Inserting co-innovation into research translation: experiences from the VALERIE project

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Abstract

Although innovation is understood to encompass much more than R&D, science continues to be an essential ingredient. In particular translation, adaptation and 'valorisation' of research results, the responsiveness of research to users' needs and improved access to results are all regarded as important in achieving a more sustainable European agriculture. These challenges can be addressed in a number of ways including increased collaboration, networking, transdisciplinary research and co-operation between researchers and practitioners. From a theoretical and practical perspective such approaches often involve inserting elements of co-innovation into the traditional science-driven model. Whilst a number of studies have examined the processes entailed in co-innovation, such as co-reflection, learning, reflexivity, and co-creation of knowledge, less attention has been paid to integrating co-innovation processes into the translation of existing scientific research outputs. This paper examines this topic within VALERIE, a project using an iterative stakeholder-driven methodology to create an effective retrieval facility for science-driven research outputs. Specifically the paper aims to understand the interplay between users' identification and articulation of research needs and providers' matching of these needs. The evolving methodology provides useful insights into the process of, and highlights some challenges associated with, integrating co-learning and research outreach.

1. Introduction

Although innovation is understood to encompass much more than R&D, science continues to be an essential ingredient, as international, EU, and national level policies reiterate (OECD, 2010). These argue that there is a compelling need for research[1] to play a significant role in meeting the innovation challenges of increased demand for food balanced against the need to deliver other ecosystem services. If this role is to be fulfilled, provision needs to be made for outreach and translation of research to enable effective deployment of innovative research, as an essential part of the process. How the innovation process operates has been the subject of much scholarship in which two broadly distinctive models of innovation have been described: linear science-driven research and interactive innovation-driven research (EU, 2012; Klerkx *et al.*, 2012). The science-driven model is largely a linear process, characterised by publicly-funded research and carried out by research organisations with little involvement of users, where outputs are judged on scientific quality; while in the interactive model, framed within innovation systems thinking, innovation is a collective process combining knowledge from many different sources, using networks of

[1] Whilst it is acknowledged that 'research' can refer to outputs from a number of sources in a number of different forms, here the term is used to denote the formal scientific process, which produces scientific information as scientific literature, reports etc.

producers and users of knowledge, who become integral to the agenda-setting and research process, and outputs are judged on user relevance.

Although distinguished by different motivations, drivers and processes, these models describe systems that often operate together. Indeed effective interaction between the two is seen as important for optimal functioning of the Agricultural Knowledge and Innovation System (AKIS - EU, 2012; McIntire *et al*., 2009). Critically, involving end-users is regarded as essential in achieving translation and boosting innovation by facilitating the uptake of formal and empirical knowledge, and its integration into field practices. The integration of different actors (farmers, advisory services, brokers, intermediaries, consumers, private sector, policy makers) in research agenda-setting and in the research process arguably strengthens the role of research (OECD, 2010). It is envisaged that such involvement of actors through innovative networks assists the translation and 'valorisation'[2] of results (EU, 2012). From a theoretical perspective this involves inserting elements of the interactive model, characterised by co-innovation processes, into the science-driven model.

Whilst a number of studies have examined the processes entailed in co-innovation (co-reflection, learning, reflexivity, and co-creation of knowledge) less attention has been paid to understanding the integration of co-innovation processes into science-driven approaches. Equally, with respect to the latter, although adoption of innovations is well understood, there has been less focus on the multiple processes that underpin the translation of research. This paper examines these gaps drawing on experiences in the VALERIE[3] project which aims to boost the outreach of research in agriculture and forestry from national, international and EU research projects, using a co-innovation approach. As EU research is increasingly advocating co-innovation approaches it is particularly useful to reflect on the methodological challenges it brings (EU, 2013).

2. Conceptualising innovation processes

A prevailing problem identified in Europe is the increasing disconnect between research and farming, which means that research is often not sufficiently related to farm praxis (Leeuwis *et al*., 2004). In several EU countries there are challenges in transferring results from research into practice and in channeling practitioners' demands for knowledge into research and advisory agendas. In particular, it is argued that many users of knowledge need more adapted knowledge from research that is better translated to their understanding and needs.

Within the framing of the science-driven research model these challenges have been addressed by an emphasis on better adoption of innovations from research (OECD, 2010) as well as an emerging interest in translational research by enhancing 'valorisation' of research results, the responsiveness of research to users' needs and access to results; and by putting more emphasis on networking and transdisciplinary research (EU, 2012). This thinking is part of a wider realisation that research interventions can take many forms, and that the utilisation of scientific information is just one element of a much broader role that research can play in enhancing practitioners' capacity to innovate (Douthwaite *et al*., 2003).

The interactive model, drawing on Systems of Innovation (Smits *et al*., 2010) and Agricultural Knowledge Systems (Hall *et al*., 2006) approaches, recognises that innovation is distinct from research. Within this thinking agricultural research is re-conceptualised as part of increasingly complex, interactive and learning based systems, and research is seen as just one of the many 'stakeholders' within the system (Sumberg, 2005). Innovation is described as an emergent product 'co-produced' through interactions

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[2] 'Valorisation' is used here in the sense of giving meaning and (non-monetary) value to research

[3] (VALorising European Research for Innovation in agriculturE and forestry www.valerie.eu)

between heterogeneous sets of actors, such as farmers, input industries, processors, traders, and researchers, as well as NGOs and government actors at different levels; as the result of a process of networking and interaction (Hall, 2001). Research plays a role in this co-production, but the involvement of end-users is central in determining, undertaking and translating research results into technologies and practices so that such knowledge is co-produced (Klerkx & Nettle, 2013). In this sense both models are characterised by some form of translation of research.

Processes within the interactive model are widely referred to as co-innovation and are linked to a range of concepts such as reflexivity (Van Mierlo *et al*., 2010), knowledge co-creation and knowledge and innovation brokering (Klerkx & Leeuwis, 2008a). These have been well researched, however, the role of actors within innovative networks in the translation and 'valorisation' of research results is less well understood. In particular, how users express and communicate their research needs, how providers respond to these needs, and how users evaluate, utilise and adapt scientific knowledge, has received little attention.

The concept of matching supply and demand has been used to frame analysis of the user knowledge needs (and other resources necessary) for innovation and how these needs are met. Studies at different scales, focusing on the research-policy interface (McNie, 2007), the role of intermediaries (Klerkx & Leeuwis, 2008b), and innovation support services (Kilelu *et al*., 2014) offer some insights. They show that the diagnosis and analysis of problems and articulation of demands can be challenging, and that the process involves concretising unspecified needs into clear demands with continuous re-articulation through dialogue between the demand and supply sides (Klerkx & Leeuwis, 2008b).

These insights into the role of users and providers in the translation of research results offer a framework for the VALERIE methodology to integrate a co-innovation approach into a more traditional model of science-driven research. This paper aims to understand the interplay between users' identification and articulation of research needs and providers' matching of these needs in the context of the VALERIE project. Specifically it looks at how stakeholders in case studies concerned with arable agriculture identify, formulate and articulate innovation issues (research demands) and how project researchers search existing scientific research outputs to suggest solutions to these issues, and in turn how stakeholders respond to these efforts.

3. Context and methodology

The premise of the VALERIE project is that many EU- and nationally-funded research projects in agriculture and forestry provide excellent scientific results but that outreach and translation of these results into farming and forestry practices is limited. The challenge is therefore seen as boosting innovation by facilitating the uptake of formal and empirical knowledge, and its integration into field practices. Overall the project's objective is to translate research outcomes with a special interest in innovative and applicable approaches into end-user content and format (for farmers, advisers and enterprises in the supply chain), and to provide easy access to it. This is through the development of a smart retrieval system (ask-Valerie) for use at a European level. It does this by extracting and summarising knowledge from national, international and EU research projects and studies concerning innovations in agriculture and forestry; with a focus on six selected themes. These outputs are screened, filtered and tested with stakeholders (SH). Essentially the methodology understands that solutions derived from research need to be re-built on the farm, with the involvement of relevant actors.

The project methodology is based on a structure that links three research approaches and activities integrated in iterative cycles, driven by stakeholders. These '*extract knowledge*', '*coordinate co innovation in case studies*', and '*create an ontology* (a structured vocabulary)'. Case studies (CS) and their stakeholder communities (SHC) are at the core of this iterative process, they are organised around a particular supply chain, a farming / forestry sector, or a landscape, and so cover different scales and dimensions.

This paper concentrates on the *co-innovation in case studies* and *extract knowledge* cycle within four case studies (Table 1), which involve SH demand articulation and the supply of scientific knowledge. The *ontology cycle* (also stakeholder driven) which is concurrently developing a digital but knowledgeable 'assistant-expert' (ask-Valerie) is described elsewhere (Willems *et al*., 2015). The cycle starts by SHs in each CS identifying innovation issues (research needs) in participatory meetings facilitated by Case Study Partners (CSPs). The project Thematic Experts (TEs) then search existing scientific literature, EU reports etc. and extract information for innovation solutions to address these issues. They synthesise this and prepare end-user formats (factsheets) and the CSPs present these to the SHC to apply, test, refine and screen for their innovation potential in the local context. The SHC then feedback their evaluation of the solutions to the TEs, thus completing one cycle. The cycle is repeated and at each iteration innovation issues are reviewed and refined, further information or clarification is sought and new, or more detailed, innovation issues are generated. CSPs use a Dynamic Research Agenda (DRA) tool for monitoring and evaluation of this process allowing the SHs to revisit and refine the innovation issues at each SH meeting, developing the Dynamic Agenda (DA) described by Van Mierlo *et al.* (2010) . Reflection on the process is built in at SHC, CS, TE and project level. As meetings have progressed the SHC have identified trials to apply and test the potential of selected innovations in the local context using SH farms. These trial results will be integrated into the ask-Valerie retrieval facility.

Data analysed for this paper are derived from three cycles using meeting reports and DRAs, semi-structured interviews with CSP, CSP training and discussion/reflection workshops and discussion with TEs. The following analysis is drawn from four agricultural CSs (Table 1) and looks specifically at the first stage of innovation: issue identification, factsheet preparation, evaluation and feedback. These CS exhibit a range of SH innovation issues as well as different contexts and CSPs. The SHC in all these CS were already connected by a previous project activity and a common interest.

4. Identification of innovation issues and finding solutions: the influence of context and process

The results to date have shown that the way SHs identify their innovation issues and articulate these differs according to an interaction between *contextual* and *procedural* influences. Identifying issues and problems and articulating these has taken different forms in the CS. This is influenced firstly by the CS context: the CS goals, the innovation system and SH experience of innovation support, the actors involved, the composition of the SHC, their interests, their 'professionalism' or research literacy, the CSPs and the TEs; and secondly by processes within the project: the nature of participation and SH engagement, participatory methods used to ascertain their innovation issues and their prioritisation. Results from four CS are summarised in Table 1.

4.1 Context

The CS are diverse in terms of their social and technical context and history and this has a strong influence both on what and how innovation issues are identified and articulated as well as on the solutions found and the responses to these proposed solutions.

Identifying innovation issues

The influence of existing project or group activity on SH identification of innovation issues was evident. Although briefed to encourage SH to step back from existing interests and boundaries and identify broad goals and visions, CSP either decided this was not appropriate or found that SH had difficulty in doing this. Furthermore, SHs in some CS found it hard to focus on research needs, straying instead to wider systemic issues related to markets or other factors which could not be addressed with scientific information. This could reflect poor understanding of the task, or difficulty in distinguishing problems and ways of addressing them, but primarily it reveals how SHs operate in innovation systems, where agronomic issues are only one factor of concern and where scientific knowledge is not particularly regarded as contributing to problem solving.

Articulating the innovation issue in terms of concrete and manageable questions or topics for researchers at an appropriate level of detail was something that some SHs found hard to do. Existing activity and innovation support in CSs influenced both the process of identification and articulation, and the SH's level of understanding and therefore expectation. SHs had all engaged in previous projects or supply chains with technical support and were already accessing up-to-date specific agronomic information. In supply chains, there has been a substantial amount of research already undertaken and utilised. The potato supply chain SHs included some professional growers who regularly sought, and were familiar with, scientific information, and they were able to focus on specific questions about causes of poor crop quality. Equally, innovative farmers in the CS concerned with soil management, with a long history of support from an agronomist, demonstrated a certain level of understanding of soil science which allowed them to define their innovation issues and questions in detail. However, those in the bread wheat supply CS, who were also well supported, found it harder to identify issues where solutions were not already available.

Finding innovation solutions

Assumptions are made that TEs could interpret and understand the SH's issues and questions. TEs' searching, extraction, retrieval and summarising of research has been highly responsive to SHs needs and provided some up to date and useful information. However in a number of cases there has been difficulty in understanding the CS context and in finding relevant information or research that is solution-oriented. There were also apparent challenges in translating the scientific information into a usable and acceptable format.

Whilst some CS SH articulated their issues clearly, the difficulty others had in expressing their issues of concern in terms of concrete or manageable research questions at appropriate levels of detail is something the TEs found challenging. In some cases issues and associated questions were too generic and this created a difficult task for TEs who encountered a vast array of scientific literature on the topic and needed to filter down to a more specific enquiry. Establishing a dialogue between CSPs and TEs was important (as well as TEs attending meetings) so that where questions or needs were not concrete enough TEs could seek clarification and SHs could reformulate issues and questions.

The first stage of factsheet preparation setting out selected solutions to SH issues met variable responses. Some CS SHs (e.g. in UK) have found them helpful in providing useful information. However other CS SHs rejected the factsheets as not being very useful because they proposed infeasible approaches or were not specific enough, or they were detailed but the SHs were already well served with similar information and the factsheets added nothing new. In the potato supply chain, although the SHs found the factsheets quite general, their expectations were not too high. The CSP described the SH as "a critically positive group of SH; they have very specific questions related to their business. SH don't expect a complete and concrete solution. When this is available, fantastic, but also information that can help to find or create a solution is fine."

Mismatching of issues and solutions was attributed by some project partners to poor formulation of issues, as one remarked "Sometimes farmers don't ask good questions, they sometimes have the answer in the question". The effective translation of scientific information into a format and content that is useful for farmers was also revealed to be a challenge. One CSP highlighted the difference between farmer information needs and what was viable from research, saying “the challenge for VALERIE therefore is to reconcile their expectations for contextualized data of practical and validated information with the available [scientific] documents which are characterized by …reports and scientific articles”. Where factsheets were not helpful, issues were reviewed, refined, removed or added to in subsequent CS meetings using the DRA tool.

The project’s aim is to be solution-oriented, with the intention that innovation issues would be identified by SHs, and innovation solutions can be derived from scientific information. However, the ability of research to provide answers to innovation issues and problems is questioned, both in terms of the delivery format and more fundamentally in terms of the utility of the scientific information. Significantly, one CSP said that SH were not so interested in the factsheets and scientific information as they “aren’t looking for research *per se* they are looking for solutions”. Another CSP reiterated this saying “(Some) SH don’t have any research gaps, they are not aware that they need innovation”.

4.2 Co-innovation process

A central part of co-innovation reported in this paper is the identification of innovation issues (research needs), and a key process for this is stakeholder engagement using participatory approaches. The project approach recognises that achieving consensus is difficult, that the co-innovation process is a dynamic and evolving process that requires re-articulation and reflection. By building on existing CS SHC relationships and holding a series of interactive meetings, the intention was to establish a dialogue between users and providers of innovation solutions over the project period of four years. Methods used in the meetings (Table 1) followed a similar format of progressively building up from individual identification of issues to group consensus and prioritisation. Two years into the project provides an opportunity to reflect on this process.

The nature and extent of SH participation is contingent on a number of factors, most of which were in the hands of the CSPs. CSP clearly have an important role, not only in selecting and convening the SHC, in facilitating the meetings, explaining the nature of the project and the aims of the meetings and exercises, but also in implementing the methods, prioritising the innovation issues and communicating these back to TEs. Although CSP were guided, trained and given a common format for approaches and methods to use and reports and DRA to prepare, inevitably different interpretations appeared.

The CSPs are thus key actors in steering the co-innovation process. They are also important intermediaries acting as interpreters for the project and gatekeepers controlling access to the SHs for the SHC. They have to manage expectations for both the SHC and the project and as such have a divided identity. CSPs have to manage project fatigue amongst SH, and disappointment and scepticism which some SHs have expressed when the project has not been able to meet their innovation needs. CSPs align themselves to their SHC (often their ‘clients’), they acknowledge steering SHs towards pragmatic or easy to answer innovation issues that can be trialed within the project period, protecting their interests and in doing so maintaining their relationship. In CS where SHs were found to prefer to have an immediate solution rather than invest time in a dialogue, CSP selected issues with quick positive outcomes, which did not always match those from the research retrieval process, to sustain SH interest. The project’s timetable and the CSP’s desire not to overload SH also meant the SH meetings were restricted to 4-5 with 6 month intervals between. This in turn limited SHs opportunity to understand and engage with the project aims and to consider and articulate their innovation issues in a thorough and meaningful way.

5. Discussion and Conclusions

The iterative methodology of identification and articulation of innovation issues and supply of innovation solutions from scientific knowledge is at an early stage of development. As the project progresses this process is evolving, assisted by reflection throughout, at project, case study and SHC levels. The DRA has been a useful tool in monitoring the process, allowing SH to review, reiterate and refine their issues, as well as evaluate the proposed solutions. Experience to date reveals that operationalising co-innovation is challenging, as described in other studies (Botha *et al*., 2014), with no set recipe or protocols to follow. The process is complex and the outcomes unpredictable due to the variable context and procedural influences in the CSs. Involvement of end-users in determining, undertaking and translating research results as others have shown can be demanding (Klerkx & Nettle, 2013) with SHs differing in the way they identify, formulate and articulate issues, and respond to researchers' proposed solutions.

More fundamentally, the results reveal the assumption that innovation issues equate to research demands and that scientific knowledge equates to innovation solutions to be quite simplistic, as in reality the process is far more nuanced. Producers already have a high degree of experience and complex knowledge which they use for everyday problem identification and solving (Baars, 2011). Asking them to externalise this process and to articulate issues in an explicit way that can be interpreted by researchers is not a straightforward process and in some cases requires sustained dialogue, clarification and a number of iterations. Furthermore, the assumption that scientific information will provide a solution to these innovation issues as opposed to other sources of knowledge, or indeed other factors, is also revealed as a rather one dimensional view. However, despite these challenges, experience to date has shown that involving end users in the translation process provides opportunities to facilitate the uptake of formal scientific knowledge.

The aim of the paper was to understand how translation of research could be enhanced by combining the benefits of interactive learning networks with those of linear dissemination models. It has done this drawing on the VALERIE project which set out to translate research outcomes. The co-innovation process is complex and, in particular, reconciling the supply and demand of scientific information can be highly pragmatic and contextual in nature. However, the VALERIE project is helping us to better conceptualise and plan for a more effective translation of research for different types of practitioners in contrasting local situations, and how better to foster coherence between co-innovation and broader scientific research agendas and processes. This project will provide important insights for the European Innovation Partnership with respect to its thinking and support of interactive innovation (e.g. through Horizon 2020 research and Rural Development Programme operational groups).

Table 1. Description of Context and Process factors that influence identification of innovation issues and solutions in VALERIE Case Studies

Context: Background, goals, SH characteristics	**Process: Participatory method for issue identification & CSP influence**	**Innovation issues**	**Innovation solution, Factsheets (FS) and initial SH response**
Innovative Arable Cropping group, France Farmer group active since 2005, working with an agronomist to test techniques (tillage, legumes, cover crops) to improve soils, reduce weeds. **SH:** mainly farmers, technical services, field advisers , co-operatives; Agricultural Chambers; institutes	Farmers each wrote keywords on a flipchart. Through successive rounds, farmers clarified and explained underlying ideas to the group. So the research questions were formulated progressively and collectively CSP tried to steer SH away from previous topics. TE attended meetings	What are the effects of direct sowing, cover crops and tillage on the N and SOM cycles? What influences the end of weed dormancy? How to evaluate field soil properties? What are the effects of direct sowing, cover crops, tillage, on varieties of rape, wheat, sunflower, legumes?	**FS:** 1. Low volume spraying; 2. Recovery of chaff; 3. Herb-sowing: sowing and combined application of localized herbicide. SH are concerned about validity - if the FS report trials, they should describe the experimental conditions and make clear/explicit the context
Potato supply chain, Poland Supply chain linked to a processor company with a large farm and 60 contract farms. The company invest in research to improve quality and yield **SH:** suppliers of seeds, fertilizers, pesticides, processors & professional farmers already accessing research	Individual participants were asked to think what the main issues are, this was followed by a plenary discussion about the topics raised and then prioritised CSP filtered the issues according to: what VALERIE can offer, filtering out systemic constraints and well known solutions	A suite of specific problems were mentioned mostly concerning potato quality. Internal brown spots in potato tubers was prioritised due to Tobacco Rattle Virus (TRV) transmitted by nematodes but also associated with Ca deficiency	**FS:** Integrated management of TRV in potato production: 1. General information; 2. Control methods; 3. Which cultivar to choose? Response to FS was positive but SH already know about general solutions, they want specific solutions
Bread wheat supply chain, Italy Quality is a key concern for this supply chain **SH:** Farmers, supply chain players, cooperatives offering storage, millers , input suppliers, retailers and processors	A moderated poster circuit method was used. Participants circulated in groups, filled and reviewed the posters for each step of the chain: production, inputs supply, technical assistance, storage. CSP guided SHs in selecting issues. TE attended meetings	Quick methods for quality assessment of grains Agricultural practices to save inputs and increase quality Economical evaluation of the most innovative practices	**FS:** 1. Use of catch crops to reduce nitrate leaching; 2. Use of a drone to monitor crop situation; 3. Late fertilization for high-protein milling wheat varieties. FS do not offer solutions, approaches are not feasible, do not focus on bread or biscuit varieties
Catchment management in arable cropping, UK A partnership comprising individual farmers, local authorities and government agencies, farming representatives, NGOs to enhance catchment management **SH:** 4-5 farmers participated in meetings	Paired discussions between farmers then a group discussion to rank and prioritise the issues CSP selected a small no. of SHs and steered them towards pragmatic issues.	Nine issues listed and summarised as: 1. Management practices to release P and K from soils; soil amendments; role of trace elements in nutrient availability. 2. Soil management and crop rotations to improve resilience (cover crops and tillage techniques to improve soil health).	**FS:** 1. Catch crops to reduce N leaching;2. Allelopathy: a tool for an integrated management of resistant Black grass. FS relevant and helpful but issues were revisited and re-prioritised in the next meeting

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