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Research paper

Systemic problems affecting co-innovation in the New Zealand Agricultural Innovation System: Identification of blocking mechanisms and underlying institutional logics

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ABSTRACT

This study identifies systemic problems in the New Zealand Agricultural Innovation System (AIS) in relation to the AIS capacity to enact a co-innovation approach, in which all relevant actors in the agricultural sector contribute to combined technological, social and institutional change. Systemic problems are factors that negatively influence the direction and speed of co-innovation and impede the development and functioning of innovation systems. The contribution in the paper is twofold. Firstly, it combines both innovation system functions and systemic problems in an integrated analysis to asses an AIS at a country level, which has not been done previously in AIS literature. Secondly, it deepens the generic literature on structural-functional innovation systems analysis by looking at the interconnectedness between systemic problems and how these create core blocking mechanisms linked to the prevalent institutional logics (historically built-up and persistent structures and institutional arrangements) of the AIS. Results indicate that the existing New Zealand AIS has three main blocking mechanisms related to three institutional logics: (i) competitive science in silos, (ii) laissez faire innovation, and (iii) science centered innovation. These findings resemble weaknesses of AIS in other countries, and provide supportive evidence that co-innovation principles in many places have not yet been translated into agricultural innovation policies due to persistent and interlocked blocking mechanism and institutional logics. They point to the absence of effective systemic innovation policy instruments that pro-actively stimulate and support co-innovation. These instruments facilitate the counteracting of individual systemic problems and have a more transformative ambition; tackling the key institutional logics that hinder co-innovation, and hence supporting 'structural system innovation'.

1. Introduction

Agricultural products make up over half of New Zealand's merchandise export with the country being the world's largest exporter of dairy products, sheep meat, venison and kiwifruit [1]. To maintain this position the New Zealand Government has set the goal of doubling the value of New Zealand exports as a share of gross domestic product by 2020. One of the six key drivers needed to achieve this goal is increasing innovation in businesses [2]. Challenges related to innovation in the agricultural sectors include developing high value foods, and enhancing primary sector production and productivity, while maintaining and improving land and water quality [3]. In response to earlier identified shortcomings of using a science-driven, linear, technology transfer-oriented approach to innovation in New Zealand (i.e. lack of end-user involvement creates a low adoption of technologies, because these do not fit in farming systems and no effort is made to create an enabling context for adoption) [4–6], there is interest in bringing together relevant actors from the agricultural sector to increase research and development efforts in a coordinated and interactive fashion through a 'co-innovation' approach [7–9]. Under a co-innovation approach, all relevant actors in the agricultural sector (including farmers, growers, consultants, banks, agri-businesses, Government, NGOs and entrepreneurs), become

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co-developers of knowledge, champions of combined technological and institutional change and entrepreneurs experimenting with new business models [10], instead of mere recipients of technologies created elsewhere, which are subsequently adopted or rejected. However, a co-innovation approach has never been fully implemented in the New Zealand agricultural R&D sector, though experiments with interactive approaches have been done [11].

Making co-innovation work is often not easy, as it depends on the receptiveness of the Agricultural Innovation System (AIS). An AIS is defined as "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge" ([12], p. vi–vii). Co-innovation is thus influenced by how the AIS is structurally composed in terms of the presence of actors, their interactions, the institutions that influence their behaviour, and the presence of supportive physical, financial and knowledge infrastructure and incentives for actors in the AIS to support co-innovation [13–15]). The structure of the AIS thus determines how so-called 'innovation system functions' necessary for combined technological and institutional change can be successfully realised as the collective outcome of co-innovation interaction among the actors [16–18]. Often systemic problems related to malfunctioning or absence of these structural elements [15], such as a lack of interactions between relevant actors, are present which influence AIS performance and the potential to enable co-innovation. Systemic problems (sometimes also referred to as systemic failures) are defined as factors that negatively influence the direction and speed of innovation processes and impede the development and functioning of innovation systems [15,19].

Therefore, it is important to diagnose such systemic problems that hinder innovation system functioning, and analyse how different systemic problems relate to each other. An innovation system diagnosis thus supports co-innovation, by drawing on diverse views and by bringing together diverse actors to (jointly) identify opportunities to deal with systemic problems [20,21].While the combined analysis of innovation system functions and structures was developed for diagnosing the pace and direction of innovation in the context of sustainability transition pathways around specific technologies, such as fuel cells and wind energy [17,22,83], it has become increasingly applied to also analyse sectoral innovation systems [23,24], such as agriculture ([25–30]; [21]), in order to assess 'systemic capacity to innovate' [31,32]. This paper aims to identify the perceived systemic problems in the New Zealand AIS that affect the ability of actors in the primary industries to co-innovate. It goes beyond previous research on the New Zealand AIS that has either focussed on particular industries within the agricultural sector (e.g. the dairy sector Morriss et al. [6]; [33]), or only focussing on specific components of the AIS (e.g. zooming in on the extension system within the AIS [34,35]).

Furthermore, our study extends the current research into systemic problems to co-innovation in two ways, aiming to contribute to theory development in AIS studies and innovation system studies more broadly. Firstly, in this paper we analyse the New Zealand AIS using a comprehensive framework developed by Wieczorek and Hekkert [15] based on a combined structural-functional analysis of innovation systems. This framework integrates structural and functional streams of innovation system enquiry to enable analysis of the effectiveness of the important functions (or processes) that support co-innovation, along with the presence and quality of the structural components that are needed for these functions to be effective [15,16,18]. Most AIS diagnostic studies [25–27,30] have only applied a structural analysis, not looking at innovation system functions. Lamprinopoulou et al. [36] did apply the combined structural-functional to national AIS, however these authors still put emphasis on systemic problems and focus less on extensive analysis of functions, and while Kebebe et al. [37] applied such a full combined functional and structural analysis, they only focused on the dairy sector of Ethiopia and not the overall national Ethiopian AIS. Our analysis thus aims to go further than previous AIS studies, providing a systemic analysis of the whole New Zealand AIS by linking the identified systemic problems to particular innovation system functions. It also aims to show what the shared underlying issues are that influence the performance of several AIS functions in New Zealand, and providing suggestions for systemic instruments that enhance the coordinated performance among functions. This also enlarges knowledge on what are common systemic problems in AIS across different countries, by mirroring our findings to results from systemic analysis of other AIS.

Secondly, the paper aims to shed more light on whether certain combinations of systemic problems are linked to each other and cause certain 'lock-ins' that prevent the execution of innovation system functions towards co-innovation. Previous research on AIS [14,38,39] has shown that innovation systems have path-dependencies reflecting certain 'institutional logics' [40], defined as "the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality" ([41], p. 804). Such institutional logics may hinder working in a co-innovation fashion and changing them would thus require 'system innovation' in the innovation system [38]. While structural-functional analysis has been adequate in detecting separate systemic problems, several innovation system scholars have argued that there is a need for unravelling the deeper patterns behind them to define 'blocking mechanisms' that are sets of systemic problems between which there is feedback [20,24,42] and how these may relate to certain institutional logics.

The paper is organised as follows: section two further describes and explains innovation system functions and structural elements in the context of AIS to arrive at the framework used to provide a systemic analysis of the New Zealand AIS, followed in section three by a description of the methods used to implement this theoretical framework for analysis. The fourth section presents results organized under each of seven functions that form part of our theoretical framework, and section five provides a deeper analysis of how the main systemic problems combined to form blocking mechanisms, along with the underlying institutional logics. We conclude the paper with a discussion of the main systemic problems and blocking mechanisms hampering co- innovation in the New Zealand AIS, as well as implications for innovation practice, policy and theory.

2. Analytical framework: combined functional-structural analysis of AIS

Next we describe the functions and structures as defined by Wieczorek and Hekkert [15] and provide for each function a brief illustration of how these have been described in the agricultural innovation systems literature (albeit not as a coherent set in a single publication). We follow here the order given to functions in Hekkert et al. [18], but it should be noted that the order is rather arbitrary as the same authors state that different 'virtuous cycles' of mutually reinforcing functions may exist in well-functioning innovation systems, as a result of different sequences and combinations of functions.

1) Entrepreneurial activities turn the potential of new knowledge, networks and markets into concrete actions to realise value [17], as has also been noted for agricultural innovation. Several authors in agricultural innovation studies [43,44] note such entrepreneurial