Actors type	Typical functions	Under-performing functions
Research domain	Universities; Research institutes; Private R&D departments (e.g. of companies or NGOs)	Knowledge development; Knowledge diffusion/ transfer; Innovation brokering; Commercial experimentation; Market formation	SC: Knowledge diffusion/transfer; Innovation brokering; Commercial experimentation; Market formation NL: Actors in the research domain tend to have stronger performance than Scottish counterparts, but there is still room for improvement
Direct demand/ enterprise domain	Food supply chain actors (e.g. Agricultural input suppliers; farmers, processors; retailers) SMEs; Large enterprises; Cooperatives	Knowledge development; Knowledge diffusion/ transfer; Innovation brokering; Commercial experimentation; Market formation ; Guidance of search; Resource mobilisation Creation of legitimacy	SC: Except for some multinational input suppliers, multiple retailers, the rest supply actors (especially farmers and indigenous SMEs) underperform in Knowledge development, Commercial experimentation; Market formation. Input suppliers and retailers underperform in Knowledge diffusion/ transfer and Innovation brokering NL: Direct demand actors have stronger performance than Scottish counterparts, but there is room for improvement especially for farmers and SMEs
Indirect demand domain	Final consumers; Governmental agencies; Other policymakers; social interest groups (e.g. charities and NGOs); Related market (e.g. pharmaceutical market)	Knowledge diffusion/ transfer; Innovation brokering; Commercial experimentation; Market formation; Guidance of search; Resource mobilisation; Funding; Creation of legitimacy	NL: The Dutch Government underperforms in Market formation; Guidance of search; ; Creation of legitimacy, but performs better than the Scottish Government in Innovation brokering
Intermediary	Education; Extensive services; Consultants; Actively-supporting levy/trade bodies; Systemic innovation brokers	Knowledge diffusion/ transfer; Innovation brokering; Commercial experimentation; Market formation; Guidance of search; Resource mobilisation; Funding; Creation of legitimacy	SC: Knowledge diffusion/ transfer; Innovation brokering; Guidance of search; Resource mobilisation; Funding NL: Innovation intermediary actors have stronger performance than Scottish counterparts

In Scotland, evidence suggests that universities and research institutes perform better than agrifood supply actors, especially farmers and SMEs, in knowledge development, but tend to underperform in areas which could lead to exploitation of the knowledge. Agricultural input suppliers, who are usually externally-owned (international or other UK-owned), and some innovation-oriented multiple retailers outperform other agrifood supply actors in some of the key functions (such as knowledge development, commercial experimentation, guidance of the search, resources mobilisation, funding, and creation of legitimacy). However they too face difficulties in knowledge diffusion/transfer and innovation brokering especially in their interactions with Scottish farmers. Scottish governmental agencies in general perform well in terms of identifying problems (guidance of the search), providing funding, and mobilizing resources, especially compared to other UK counterparts. In terms of these functions, the UK research councils and Technology Strategy Board (TSB) are seen to perform relatively strongly, but again underperform when interacting with Scottish farmers or agrifood SMEs. Levy boards have

improved their performance in their key areas of operation but there is still room for improvement, especially in funding and knowledge diffusion/transfer. Some social interest groups such as NGOs and charities perform strongly in creation of legitimacy, guidance of the search and resources mobilisation. In many cases, the innovation intermediary domain of the Scottish agrifood IS tends to underperform in knowledge diffusion/transfer, creation of legitimacy, guidance of the search, resources mobilisation and especially innovation brokering, with the exception of satisfactory performance from particular innovation brokers such as SAOS and Biosciences KTN and to a less extent Scotland Food & Drink (SF&D).

In the Netherlands, agrifood innovation agents fulfill similar functions to their Scottish counterparts, but the performance appears stronger, especially in the side of the direct demand for innovation domain (i.e. agrifood supply actors) and the innovation intermediary domain. In particular, the Dutch agrifood IS has a longer tradition and accumulated experience in cooperation, shared-learning and knowledge co-production, using a multi-stakeholders network approach that also validates and exploits non-scientific knowledge, such as that of the farmer. In many cases, these collaborative networks are self-organised. Thus, the Dutch innovation agents tend to present a more satisfactory performance in knowledge diffusion/transfer, creation of legitimacy, guidance of the search, resources mobilisation, funding and innovation brokering compared to the Scottish counterparts.

However, the Scottish Government (SG) has taken a more proactive and leading role, compared to the 'hands-off' neoliberal approach of the Dutch Government that leaves the market to decide how the future of the sector should look like, based on where commercial companies see their business opportunities. Although for somewhat different reasons, evidence suggests that in both countries the reliance on the market has led to agrifood innovations systems where there are deficits within functions. Also, there has not been one actor, or a coalition of actors, able to unite the agricultural sector behind a common vision, which indicates a systematic problem relating to lack of vision and leadership. So, the Scottish agrifood IS benefits from deliberate efforts of the SG to fill this vision and leadership gap and eliminate other systemic deficits.

It is widely recognised that the abolishment of the traditional 'Education, Extension and Research (EER) tryptich' in the UK and NL, led to the privatization and a proliferation of new knowledge creators and providers. Although within the UK there were differences with the privitisation process in Scotland being considerably less severe than in England. So, the public extension service have been transformed into a considerably downsized private service, which competes with many emerging smaller (and some large) agro-consultancy firms in what can be called a pluralistic system of advisory service provisioning. Besides, some NGOs have their own-research facilities and universities offer consultancy services. In addition, new private organisational forms as well as new public/private partnerships for research and innovation (e.g. platforms and networks) emerged. This makes the boundaries between functions performed by those traditionally categorised as innovation creators, facilitators and users vague. Innovation agents now have been expanding their functions' range, aiming to adding value to their specialist services, and in turn increased competiveness in the innovation arena. Innovation-related functions are mainly extended in scope by either acquiring new 'in-house' competencies or entering into strategic partnerships with skills-complementary organisations. Criticism raised that current Scottish agrifood IS leads to an unbalance in jobs creation between research and the domain of direct demand of innovation i.e. agrifood supply chain actors. Also, because extension

advisory services and consultants have to work now on a more commercial and demand-driven basis, basically on what the client is asking, this has resulted in both countries in the disappearance of certain fields of expertise, due to lack of demand, and that some public goods issues remain under addressed. Yet Scotland has maintained advice relating to public good provision at the farm level at least.

Next, the separate IS failures proposed by Klein-Woolthuis *et al.* (2005), Van Mierlo *et al.*, (2010) and Weber and Rohracher (2012) are used as a framework to systematically analyse the inducing and blocking mechanisms in the Scottish and Dutch agrifood ISs.

4.2 Knowledge Infrastructure

First, the presence and quality of the knowledge infrastructure of the Scottish and Dutch agrifood ISs are assessed. It is clear that both systems benefit from a high concentration of universities and research institutes. They also both have a reasonably strong and wide network of education institutions, extension advisory services and consultants.

Knowledge infrastructure appears also reasonably strong and well-spread across the two countries across policy-making agencies[1] and social interest groups (e.g. Scottish Society for the Prevention of Cruelty to Animals – SSPCA, or various groups of nature conservationists and environmentalists in the Netherlands).

In the direct demand for innovation side, with some exceptions, the knowledge infrastructure of Scottish agrifood businesses is argued as rather weak and insufficient, and recognised as having a detrimental effect on the Scottish agrifood IS. In contrast the Netherlands appears stronger through the activities of independent advisors, input suppliers, food manufacturing, multiple retailers and farmer peer networks and other self-organised networks in the Netherlands.

4.3 Physical Infrastructure

Both the Scottish and Dutch physical infrastructure appear sufficient, including transportation (e.g. train or road network) or telecommunication systems (e.g. 3G mobile network and broadband) and availability of utilities (e.g. Gas). However, speed and coverage of broadband and 3G mobile network cited as almost the only significant restricting factors for innovation in Scotland. These deficits potentially can inhibit information/knowledge accessibility, interactive learning and ultimately innovation for all categories of innovation actors, however, the most likely affected are Scottish farmers, due to relatively low mobility and farm remoteness.

4.4 Hard Institutions

The Governments of the Netherlands and Scotland shape the conditions determine the agrifood sector's development by legislation and regulations, often derived from European directives. In both countries, interviewees reported the following regulations as having the most impact: environmental regulations that have restricted the options for intensive animal production; spatial planning laws; employment legislation and; health and safety regulations. In the Netherlands, as

[1] Except for the Scottish Government (SG), interviewees indicated as influential to innovation the following policy-making agencies: the Scottish Enterprise, Highland & Islands Enterprise, UK Research Councils, UK Technology Strategy Board (TSB) and particular governmental agencies including Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH) and Forestry Commission (FC).

a highly-populated country, spatial planning laws are an issue with municipalities enforcing zoning rules and granting permission only for specific activities.

In both countries, it is observed that application procedures for innovation programmes were considered too complex, cumbersome and laborious. At the same time, agrifood industries in both countries have emphasised the need for greater Government support[2] in reducing the burden of EU/Government imposed regulations, cutting the 'red tape', and making flexible and streamlined regulations.

R&D tax credits and tax breaks, and Intellectual Property rights (IP) such as patents and trademarks were considered as powerful enabling factor for innovation in both agrifood ISs. However, the EU ban on GMO technologies was regarded by many interviewees as posing a significant barrier to innovation, and as potentially threatening the EU, Scottish and Dutch agrifood sectors' competitive market position. Despite its potential for substantial positive impact, the use innovation-oriented procurement mechanisms to directly stimulate the advancement of novel solutions is rather weak in both Scotland and the Netherlands, thus improvements are needed to this direction.

Public-funding Instruments

A common problem for most public-funding instruments appears the very tight EU control of state organisations on what is allowed to be funded. This is cited as a barrier in innovation projects, because only the start-up costs, and not the running costs can attract funding, while the on-going capital requirement for covering the running costs is the real constraint for agrifood businesses. However, in the Netherlands, one can see more and more the implementation of novel innovation instruments without giving companies the direct financial support that is prohibited by the EU, the so-called investment funds. These are often a mix of public and private funds brought together to invest in start-up companies with a market focus and commercial potential.

Much attention, especially in Scotland, has been drawn to the distortions caused by EU farm subsides that appear to have a strong influence on farmers' behaviour towards innovation. In particular, existing subsidies were regarded as hampering innovation, because they do not create enough incentives for innovation, efficiency and market-orientation. This is evident especially when being compared to unsupported industries where continuous cycles of innovation are witnessed.

Innovation vouchers were considered as powerful enabling factor for innovation in both agrifood ISs. In the Netherlands, specific policies are targeted at innovation and the agrifood sector, with a strong focus on stimulating the match of knowledge demand and supply through the funding of brokering initiatives. At the national level, a high profile 'innovation platform' was formed in 2003, identifying 'TopSectors' for Dutch innovation, including also flowers and food sector.

Production-oriented research in both countries is often funded by farmer or agribusinesses' (e.g. abattoirs) levies, which are a kind of sector specific tax. Though it appears that more of the levy is directed at research determined by farmers needs in the Netherlands when compared to

[2] Interviewees have credit the SG with already significant efforts to this direction.

Scotland. In legal terms, Scottish levies are still categorised as public/government money due to mandatory nature which automatically means that levies do not counted towards industry's required monetary contribution, supplementing the in-kind contribution when levy boards apply in most public-funding schemes.

4.5 Soft Institutions

The view is that at present, the demand for innovation from Scottish farmers is not that strong, with most farmers being passive receivers of advice, mostly for everyday management issues. This is evident from farmers' willingness to pay consultants for advice for administrative tasks (such as claiming CAP support) rather than seeking advice on innovative production and management practices. In the Netherlands, advisory services also concentrate on accountancy, legal advice regarding spatial zoning and environmental regulations rather than production.

In Scotland, other IS stakeholders talk of an attitude amongst researchers and consultants that hinders the development of relationships with their customers, named by interviewees as 'intellectual arrogance'. This refers to the subjective belief of having superior knowledge to that of their customers, and reflects a lack of accommodative attitude of outsiders to farmers and other industry actors' knowledge, perceptions and values (Assefa and Fenta, 2006). In the Netherlands, such an attitude amongst researchers and consultants is far less apparent, thanks to the long tradition of engagement in multi-stakeholders collaborative networks for learning and knowledge exchange. There is strong focus on learning in peer-to-peer networks, with study clubs being unabatedly popular. Apparently, collaboration and the idea of communities of practice are historically well developed in the Dutch agrifood IS.

One major weakness relates to the reported prevailing culture across different Scottish research providers, that communicating research findings to knowledge exploiting organisations takes a low priority over other tasks, such as conducting research, publishing in academic journals or reporting to public funders. Thus, organisational culture and institutional barriers are blocking innovative initiatives. Although, there is a relatively stronger pressure on Dutch researchers towards translating and communicating research findings, interviews revealed that lessons drawn from successful cases can have difficulties reaching the innovation pioneers of these cases.

4.6 Demand Articulation

Seeing researchers' behaviour from a slightly different perspective, one can see a demand articulation failure i.e. a deficit in anticipating and learning about user needs (Weber and Rohracher, 2012). First, the Scottish case provided evidence that researchers often do not seem to appreciate the innovation needs and expectations in terms of knowledge exchange of particular categories of funders, such as levy/trade bodies, farmers' organisation or the industry. This seems to be in contrast to the situation in the Netherlands. Overall, a mismatch between the ability or willingness of research providers to help and the requirements of knowledge exploiting actors e.g. levy/trade bodies or the industry, especially indigenous SMEs is apparent in Scotland. Furthermore, some interviewees pointed to the lack of the recognition that customer relationship management is a very vital, and different set of capabilities from R&D skills. As a result, most Scottish universities and research institutes have not arranged a single contact point for customers, but relying on individual researchers' skills and willingness to build (personal) relationships with commercial customers (e.g. retailers or input suppliers). This fragmented

approach on customer relationships is recognised as a barrier to innovation. In the Netherlands, research institutes have relationship managers, which make connections with large clients, but also participate in agenda setting for farm level research issues.

4.7 Interactions

Repository of Knowledge Co-producing Experiences

Both countries provided examples of participatory and knowledge co-producing networks, some of which have a profound educational impact, and are promising initiative in fostering innovation. Overall, the Dutch, and recently the Scottish agrifood ISs have built a repository of positive local experiences from experimentation in learning and collaborative arrangements fostering innovation. These repositories potentially form a good basis to develop the knowledge exchange/networking approach even further, by drawing lessons and attempting to transfer these lessons to other areas or agrifood sub-sectors. In both countries, the farming press is a key mechanism for communicating innovation developments, as most farmers still like to receive information in written form.

Weak Network Failure

The Scottish agrifood IS has a high potential of benefiting from the Scottish Agricultural College's unique structural model of linking Research-Consultancy-Education under one roof. However, sufficient evidence suggests that currently this potential benefit has not been fully exploited, because there are too rigid lines between the three SAC' s divisions, especially between SAC consultants and researchers. This deficient interaction has become visible to external actors, and sometimes negatively effect on the institute's reputation, as SAC consultants often have not being kept update of the most recent research activity being undertaken within SAC research division. However, this fragmentation of knowledge infrastructure should not be mistakably considered a symptom observed only within SAC. Evidence suggests that is apparent across the whole fabric of the Scottish agrifood IS.

One major weakness evident relates to that in many respects Scottish universities have stronger links with spin-outs and externally-owned (international or other UK-owned) firms (evidence of strong network failure) than with indigenous SMEs. The former tend to have higher absorptive capacity and ability to capitalise on the knowledge generated at Scottish universities (e.g. maximise royalty revenues from licensing). Similar evidence for SME's absorptive capacity was provided in the Dutch case. Moreover, Scotland's universities appear not to regard indigenous SMEs as being good vehicles for licensing activity, compared to spin-outs or large-scale companies, often international in scope. In contrast, the Dutch agrifood IS benefits from short lines between policy makers, research institutes, agri-businesses and farmer unions, in which strategic cooperation is key. In particular, the close connection of WUR-Government-Businesses has become a role model for other Dutch sectors to follow and is featured prominently in the new TopSectors (Platform) innovation policy.

Strong Network Failure

Efforts in Scotland for overcoming the directionality failure (see Section 3.8) between research and industry by the SG, TSB and UK research Councils are partially successful for two reasons.

First, these efforts argued to have led to a strong network failure, where interactions are too dense between public funders with researchers, compared to their ties with other stakeholders to allow for novel insights or inspirations to emerge. Often this is reflected to the commonality in language used by policy-makers and researchers, in contrast to the language of agrifood businesses, levy or trade boards. Second, this observed consensus between policy-makers and researchers was further argued to result from policymakers' power over researchers as the main source of research funding. In fact, great dependency of R&D institutes on the Ministries of Agriculture for funding (such as DEFRA in the UK and especially SEERAD in Scotland) is observed in both countries. Evidence suggests that both Scottish and Dutch policymakers tend be more sensitive to the voice and influence of social interest groups such as NGOs rather than to that of agrifood businesses, levy or trade boards, even consumers. As a result, the same interviewees concluded that the prevailing model in supporting innovation in Scotland traditionally was and remains supply (research)–driven, providing less opportunities to generate solutions that fit the needs of agrifood businesses, levy or trade boards. It becomes apparent an almost complete mismatch between the type of knowledge being generated and demanded. In the Netherlands, whereas previous systems to support innovation amongst agrifood entrepreneurs was largely supply-driven and prescriptive, the current situation has a clearer demand-driven character thus requires more initiative from entrepreneurs. Moreover, the Dutch policy stresses the importance of inclusivity i.e. inter- disciplinary research projects involving a wide array of scientists, businesses, government agencies and NGOs in the process of creating knowledge and innovation.

Innovation Brokers and Intermediaries

The Dutch agrifood IS benefits from a wide array of innovation brokers and intermediaries which are established to function as 'catalysts of innovation' and 'market facilitators', by connecting innovation demand and supply in the markets of R&D and extension service. In Scotland, the array of systemic innovation brokers is smaller and more recently developed.

4.8 Directionality

The Dutch 'Hands-off' Approach versus the Scottish 'Hands-on' Approach

In the Netherlands, the main systemic bottleneck for innovation is the lack of a shared vision of the future of the agricultural sector and Dutch countryside. At the moment there is not one actor, or a coalition of actors, able to unite the whole agrifood sector behind a single vision. The Dutch Government takes a 'hands-off' approach, namely that the sector should be able to develop the way which entrepreneurs want to take, depending on where they see their business opportunities. In contrast, the SG has taken a 'hands-on' approach, after seeing that market forces had not eliminated deficits in the functioning of the Scottish agrifood IS, and there was not one actor, or a coalition of actors, able to unite the agricultural sector behind a common vision, indicating some lack of leadership. So, the SG attempts to define a direction by setting collective priorities in research and innovation that need to develop solutions for identified major societal-natural challenges e.g. climate change or sustainable agriculture. It also demands the integration and collaboration of land-based research institutes. However, some Scottish interviewees pointed to that creating a shared vision and setting strategic targets is just the beginning, they wait to see a clearer and more practical strategy of 'how" to achieve these targets. Behind the issue of the difficulty of articulating a common vision, are issues of interests and accountability mechanisms.

In particular, scientists are primarily evaluated on the peer-reviewed publications, farmers and agri-businesses on profitability, while Governments on delivering public goods and not 'wasting' taxpayers money on uncertain and possibly controversial innovations.

As a response to the need of accommodating better the needs of the Scottish agrifood businesses, the SG has strongly supported the establishment of non-for-profit organisations as systemic innovation brokers, such as Scotland Food & Drink (SFD), Interface, Scottish Agricultural Organisation Society (SAOS), Food & Health Innovation Service (FHIS) Scottish Enterprise (SE) and Highland & Island Enterprise (HIE). The SG assigned SF&D a leadership role and tasked with guiding Scotland's food and drink companies of all sizes towards increased profitability and competiveness in domestic and global markets. Innovation is a central element of SF&D's strategy.

Innovation Agendas

In Scotland, the TSB has formulated an innovation agenda including energy (with a particular focus on renewables), food and drink sector (that comprises agriculture and fisheries) and tourism. In the Netherlands, innovation agendas have been formulated for the separate sectors e.g. the dairy sector, horticultural sector, poultry sector, etc. in cooperation with commodity boards and farmers' organisations. However, the national innovation policy aims at sectors e.g. TopSectors/Innovation Platform, with little room for inter-sectoral innovation. At the same time, there is tension between collective and private interests with regard to funding of innovation support instruments.

4.9 Policy Coordination

Both the Dutch and Scottish Governments have made a steady progress towards overcoming another IS failure, namely policy coordination failure that goes beyond directionality failure. In particularly, both Governments have attempted to create coherent policy impulses from different policy avenues to ensure transformational changes in most layers of their national agrifood ISs. Evidence suggests that although progress has been made towards this direction, there is still considerable room for improvement. Incidents were reported that interpretation and application of specific EU directives or Government strategies sometimes differs amongst municipalities or Governmental agencies.

4.10 Reflexivity

Due to the uncertainty and inherent unpredictability surrounding innovation and sustainability challenges, interviewees in both countries acknowledged that although more fundamental scientific research is absolutely necessary, supplying even more of that alone is not going to solve these issues. Instead, interviewees called for more involvement of societal 'stakeholders' i.e. those actors that are either affected by, or possess the ability to influence its development. Interviewees pointed to the need of the Dutch and Scottish agrifood ISs to involve multi-actors in processes of reflection and self-governance by providing sufficient platforms for interaction and spaces for experimentation, monitoring and learning. Both the Scottish and Dutch Governments have seen as working on this direction, however, interviewees sometimes questioned their ability to stop or alter policies that turned out to be less promising than initially expected.

4.11 Competencies

In both countries, there is the problem of ageing population, and given the sectors' negative image among young people, their agricultural sectors are likely to continue suffering in attracting sufficient and well-educated labour force. There is a decreasing inflow of new students for studies focussing on primary production, both at the level of higher education, but especially the mid-level and vocational jobs. In recent years, labour needs in both countries are covered by cheap labourers from Eastern European countries to perform menial tasks on farms and in glasshouses. There is a shared concern about availability and quality of labour force that has led the industry, together with unions and agricultural schools in developing campaigns to attract more students.

Current systems to support innovation in Scotland and the Netherlands require more initiative from agricultural entrepreneurs, so as to be less supply-driven and prescriptive. This calls for competences with regard to knowledge and information acquisition and learning for innovation, i.e. sufficient absorptive capacity. Evidence in both countries suggests that such competences are often lacking in agrifood SMEs and farms. This affects their ability to define strategic, organisational and technological deficiencies in their efforts to express clear demands to researchers and advisors. Apart from competencies, farmers often lack resources such as time and funds to invest in new knowledge and technology.

Provided that there are skillful facilitators playing the role of translators the language barrier between researchers and farmers/agrifood businesses can be overcome. However, evidence in Scotland suggests that the direct relationship between researchers – farmers/agribusinesses is often problematic. This is due to researchers' weak communication skills in translating research findings into a simple, practical language, understandable by this particular audience. This may imply the need for research institutes to recognise that effective communication skills with industry actors may differ from the R&D skills. Furthermore, instead of requiring from any researcher to become an effective communicator, evidence strongly supports the strategy of identifying the people that already have proven adequate skills, and use them exclusively to facilitate sharing knowledge between researchers and users. In the Netherlands, such needs appear already recognised and served. In fact, amongst consultants and advisory services there are many managers of innovation processes available. Innovation brokering is also starting to get more attention in the education curriculum, at least in some of the MBA type of programmes

4.12 Market Structure

Strong evidence in both countries suggest that the privatisation of extension services has for long now led to increased competition, and the shielding-off of information either amongst different research providers or between research and extension/advisory services (sometimes within larger institutes e.g. SAC). Information that was freely exchanged into the state scheme of linking agricultural researchers-extension services-farmers, has become a (potentially) purchased commodity that actors now have strong interest to protect its commercial value. As a result, information asymmetries are apparent in the Dutch and Scottish agrifood ISs.

Overall, commercialisation and privatisation of knowledge have paradoxically slowed down the knowledge and innovation diffusion. Evidence is also provided from the demand side. Scottish and Dutch farmers appear to have a less incentive to seek knowledge due to a number of reasons. First, the charged fee rates are significant, while there is some mistrust on the neutrality of

knowledge/information providers as having own-commercial interests. Second, 'information smog' has been created by mixed messages about new technologies or from separate innovation agendas (devolution in Scotland), plethora of providers and different types of knowledge supplied. Consequently, the industry face a difficulty in scanning the market, assessing differences in providers' quality, ex ante evaluating service value, and in many cases even identifying the provider(s) possessing the needed piece of information/knowledge they are looking for. The observed information asymmetry complicates the search for and selection of suitable cooperation partners, and raises transaction costs. Additional to that, a third challenge comes form the economic changes that food sector is facing at the moment, where short-term pressing economic issues destruct the supply-chain actors from the longer-term sustainability goals. The aforementioned reasons have a combined effect.

Both the Scottish and Dutch agrifood sectors have undergone structural changes and has become increasingly consolidated with a continuous trend towards fewer but larger-sized establishments, accomplished through merges, acquisitions, vertical integration, joint ventures and market exit. Farmers in both counties are confronted with substantial concentration of either sides of the farming sector: upstream i.e. agricultural input providers and downstream side i.e. food manufacturing and especially in food retailing sector (IFAP, 2002). There is the domination of a few large firms both in the input and distribution sides of the agri-food chain. There is genuine concern in the farming community and their levy boards that as a result, farmers have significantly less choice from whom to buy their inputs and to whom to sell their product, or about what and how to produce.

Much attention has been drawn to the dominance of multiple retailers, especially by Scottish interviewees. Especially in the UK, retailer concentration has skewed the balance of power in agrifood supply chains, which financially appear quite hard bargain-driven. Interviewees reported an increasing retail-to-farm price spreads, with the multiple retailers exercising excessive bargaining power over supplying food processors/manufactures, due to supermarkets' sheer market share, and easy access to imports markets. Tight profit margins, especially for SMEs, result from, first, the difficulty in passing on increases in production costs of raw material, due to increased agricultural input prices, and second, the requirement for food processors/manufactures to participate financially in retailers' promotion campaigns. More specifically, even large UK food manufactures find it tough to negotiate with multiple retailers. This economic pressure is transferred by food processors/manufactures to farmers who generally operate with the lowest profit margins in agrifood supply chains. Inevitably, tighter margins and low access to finance, especially for SMEs after the economic downturn (financial infrastructure failure), are highly regarded as posing significant growth and innovation barriers, affecting the ability and willingness (confidence) of farmers and agrifood companies to invest in knowledge and innovation development.

Evidence suggests that Scottish farmers, to an extent, remain dis-organised and scattered, that results in weak market power, and vulnerability to attempts by the large firms to exert control control In contrast farmers in the Netherlands appear more organised and willing to work collaboratively to secure greater power in the supply chain.

To a number of interviewees, retailer concentration and excessive bargaining power appear to an extent, to act as an innovation barrier. However, other interviewees also credit UK multiple

retailers with offering to food manufacturers and their supplying farmers an increased access to consumers and being the real driving force for innovation within agrifood supply chains. Evidence suggests that food processors/manufactures tend to (sometimes be forced to) respond to retailers' demands, rather drive innovation.

5 Conclusions

The findings confirm the appropriateness of considering actors, functions, inducing or blocking mechanisms and innovation instruments as analytical tools to evaluate the performance of agrifood innovation systems. By combining the four additional types of transformational failures (Weber and Rohracher, 2012) with the two market failures (van Mierlo et al., (2010) and the four structural failures (Klein Woolthuis *et al.,* 2005), together with the coupled functional-structural approach taken by Wieczorek and Hekkert, (2012), the new integrated framework is proven to include all the necessary analytical blocks of a policy framework, aiming to identify systemic problems and propose systemic instruments to fix them. It produced a very rich and systematic analysis.

In both countries, blocking mechanisms in terms of actors' interactions and competencies as well as market and institutional structures were revealed. Many blocking mechanisms found in the Dutch and Scottish agrifood ISs were almost identical such as the impact of privatisation and commercialisation of extension services on the knowledge infrastructure. This may imply some universal effects of globalisation or the EU policy or even indicate similar trajectories and associated needs in the evolution of innovation systems over the years. In other cases, differences in the intensity of negative or positive impact of innovation-targeting mechanisms seems to be directly affected by the long traditions and cultures in each country that remain firmly rooted in the collective memory and consciousness of its people e.g. the Dutch people's inclination for collaboration, working on the basis of consensus, learning networks, and knowledge co-production. This may explains why the Dutch agrifood IS could be served better or for longer from a 'hands-off' approach from the Government, compared to the Scottish case, where the need to undertake a vision building strategy emerged earlier for the Scottish Government. In both cases, it was primarily the transformational failures of the agrifood ISs that most justified policy intervention, due the long-term character of transformative change, associated with the uncertainty surrounding innovation and change. Such conditions often go beyond interests or capacities of a fully competitive and decentralised market system to address.

However, the analysis benefits from the comparison of two countries which, one can say, demonstrate signs of different levels of maturity in terms of their propensity and capacity to innovate. In other words, it was interesting to see what kind of challenges faces a society (or agrifood system) that appears to have already comprehended the importance of multi-stakeholders collective learning, and have progressed with experimentation in learning networks, such as the Dutch agrifood system. Is it easy for actors to manage the accumulated experiences in fostering innovation processes, transform them from tacit to codified knowledge and disseminate lessons learned? Analysis shows that agrifood ISs tend to be so complex and changing over time similarly to the sustainability challenges that have to address, that such a task represents a huge challenge itself.

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