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How do we enact co-innovation with stakeholders in agricultural research projects? Managing the complex interplay between contextual and facilitation processes

Julie Ingram *, Pete Gaskell, Jane Mills, Janet Dwyer

Countryside and Community Research Institute, University of Gloucestershire, UK

1. Introduction

It is now widely understood that agricultural innovation needs to address and accommodate complex socio-scientific problems and thus requires mobilising a growing range of stakeholders[1] with multiple perspectives. In such cases innovation is 'co-produced' through interaction between heterogeneous sets of actors (farmers, land managers, advisory services, brokers, intermediaries, consumers, researchers, private sector, policy makers) (Hall et al., 2001). When such groups jointly identify problems and co-create potential solutions through the collective learning process of all actors, this is described as co-innovation (Dogliotti et al., 2014; Nederlof et al., 2011).

Co-innovation can be enacted, both as a process to bring about systems change in technology, markets, regulations and other practices that support commercialisation and production through modes of organisation such as innovation networks or platforms, and as a methodology to understand and facilitate co-innovation processes through participatory research in a research project. Researchers are involved in both in different capacities. While the former have been studied in many different contexts (Eastwood et al., 2012; Turner et al., 2016; Botha et al., 2014, 2017), the latter have received less attention and as such are the focus of this paper.

Co-innovation sits within a suite of integrative knowledge production research approaches (e.g transdisciplinary, action research, participatory research, multi-actor). Referred to broadly as Mode 2 knowledge production, these approaches have been developed to address complex socio-scientific problems, and meet the needs for opening-up research towards society (Gibbons et al., 1994; Nowotny et al., 2001; Nerbonne and Lentz, 2003; Hessels and Van Lente, 2008). They resonate with wider debates about democratising science in which notions of 'open innovation', 'responsible innovation' and 'reinventing innovation' have attracted attention, and point to the need to give space to multiple actors' concerns, knowledge, experiences and practices (Felt et al., 2007; Chesbrough, 2003; Berthet et al., 2018). However, despite the multiple normative claims about the potential for such interaction, commentators point to a lack of systematic appreciation of their relative merits. This has led some to suggest that there is an element of 'wishful thinking' involved (Hessels and Van Lente, 2008). In line with this Jahn et al. (2012) point to the danger of such approaches becoming part of the researcher lexicon through 'rhetorical mainstreaming' but without any agreed understanding of what co-productive modes of engagement actually entail in practice.

Co-innovation has been variously conceptualised as a process that combines complex systems theory, social learning, diagnosis and design and dynamic monitoring, and evaluation, and is delivered using participatory[2] multi-stakeholder methodologies (Botha et al., 2014; Dogliotti et al., 2014). However, as with other diffuse concepts, although widely theorised, the co-innovation research process is still largely an abstract concept and there is not as yet a shared understanding of how it is carried out in practice. Researchers are left to translate the concept in different ways. This presents challenges for those enacting a co-innovation research project since these require some form of standardisation and coherence around an agreed understanding of the research approach and methods used. This is especially so when cross-case comparative analysis is intended, as is increasingly the situation with multi-country research projects (Klerkx et al., 2017). Key questions being raised are: how to accommodate different institutional, social and cultural contexts that govern co-innovation and inherent social processes of learning (Hall et al., 2003); how to organise and facilitate groups of people so as to foster situated innovation, and what methods and tools are required (Berthet et al., 2016); and what roles to assign to different project partners in the knowledge production processes (Felt et al., 2012)?

* Corresponding author.
E-mail address: jingram@glos.ac.uk (J. Ingram).

[1] Defined as those actors or groups who are affected by or can affect a decision, and have a vested interest in the outcome of a decision (Mcnie, 2007).

[2] Referred to here as stakeholder engagement or participation, meaning the two way communication and learning process between participants and process organisers and facilitators.

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This paper draws on analysis of activities in a Work Package (WP) of the VALERIE[3] project which employed a co-innovation methodology across 10 diverse case studies in Europe to facilitate the identification and testing of stakeholder innovation needs and solutions respectively, with project scientists. As such, the project offers the opportunity to examine the factors shaping the process of co-innovation in a research project in which multiple partners translated the concept into varying case study contexts. The paper aims to understand how co-innovation is enacted as a research process and specifically asks:

- How does context affect the co-innovation research process in different case studies?
- How does stakeholder facilitation at the case study level affect the co-innovation research process?
- How can research design and management adapt to these?

In addressing these questions the paper aims to contribute to theoretical development of the co-innovation concept particularly with respect to how co-innovation is enacted across different contexts and by different agents in a research project, which hitherto has been undeveloped.

With co-innovation the central tenet of the European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI) and the multi-actor approach embedded in European Horizon 2020 and Horizon Europe programmes, it is especially pertinent to pause and critically assess this interactive research and innovation process carried out by multi-country consortia. The value of accounts of how such approaches are operationalised and mediated has been highlighted by other scholars (Flyvbjerg, 2006).

2. Co-innovation concepts and methodologies

2.1. Concepts and methodologies

Co-innovation draws on a number of conceptual and methodological approaches. Conceptually co-innovation has its roots in innovation systems thinking and the co-production of knowledge (Hall et al., 2006; Sumberg, 2005; Rossing et al., 2010). Complex Adaptive Systems[4] capture the dynamic and evolving innovation process and Agricultural Innovation Systems[5] (AIS) promote participatory stakeholder engagement to identify both farm level needs and the broader structural constraints to local adoption of new knowledge. The co-innovation process advocates an interactive style of problem solving that recognises "local actors' capacity to find solutions to problems and towards rebalancing relationships between farmers and researchers/extension services" (Berthet et al., 2016 p283). In this sense co-innovation resonates with co-design processes, in that it aims to position end-users as co-designers of solutions to their needs (Berthet et al., 2018; Triomphe et al., 2013). Systems thinking and co-production of knowledge concepts equally emphasise the iterative exchange, through repeated interaction in all phases of research (Lemos and Morehouse, 2005; Eastwood et al., 2012; Rowe and Frewer, 2000). These constructs underline social learning[6] which emerges from these sorts of social interactions and is characterised by negotiation and co-creation through iterative reflection on shared experiences, ideas and actions (Turner et al., 2020). Outside intervention taking the form of facilitation is an essential process of enabling active learning and effective action amongst interdependent actors (Leeuwis et al., 2002b; Ernst, 2019).

Methodologically co-innovation is delivered according to different models which engage actors in dynamic multi-stakeholder innovation systems or in iterative learning for change processes (e.g. Eastwood et al., 2017; Hoffmann et al., 2007; Lundy et al., 2005). The nature and extent of interaction of stakeholder engagement or participation varies. It can cut across multiple actors to provide holistic and systemic views of problems (Turner et al., 2016); have a strategic, rather than a complete representation of stakeholders, based on their relative levels of interest, influence and benefit (Reed, 2008); or be applied to a more limited group of actors (Dogliotti et al., 2014). These can operate at different scales and levels of intensity and with different actors and at any stage of the innovation process (Botha et al., 2014; Dogliotti et al., 2014). There are a multiplicity of participatory tools and methods available which seek to integrate varying types of stakeholder interests in innovation and to elucidate and co-solve problems (Berthet et al., 2016).

2.2. Co-innovation research – defining features of research design and methodology

While a research project may apply a co-innovation approach founded on these combined concepts, what this means in practice, as distinct from other approaches which foster social learning and co-production through participatory research, is rarely elaborated. Those operationalising co-innovation have identified characteristics that help achieve co-innovation project outcomes and impacts (Fielke et al., 2018); and principles for managing the space within which actors can negotiate co-innovation in practice (Coutts et al., 2017). However, these are often derived for the specific context of primary industry co-innovation platforms and tend to emphasise higher level change processes rather than purposeful elicitation of knowledge in research project cases studies. The literature does, however, suggest some defining features which are specifically associated with co-innovation methodologies relevant to research projects.

A core process is *jointly framing problems* and testing solutions, often through *experimentation*, engaging all stakeholders (Schäfer and Kröger, 2016). In this respect co-innovation explicitly deploys participatory 'exploration' processes' which entail a 'search for new knowledge' (Berthet et al., 2016; Greve, 2007). This aligns with an understanding of innovation processes as addressing the unknown (Agogué et al., 2017). Outputs are both co-evolved technologies and practices with relevance to settings and enhanced capacities to innovate and change in the longer term. In this respect, social learning is understood as highly interactive processes among different researchers and social actors, resulting in problem solving, new knowledge, a new practice or a change in shared understanding (Akpo et al., 2015).

Building in *iterative design* is also vital for achieving mutual understanding through repeated interactions and feedback loops between research producers and users (Sumberg et al., 2013). The methodological design typically follows an *adaptive cycle* of plan-do-review, or diagnosis and redesign (Rossing et al., 2010; Dogliotti et al., 2014). The cycle progresses in stages from problem definition and identification, solution testing through conducting collaborative research, to applying results (Johnson et al., 2003). *Dynamic (reflexive) monitoring and evaluation* is an important component of this cyclical process, allowing the stakeholders to deliver creative solutions through reflection. This is in accordance with

[3] FP7 EU funded project VALorising European Research for Innovation in agriculturE and forestry (www.VALERIE.eu).

[4] CAS are defined as self-organizing systems "whose properties cannot be analysed by studying its components separately […] formed by many agents of different types, where each defines his/her strategy, reacts to the actions of other agents and to changes in the environment, and tries to modify the environment in ways that fit his/her goals" (Spielman et al., 2009, p. 400).

[5] In the AIS approach, innovation is considered the result of a process of networking and interactive learning among a heterogeneous set of actors, such as farmers, input industries, processors, traders, researchers, extensionists, government official, and civil society organisations (Leeuwis et al., 2004; Hall et al., 2006).

[6] With multiple definitions social learning has been used mainly as an analytical concept to investigate complex resource dilemmas and environmental management.

systems thinking which needs to incorporate flexibility to enable re-evaluation of the unpredictable processes and continuous adaptation and readjustment. For Rossing et al. (2010), reflection means constructing the co-innovation approach as the project advances. In fostering co-innovation, the fulfilment of *facilitator or intermediary roles* is seen as particularly important (Agogué et al., 2017; Klerkx and Leeuwis, 2009).

2.3. Key issues

Elaborating these core components of co-innovation concepts, design and methodology, highlights a number of issues research projects need to consider when enacting co-innovation.

Firstly, innovation is a dynamic, continuous process of planning, acting, reflecting and readjustment, and any research process needs to continuously adapt in response to issues and solutions that emerge over time (Kilelu et al., 2013; Klerkx and Jansen, 2010). Co-innovation therefore needs to be thought of as a research-guiding principle rather than a methodological blue print (Rossing et al., 2010). The absence of a uniform model for implementation and the difficulty in achieving a 'true' approach have been described for other integrative approaches where the process is subject to case dependent and relational influences (Macken-Walsh, 2019). As Felt et al. (2012 p25) concluded from a review of participatory projects "there is no single, coherent entity that could be labelled 'participatory research', but instead, a multitude of constellations and practices became visible in the different project choreographies and even in narratives of different researchers within one project". Those implementing related concepts like social learning which is defined in multiple, overlapping ways, experience the same uncertainties (Ernst, 2019; Turner et al., 2020; Reed, 2008).

Secondly, and in relation to this, researchers have to negotiate different institutional, social and cultural contexts, as shown for innovation research projects, commercial co-innovation and for environmental governance (Reed et al., 2018; De Vente et al., 2016; Neef and Neubert, 2011; Botha et al., 2014). They cannot rely on replicating a common set of participatory methods across different contexts and countries, but need to translate these to different institutional conditions (Klerkx et al., 2017). As a socially embedded process, innovation can also be 'cumbersome' due to group relational dynamics linked to context (Felt et al., 2012; Thompson et al., 2017; Neef and Neubert, 2011). Describing inherent tensions in the development of innovation networks and platforms, Foran et al. (2014 p90) noted how "efforts to steer innovation face discourse-dependency, context-dependency, and power asymmetries".

Thirdly, successful stakeholder engagement in the co-innovation research process relies to a large extent on properly mediated participatory research (Akpo et al., 2015; Sumberg et al., 2003; King et al., 2019). However, how best to achieve this remains a challenge (Neef and Neubert, 2011; Foran et al., 2014; Reed et al., 2018). Facilitation is particularly important in participatory research (Medema et al., 2014). Although the emphasis is often on the facilitators' role to mediate, structure discussion, balance contributions and coordinate legitimate process (Wiek, 2007), in co-innovation this role has other demands of fostering problem solving and managing the iterative and reflective monitoring process (Fielke et al., 2017). Overall facilitators have to deal with inherent unpredictability as processes are evolving, contextual and affected by uncertainties of various kinds (Leeuwis et al., 2002a). As Lundy et al. (2005 p4) point out, "one cannot predict in advance how processes will evolve, and what intermediary outcomes will be achieved, and neither can one foresee the capricious dynamics of human negotiation processes".

3. Methodology

This paper analyses data collected concerning case study activities in a Work Package (WP) of an international co-innovation research project.

3.1. Project methodology

A co-innovation methodology was applied in a WP of the VALERIE project. It sought to work with a range of stakeholders across a number of agriculture and forestry themes[7] to help them identify their innovation needs and address them with solutions from research. The approach was applied to 10 case studies across Europe which were selected to represent different supply chains, farming or forestry sectors, or landscapes, and to cover different regions, scales and dimensions (Ingram et al., 2018).

At the WP level the approach was designed, coordinated and monitored by researchers (the authors) and operationalised by Case Study Partners (CSP), local advisers who facilitated research activities in the case studies. CSP, as project partners, had some early input in the project proposal identifying case studies and potential stakeholders. Thematic Experts were the scientific project partners from each case study country. Although *all* project partners are stakeholders in the co-innovation process, we distinguish the case study community actors as stakeholders here to reveal how (and by whom) co-innovation is enacted.

The co-innovation methodology was guided by the project aims and the core principles outlined above: namely an iterative or cyclical process based on regular interaction with stakeholder communities in case studies. The design followed planned stages of problem identification and testing, but was adaptive responding to different situations, based on a learning-oriented project design (Rossing et al., 2010).

Stakeholder communities in case studies identify *innovation issues* (research needs) in participatory meetings facilitated by CSP. The Thematic Experts then search existing scientific literature, extract relevant information and prepare end-user formats (factsheets, summaries) for *innovation solutions* to address these issues. Stakeholders next screen, evaluate, test these for their innovation potential in the local context and feedback their evaluation of the solutions to the Thematic Experts. This cycle is repeated and the innovation issues and solutions are reviewed, re-articulated, refined and prioritised, further information or clarification (by stakeholders or Thematic Experts) is sought and new or modified innovation issues and solutions are generated. As the cycle progresses the stakeholders identify trials to apply and test the potential of selected innovation solutions in the local context. Results from these trials (which represent adaptations and further knowledge production) feedback into the iterative process and provide co-created empirical knowledge. They are compiled into stakeholder trial leaflets which capture the story of the co-innovation process for dissemination.[8]

A minimum of five stakeholder meetings were held in each case study over the four year project period, CSP were also encouraged to continue the dialogue at interim meetings. Each meeting was documented in reports by the CSP who were asked to include their own analysis and reflections.

Managing the co-innovation approach across 10 diverse case studies required some systematic coordination of case study activities. WP leaders guided and trained CSPs (in workshop sessions) to follow a common approach and timetable for: stakeholder selection and analysis, participatory meeting formats, data collection and reporting structure, trial design and reporting. CSPs were also trained to use a Dynamic Research Agenda tool (Van Mierlo et al., 2010). A Dynamic Research Agenda document is created to record how the innovation issues and solutions are reviewed and refined with stakeholders at each meeting. In recognition of different case study contexts and stakeholders, some flexibility in the exact mode, timing and number of interactions was allowed and CSPs selected different participatory methods and tools

[7] Six themes: Crop rotation, soil cover management, IPM; Ecosystem and social services in agriculture and forestry; Soil management as an integrated agro-ecological system; Water management in agriculture; Sustainable integrated supply chain services & tools; Recycling and smart use of biomass and food waste.

[8] Available at: www.valerie.eu/index.php/downloads.

from a project methods toolbox to facilitate stakeholders in identifying, prioritising, and evaluating solutions. They also adapted the Dynamic Research Agenda format and trial protocols to suit local conditions.

There was continuous interaction between CSP and the WP research team. Given the evolving nature of the co-innovation process, reflection was explicitly built in, at case study level facilitated through the DRA, at WP level through interactive feedback sessions at WP meetings (face to face and skype), and at project level as all partners reviewed progress and contributed to decisions about methodology and concepts of co-innovation. This approach allowed evaluation and adaptation of the methodology as the WP progressed. Each member of the WP team provided dedicated support to individual CSPs throughout the project.

3.2. Data collection and analysis

The data collection and analysis presented here is drawn from activities in all five iteration cycles in three agricultural case studies (Tables 1 and 2). These were selected for analysis here as they all have agricultural production as a core activity (not forestry or environmental goals) but provide a range of different contexts with respect to the stakeholders and the existing innovation support services.

The data set comprises all documents prepared by CSP for their respective case studies: stakeholder meeting reports, Dynamic Research Agenda, trial plans, reports and leaflets. In addition WP team members each carried out semi-structured interviews with CSP at 6 monthly intervals. The interviews were intended to both provide a means of reflection for, and understand the role of, the CSPs. The WP team also continuously conducted participant observation at the four project meetings, and associated field trips to case studies, and two training workshops, where discussion and reflection took place with CSPs and Thematic Experts and other partners. All interviews and meetings were recorded and transcribed. The WP team met regularly to discuss and triangulate findings. Document analyses of case study reports and other materials, together with analysis of interview and meeting transcripts, was carried out using manual coding. This was done by one WP member who built an initial coding framework at month 6 which was subsequently refined at intervals as new data was analysed, and new insights were gained from WP team discussions.

The approach combined deductive and inductive analysis. Observing and documenting the cycles of the WP gave the authors the opportunity to follow a set of inductive strategies for data collection and analysis in a grounded theory approach (Charmaz and Belgrave, 2007). These were shaped by guiding interests in how co-innovation is enacted and informed by the concepts discussed earlier in the paper. Together these were used as 'points of departure' to look at data, and think analytically about it. Starting with the early case study reports, issues of context, facilitation and research design and management emerged and were explored further in the CSP interviews. The other documents and observations were progressively used to reinforce or validate the analysis. In this way research was guided by theory and allowed us to weave theory and evidence together (Rule and John, 2015). As the analysis advanced the three high-level themes of Context, Facilitation, and Research Design and Management were progressively unpacked, as in shown in Fig. 1. The notion of an interface space between these which links two levels of co-innovation, at the case study, and at the project level, also emerged (Fig. 1).

4. Results

These results reveal different insights into enacting co-innovation at case study level and focus on the influence of context and facilitation of the stakeholder process, themes which were disentangled as the analysis progressed. Processes active in the interface space between WP and case study are also revealed. There is insufficient space here to report on the full process between the project scientists and stakeholders and the co-innovation outcomes, although these were considerable. Table 2 lists details of context (background, goals and stakeholders); facilitation (participatory methods); innovation issues and solutions (factsheets, responses and trials selected).

Table 1
Activity and data analysis for each case study.

ACTIVITY	DATA ANALYSED
Participatory meetings with case study stakeholders at 9 month intervals	Case study meeting reports (5 per case study) describing the co-innovation process at each stage
Solutions found by Thematic Experts	Factsheets (2–8 per case study)
Dynamic Research Agenda created and updated at each meeting	Dynamic Research Agenda (3–4 rounds for each case study as an excel sheet or diagram)
Trial activity records and documentation	Trial plans, results and leaflets (2–6 per case study)
Interviews with each CSP at 6 month intervals	Transcripts (3 interviews per case study)
CSPs and WP team group internal project meetings and skypes	Notes and audio transcripts (12 internal meetings)
Annual Project meetings and associated field trips to case studies, and two training workshops. Participant observation at these events	Project meetings minutes (x 4), and associated audio transcripts (x 4); training workshop observation notes and audio transcripts (x 2) participant observation notes (x 6)

4.1. Case study: agroecology - managing plant protection, France

4.1.1. Context in which co-innovation is enacted

The stakeholder community in this case study come from an established initiative funded under the agroecological plan for France which brings together a local farmers' cooperative, technical institutes and an agricultural college. The CSP works for a national innovation support service (with regional offices) and was not directly connected to this initiative. The CSP selected this as a case study because "the aims of the two initiatives [VALERIE and the existing initiative] are close: promote a bottom-up approach and transfer innovative practices on the ground", and its meetings provided opportunities for the CSP to convene a group of engaged stakeholders.

Given this background, innovation issues had already been widely discussed and problematised in the existing initiative and some farmers were investigating field methods in relation to herbicide and fertiliser management. As a result, in the VALERIE participatory exercises, despite being asked to step back and think about broader goals and visions, farmers identified these same issues. The CSP also acknowledged that the farmers were influenced by the exercises being held within scheduled meetings of the existing initiative.

Of the factsheets prepared by Thematic Experts, most were thought to be of no interest to farmers, or already well known through local innovation support services or research institutes. Overall the CSP reported "farmers find …. the content as too general and did not bring them anything new. They are already very advanced and accompanied on innovative techniques". Also for many of the topics "some farmers were interested but already mastered the subject". The specific comments from the farmers also revealed their requirements for rigorous and credible research outputs, for example these included: "Beware that the results indicate the dates and experimental conditions"; "We must pay close attention to the references"; and "One must be sure of the figures otherwise it is better not to give any".

Due to contact with the stakeholders being limited to meetings of the existing initiative, and the failure of the factsheets to inspire or provide sufficient new research knowledge, the cycle of identification, evaluation and refinement did not progress as intended. As such, choice of a trial topic to fulfil VALERIE's aims became pragmatic and trials already planned within the existing project were utilised. The CSP explained "These trials [intercropping] don't depend on the VALERIE project and are already budgeted by partners". These 'demonstration' trials were run

Table 2
Summary of selected case study background, methods used, innovation issues and solutions (SH=Stakeholders; CSP= Case Study Partners; TE = Thematic Experts; FS=Factsheets).

Context: Background, goals, stakeholder (SH) characteristics	Facilitation: Participatory methods for issue identification and prioritisation for trial selection	Innovation issues, problem framing	Innovation solution evaluation –factsheets (FS), trials and co-learning
Agroecology: managing plant protection, France This existing project brings together relevant technical partners: two other cooperatives, technical institutes, an agricultural college, a water association and research teams. An agroecology platform located at the college supports the technical services **SH:** mainly farmers (10–20, largely organic), supply chain actors, field advisers, co-operatives; members of Agricultural Chambers and technical institutes **CSP**: employee of lead organisation of networks of: agricultural technical institutes, a national and regional agency supporting farmers **TE:** national research institute, attended some meetings	In the first meeting of mainly farmers they were given 3 different color sticky notes to indicate priority: short term, mid term, long term. Outcomes were summarised and issues with the most votes in the short-term category prioritised.	Four broad areas of research were identified by the stakeholders in the initial meeting corresponding to existing project themes: Reduction of the use of herbicides and the optimisation of fertilisation in arable crops; agro-ecological management of pests and risk taking; lengthening the rotation; limiting nitrate leaching. Stakeholders followed up by identifying 10 priority issues from these themes, then refined these to 3: Low volume spray, localised fertilisation, precision farming.	**FS:** Seven factsheets produced by TEs, two selected as useful: • Low volume spraying technique • Improving the quality of bread wheat by late mineral fertilisation **Trial:** a demonstration of combined cropping of wheat and lentils to evaluate how different sowing and establishment methods affect lentil performance (yield and quality) and wheat protein content. **Co-learning:** farmers visited the demonstrations on open days at the agricultural college with project technicians and development services. It did prompt discussions between technicians and farmers, and stakeholders who found the trial useful.
Sustainable potato supply chains in northern 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, fertilisers, pesticides, processors, farmers, representatives from experimental station and company research **CSP:** agronomist for commercial company **TE:** project partner did not attend meetings	Individual participants were asked to think what the main issues are, this was followed by a plenary discussion about the topics raised. He acknowledged that he did not use particularly innovative methods.	Stakeholders identified nine broad issues in the first meeting all concerned with crop quality and they quickly refined the issues to the potential solutions for brown spot (caused by TRV transmitted by nematode), a major problem for the growers and the value chain.	**FS:** Three TRV factsheets: Integrated management of TRV in potato production: 1. General information; 2. Control methods; 3. Which cultivar to choose? 10-15 scientific papers on the topic provided some up to date and useful information **Trial:** testing the susceptibility of potato varieties to TRV. Two sorts of trial were used: ***A field experiment*** was set up to test susceptibility in 5 varieties at the company farm with 5 replicates. ***A demonstration plot*** was also set up at the same site testing 11 varieties with 1 replicate. **Co-learning:** stakeholders visited the trial and discussed the results on a regular basis, and visited the demonstration plot after the growing season. Results showed promising varieties but stakeholders pointed out, TRV susceptibility is only one of the important characteristics of a variety.
Irrigated Maize and Tomato, Italy Supply chain linked to cooperatives and a processors concerned with increasing yield and the viability of irrigated crops in this area. **SH:** farmers – 8, Irrigation system suppliers - 2, Processers - 2, Cooperatives – 3, Seed and pesticide companies – 2, Technicians – 3 **CSP:** agronomist/technician from local private innovation support service **TE:** from local university attended all meetings	In the first meeting a moderated poster circuit method was used referring to the 4 steps of the chain: production, inputs supply, technical assistance, storage. The trial choice was refined down to two options which the stakeholder community voted on. For trial evaluation farmer experiences were monitored in the field and negative and positive aspects were collected through a participatory ranking exercise with all stakeholders.	Themes concern water use efficiency in the production of maize and tomatoes without reducing yield or quality; the cooperatives and producer organisations are concerned with mycotoxins in maize, fungal pathogens and their impact on product (grain and processed tomato) quality; advisers' interests are for tools to support irrigation decisions. Use of low-volume irrigation systems requires a higher level of technical knowledge in terms of crop needs and irrigation scheduling according to weather data.	**FS:** Three factsheets described tools: Probes to measure water soil content; the use of probes to manage irrigation in the field; and the use of drones to monitor crop situation in a wide area. **Trial: a** field demonstration using a sensor station able to detect simultaneously weather data and soil humidity values. Three farms, tested the Netsens sensor units and BlueLeaf platform with a strong interaction with other farmers. Following this, three different farms specialising in processing tomato production trialled the sensor and shared their experiences in the field with the group **Co-learning:** farmers were very positive but the CSP concluded "Even if this innovation is useful for the farmer and has a positive return on his/her activity, it does not mean that the farmer is the direct user of the innovation"

as part of the formalised platform at the local college to provide wider dissemination in the region, not as co-learning activities. The process therefore did not contribute to the learning cycle envisaged in the VALERIE project.

4.1.2. Facilitating co-innovation

The CSP was sensitive to intruding on existing relationships in the initiative and very aware of the existing "strong dynamic" and did not want to burden the farmers with alternative project requirements, as they explained:

> "The group of actors on which the case study field is based has not been gathered specifically for VALERIE but pre-exists. This organisation has the advantage of ensuring the opportunity to work with a permanent group, in which the parties know each other and have some trust and freedom speech. Conversely, we must be attentive to how the "newcomers", [namely VALERIE partners - CSP and Thematic Experts] will interact with the group and even more so because they are not local players."

This comment reveals the balance that has to be struck between the advantages of using an established stakeholder community but at the same time negotiating the new project's goals. There was a strong reliance on the existing project arrangements and consequent difficulties in aligning the VALERIE project timetable, iterations, meeting aims and protocols. VALERIE activities became subsumed into those of the existing project, such that in meetings the participatory exercises were not completed. As the CSP noted for the issue priority exercise they employed "Unfortunately, we did not have time to present them the detailed result of the grouping but only a rough synthesis and have no time to interact after that". Overall this negotiated approach meant the opportunity for facilitation, feedback and iteration according to the co-innovation approach was limited. Trying to build a stakeholder community as part of the VALERIE project, and the associated understanding required, in an already well-established initiative was problematic. Nevertheless, the CSP's negotiations and adaptive behavior driven by project deadlines enabled some level of collective learning as evidenced by the trials and accompanying leaflets.

4.2. Case study: Irrigated maize and tomatoes, Italy

4.2.1. Context in which co-innovation is enacted

This case study brings together supply chain actors involved in the production and distribution of irrigated maize and tomatoes in northern Italy. Due to the specialised nature of irrigation systems and high quality standards for the produce, the CSP decided to initially involve the actors from the whole supply chain "in order to have a more comprehensive vision" (as listed in Table 2). The CSP represents a company that provides agronomic advice and laboratory support through a fee paying relationship. They explained "most of them [stakeholders] are among our client list or they are our partners in other projects, or simply other colleagues". This group had not come together before.

Methods used by the CSP for identification of issues in the first meeting (Table 2) were planned to allow sufficient scope in innovation issues across the whole supply chain to be expressed. Although the methods were well structured, some participants were not always clear about what sort of innovation issue to identify, asking the CSP "What type of answer do you want?" Overall yield and quality of the crops were the key issues selected. However, stakeholders had varying motivations and interests. For example: farmers want to improve water use efficiency in the production; the cooperatives and producer organisations are concerned with pathogens and their impact on grain and processed tomato quality; while advisers' interests are for tools to support irrigation decisions. This long and diverse list of issues brought some challenges as the CSP remarked:

> "Unfortunately, we noticed that more general issues than research questions came out …. .In fact I remember that after the kick-off meeting they were more confused than before, because they spoke about a lot of different things, because we let them speak in groups and so we have a very big list …. [so] we got into trouble about how to answer, because we had many, many contributions."

The many issues were reviewed and filtered in a process steered by the CSP and Thematic Experts, towards those concerning irrigation management on-farm since these could be realistically addressed with research outputs, and could benefit from factsheets assembled by Thematic Experts. The CSP acknowledged that he "drove the choice". When summarising the issues using the Dynamic Research Agenda, he directed participants away from those that were "too complex or too general", or where solutions to them were already well known. The CSP was also guided by the fact that "stakeholders expect mostly real and useable solutions or innovations". He noted that "if we have a field demonstration that was not useful, we would have lost their trust and engagement in the project". As a result, innovative tools which offered immediate impact, rather than innovative agronomic methods, were promoted by the CSP and the trial choice was refined down to testing a sensor station which works as a Decision Support Tool to help manage irrigation at farm scale. The CSP described this process as: "the stakeholders reached a consensus in a democratic way by finding what the majority wanted". This was carried out through a well-structured participatory activity, although it was evident that options had been narrowed down by the CSP.

4.2.2. Facilitating co-innovation

Participatory approaches were new to the CSP and enthusiastically adopted, as this remark shows:

> "We definitely got more results from participatory methods because every participant had the opportunity to speak and to note down his/her idea. We will try to avoid plenary discussion for the next meeting, given the fact that we need stakeholders' contribution and not only their presence".

When asked about their understanding of co-innovation the CSP replied:

> "It is a process that identifies an innovation together. We work together with the stakeholders to find an innovation and try to co-operate with stakeholders and set up a dialogue. I see your needs, give you answers and receive your feedback".

They also reflected on their own learning as part of this process, noting that "it [the trial] was an innovation for ourselves too". However, although they embraced these elements of the co-innovation approach, they saw an imperative to provide the stakeholders with some solutions quickly, saying "During the meeting, we perceived from the stakeholders the need to see some tangible results from the project, especially after one year". The CSP questioned the iterative nature of the methodology and the repeated articulation of innovation needs, explaining that they:

> "Stopped refining the research questions and started looking for answers. Otherwise it is repetitive and no one likes repetition …. . sometimes you have to stop because you need to give answers instead of keep asking questions, otherwise the project will not leave any trace".

He again raised the importance of identifying a suitable solution with his farmers particularly with respect to his own credibility and the nature of his role as an adviser operating in a commercial environment:

> "There is a problem in getting feedback from people that prefer to have the solution rather than investing time in a dialogue. If you give them a solution that doesn't work they won't trust you anymore. If I give them some impossible solution, such as cover crops, they say "don't you understand that they don't work for us …. Sometimes it is difficult to cope with project requests and daily work life, so, especially if you are private and don't get funding from the State".

4.3. Case study: Sustainable potato supply chain, Poland

4.3.1. Context in which co-innovation is enacted

This case study comprises stakeholders who represent a professional group of growers, processors and input actors active in a potato supply chain. Growers within a region of Poland are contracted by a processor

company to deliver high quality potatoes. They are accustomed to accessing and utilising scientific information with technical support from the CSP's (a research agronomist) commercial organisation. As such, the stakeholders quickly identified brown spot (caused by TRV transmitted by nematode), as a major problem for the growers and the whole value chain.

Thematic Experts' retrieval of relevant research was described by the CSP as highly responsive to stakeholder needs. However, it was difficult for them to find new innovative solutions as the stakeholder community are already familiar with a lot of the research on this topic as they are operating in a knowledge rich and competitive arena that demands a high level of innovation support.

When it came to selecting trials, two main solutions to TRV were considered from the research: the susceptibility of new varieties to TRV or a nematode control strategy through farm management measures. The former was chosen by the group as it was familiar to stakeholders, while the latter was as "a different story" since a TRV control strategy "is not so easy", technically demanding, and regarded as costly and risky with respect to ensuring a crop for the supply chain. The CSP acknowledged his role in steering the process of identification and prioritisation of questions to "what the project can offer, filtering out systemic constraints and 'well-known' solutions", explaining that this was a pragmatic decision to ensure both the project needs and stakeholder interests were met. The trial did not necessarily create novel solutions and was conducted on company plots according to conventional protocols, and farmers visited on open days, removing the opportunities for farmer-led trials as anticipated by the WP team.

4.3.2. Facilitating co-innovation

Although the CSP already knew the growers and some of the other stakeholders, for him the case study was "non-existent, I had to start from scratch", that is, he had to purposely assemble supply chain actors to create a stakeholder community, and to coordinate and facilitate meetings and activities to meet the WP goals. This extended his day to day role beyond that of a technical adviser/agronomist to the growers, to a facilitator for the project. Accustomed to providing agronomic support, the CSP found the participatory methods suggested by the WP unfamiliar, however, he reported that the stakeholders were responsive:

> "We used rather conservative methods: presentation, demonstration and discussion. But the items we discussed were of interest for the people, we had a very interactive meeting with a lot of discussion".

Although the brown spot topic is well known, overall the CSP felt that the iteration process of identification, evaluation and feedback acted to prompt better articulation and identify research gaps. This iterative process continued through a number of meetings and was captured on the Dynamic Research Agenda. However, the CSP recognised some limitations with respect to raising expectations of the stakeholders, he illustrates this with reference to using the tool.

> "At least it [Dynamic Research Agenda] helped in the first meeting to identify the research gaps, to identify the problems that we want to work on. But what I experienced in my career that too many times research people asked for research gaps, and you articulate the research gaps and nothing is going to happen … when you make that dynamic agenda and you cannot show any progress in one year, then you cannot come back with that same dynamic agenda because it is not very dynamic".

Although for him the theory of iteration is good, in reality there were bottlenecks, and, ultimately, as the CSP said "Practical people are more interested in outcome than in the process". He highlighted the need to demonstrate progress to the stakeholders, which was not always possible due to the demands on the Thematic Experts and other project factors. The CSP explained:

> "You have to deal with and serve the interest of your stakeholders, that will keep them enthusiastic. Of course they are, to a certain extent, willing to contribute …. ., that is what they have done so far. But we should realise that the frequency at which we can show progress …. is not very high. This is no problem as long as we can show significant progress each time we meet them".

This highlights the important role of the project scientists in driving the iterative process. There were some interesting factsheets to discuss in the early part of the project, however, the CSP felt that progress was slow and he had to supplement the meetings with other activities such as expert presentations to continue the engagement. Nevertheless, the trial outcome was valued by the CSP and the stakeholders, albeit bringing only incremental innovation, and was testament to the CSP's commitment to achieving the project aims and his ongoing relationship with the stakeholders.

5. Discussion

In this research project the CSPs facilitated a collective process of joint problem framing, identification and prioritisation of innovation issues and screening, testing and evaluating solutions with stakeholders over 4–6 iterations. The co-learning process was enabled by iteration and feedback and captured using the Dynamic Research Agenda tool, with the outcomes seen most concretely in the trials (Table 2). However, the three case study results show that co-innovation unfolded in different ways illustrating how the research process cannot be mobilised across case studies independently of context or facilitation activities, and consequently requires a managed but adaptive research process. The following discussion develops theoretical insights drawing on this analysis and builds a conceptual model that links three interacting building blocks and the interface space between them (Fig. 1). This analysis also shows that the co-innovation process manifested itself at both the case study and WP level (Fig. 1).

5.1. Context in which co-innovation is enacted

The case studies were selected from pre-existing groups with prevailing situations, conditions and structures (projects and supply chains) which shape what and how innovation issues and solutions are jointly framed. In this respect co-innovation research projects like VALERIE are never enacted in a vacuum. As others have noted for collaborative innovation and participatory engagement processes, stakeholders are embedded in social, institutional, economic and technological contexts which determine process outcomes (Turner et al., 2020; Vereijssen et al., 2017).

5.1.1. Joint issue identification - existing knowledge systems

Pre-existing organisational contexts and cultures intervene and can influence identification of shared goals or problems (Ekboir and Rajalahti, 2012; Botha et al., 2017; Vereijssen et al., 2017). The case study stakeholder communities, by interacting with their settings, exhibit varying levels of knowledge, competence, expertise and scientific understanding. They have developed their own knowledge systems and routines with numerous shared experiences and expectations of innovation support. This determines the key co-innovation processes of joint problem identification and solution evaluation, and the exploration of new knowledge, specifically the scope of their innovation problems and the extent to which they are pre-defined or addressed. This is manifested in two interconnected ways: a tendency for stakeholders to have a bounded view on innovation options; and for these tendencies to be reinforced by established innovation support services that enhance stakeholder competencies and expectations within boundaries.

With respect to the first, although encouraged to identify innovation needs from the perspective of broad goals and visions, stakeholders tended to immediately identify and reiterate known topics, particularly

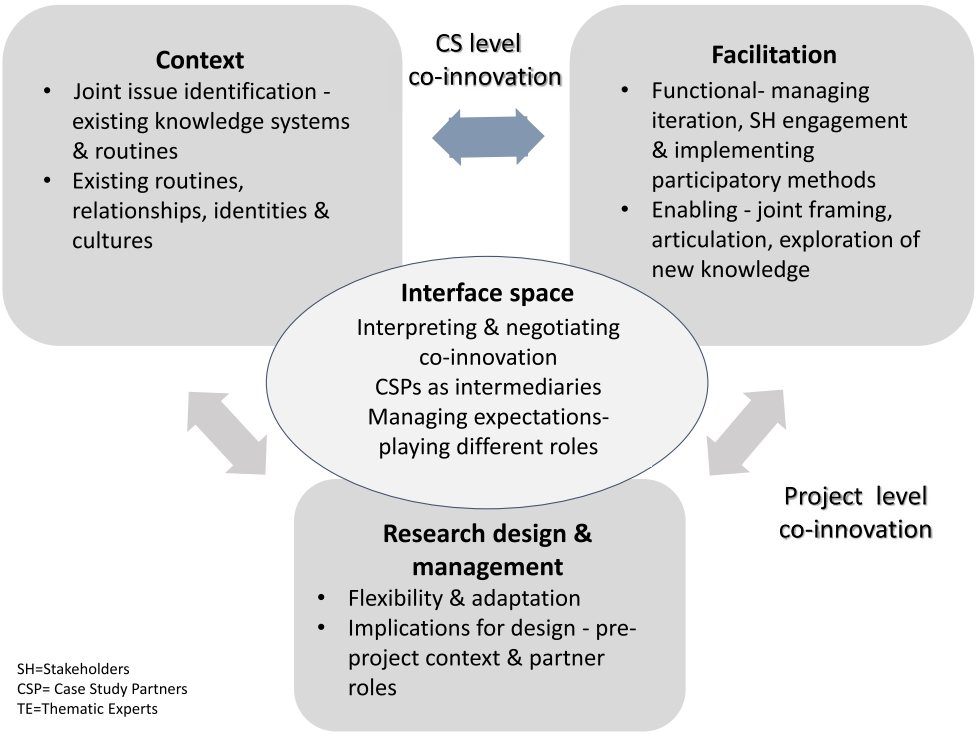

Fig. 1. Interaction between context, facilitation and the research design and management shapes the core co-innovation processes. These processes pivot around a central interface space.

in more established groups. The inclination in problem framing to restrict choices to familiar themes has been reported elsewhere (Kilelu et al., 2013; Sumberg et al., 2003) and resonates with what Foran et al. (2014) refers to as 'discourse dependency' where stakeholder ideas are embedded in existing settings. Secondly, and in relation to this, past and existing innovation support influences identification of innovation issues and evaluation of research solutions. Stakeholders in the Agro-ecology and Potato case studies were already well supported in accessing up-to-date specific agronomic information from research, such that it was hard for Thematic Experts to find anything they had not already heard of or "mastered". In these cases, options for exploring new knowledge were closed down, whereas stakeholders from the Irrigated maize and tomato case study, with less support from agronomic researchers, had problems in expressing their issues of concern in terms of concrete or manageable research questions.

Understanding the processes and determinants of joint issue identification is important as ill-structured problems are critical in that they affect how the solution space is defined (Jahn et al., 2012; White et al., 2010) and ultimately how co-innovation progresses. Although it is known that personal attributes such as prior knowledge, expertise and past experiences contribute to information seeking behaviors (Brown et al., 1989), and that problem framing processes demand that farmers have competence and capacity (Leeuwis et al., 2004), this research emphasises how contextual factors determine these attributes. This is supported by Vereijssen et al. (2017) who found that problem definition varied with availability of ready-made solutions and prevalence of interests and conflicts in a study of New Zealand primary sector projects.

5.1.2. *Existing routines, relationships, identities and cultures*

These outcomes are the product of institutional settings with existing sets of norms, rules, routines that govern actors' behavior, not only in terms of knowledge, innovation capacities, expectations and diverging interests of the stakeholders, but also with respect to 'how things are done'. This is shown in the way the trials were implemented in Agro-ecology and Potato case studies, being largely appropriated by, and executed according to the conventions of, the innovation support services linked to the case study.

Relationships, identities and cultures are also conditioned by these institutional settings. The pre-existing relationship between CSP and farmer stakeholders is often one of support rather than of fostering co-innovation, and as such expectations are for results where people "prefer to have the solution rather than investing time in a dialogue". These contexts also shape the stakeholder and CSP willingness to engage in iterative and reflective exercises, as noted by others with respect to participatory research (Neef and Neubert, 2011). The findings resonate with other observations, that institutions create both context specific histories and path-dependencies, which can lead to different starting positions for participatory approaches (Klerkx et al. (2017), and expectations of actor behaviours and roles (Williams and Brown, 2014).

In enacting the co-innovation approach in this research project it is clear that the context "speaks back" (Nowotny et al., 2001) in that existing case study structures and arrangements constrained opportunities to fully instill the WP coordinators' vision of the concept. Several studies have emphasised the role that contextual factors can play in determining the processes and outcomes of co-production and participatory engagement (Stringer et al., 2006; Botha et al., 2014).The situational or contextual elements of information seeking, learning and the translation of research are also well understood (Sewell et al., 2014; O'kane et al., 2008; Pannell et al., 2006); as is the influence of different institutional settings on social learning outcomes (Turner et al., 2020; Ernst, 2019). However, recognising and accounting for the influence of contextual forces specifically on issue identification and articulation in a co-innovation research project has had limited attention.

These contextual influences both shape, and are shaped by, facilitation in a reciprocal process, and this has implications for designing and managing the research, and is pertinent to the processes in the interface space, as considered next.

5.2. *Facilitating the case study process*

Facilitation is key to managing and mediating the social processes with case study stakeholders. At a *functional level* the CSP conduct

project tasks, manage stakeholder engagement and coordinate trials. At an *enabling level* facilitation was shown to be crucial in supporting the joint framing process and exploration of new knowledge by stimulating the learning process and organising the articulation, combination and manipulation of knowledge. This is regarded as a core function of an innovation intermediary, as a broker for problem solving (Agogué et al., 2017) and for enabling a creative process that prevents blind spots in self-observation (Howells, 2006). In doing this, CSPs need to overcome stakeholders' focus on pre-existing knowledge by encouraging them to re-examine and interrogate known themes, to refine and generate novel questions and solutions, and so deploy explorative processes to identify new knowledge (Berthet et al., 2016), as observed for the Agroecology and Potato stakeholders. Equally they have to curate and focus diverse questions, as in the Irrigated maize and tomato case study and resolve questions like "What type of answer do you want?". Recognising the importance of highly skilled facilitation for supporting stakeholders in problem-based learning (cognitive) and in challenging existing practices (normative) in not new (Turner et al., 2020). The influence of the breadth of engagement on problem definition has also been observed (Vereijssen et al., 2017). However, the significance of the facilitators' role in enabling exploration of knowledge against a pre-defined knowledge context is revealed here.

5.3. Designing and managing the research process

5.3.1. Flexibility and adaptation

As the project unfolded it became apparent that the case study arena was characterised by a range of unpredictable experiences and outcomes, due to the interlay of context and facilitation, specifically the CSP and stakeholder dynamics. Lundy et al. (2005 p3) observe, with respect to social learning, that "There are usually several variations and adaptations underway at any given time in diverse contexts". A consequence of including societal actors in collective experimentation and the process of knowledge generation, as Felt et al. (2016) points out, leads to openness and uncontrollability of the potential outcome. Thus attempts to standardise the case study methods, or replicate participatory approaches developed in one context in another, encounter difficulties (Turner et al., 2016; Klerkx et al., 2017).

In response to this the WP coordinators intensified the continuous reflection between CSP, Thematic Experts and WP coordinators on intermediate achievements and next steps using frequent communications and meetings. Through this flexible 'adaptive innovation management' (Klerkx et al., 2010) process, experiences from the case studies helped the WP team to revisit how the concept of co-innovation could be operationalised. This feedback across the interface space from CSPs helped to reshape the research design, as Fielke et al. (2017) has observed for other contexts.

Overall the process became outcome, rather than task-orientated. Rossing et al. (2010) points out that, establishing such a project culture is as important as standardising research tools and methods, and regarding it as 'work in-progress' ensures that the process is one of a collective learning of all actors, including all project partners, involved in the process (Dogliotti et al., 2014). This can help to build a shared understanding of concepts and WP goals (Schäfer and Kröger, 2016; Jahn et al., 2012). In this sense the co-innovation process occurred, not only with the stakeholders in the case studies, but also within the project.

The WP team became participants in co-innovation and through interactions with the CSPs reassessed their understanding of the process, questioning the idealised outcomes of co-innovation concepts, and refocused more on supporting of the CSP facilitation and less on the procedural matters (Williams and Brown, 2014). At the same time the CSP learn from participation as project partners. Felt et al. (2016) noted that such partners rarely become epistemic partners or knowledge agents in integrative research, often being assigned to the role of data collector as opposed to processor, which is seen as the researcher's role. However, in this study the CSP were exposed to and included in the conceptual and practical aspects of the project. This, together with their use of the Dynamic Research Agenda for analysis and reflection in case study activities and report writing, went some way to bridge the epistemological gap. Furthermore, they learned technical insights from the case study activities and trials, as one said "it was an innovation for ourselves too", as well as how to manage stakeholders through negotiation, adapting to uncertainty, emergent and unexpected outcomes, and dynamic interactions, all skills necessary for a facilitator in any participatory research (Menconi et al., 2017).

5.3.2. Implications for design

The results highlight the need for researchers, together with local partners, to complete some preliminary contextual analysis to uncover existing actors' knowledge systems, social relations, structures, norms, routines and behaviors to understand what will condition co-innovation processes. The advantage of gaining a historical understanding of individual roles and knowledge of actors and the presence of expected behaviours and power hierarchies that reflect participant previous experience, has been identified for social learning (Williams and Brown, 2014). This so called end-to-end model can help sustain and prolong meaningful participation by understanding the early context-specific perspectives of actors and help to understand collective expectations for the project's initial trajectory (Prokopy et al., 2017).

The results also suggest that early stage analysis of CSPs, as key project partners, through joint reflection on existing relationships, interpretation frames and working imperatives and cultures could have strengthened the project, as could a full discussion and briefing of their anticipated roles. Furthermore, their enhanced input early in the research design and development of agreed goals and understandings to shape project expectations, ambitions and timetables would have been valuable. However, the implications of such proposals for resources, timetables and capabilities should not be under estimated (Ernst, 2019).

The need to examine the researchers' own perspectives and expectations about the sort of engagement (importance, type, timing) they think needs to takes place to achieve co-innovation outcomes is recognised here and by others (Allen et al., 2014). More fundamentally, these findings raise the question of how a research project should evaluate co-innovation success. Although CSP struggled to deliver the project's idealised framework, they adapted what was offered, and used the space created to elicit valuable learning processes and more concretely trial results. Arguably this can led to 'real' co-innovation, in line with the notion of 'real participation' described by Quaghebeur et al. (2004), which emerges when stakeholders contest and negotiate directive participatory approaches and project assumptions, but in doing this create other unintended learning and innovation outcomes.

5.4. The interface space

We can conceptualise an interface space around which these three dimensions (context, facilitation and research design and management) pivot. The frequent feedback processes between the CSP and the research team, and between the CSP and the stakeholders, come together in this space connecting the research design and the enactment of co-innovation.

5.4.1. Interpreting and negotiating co-innovation

Although the co-innovation methodology was conceptualised and designed by WP coordinators, the act of co-innovating was carried out by the CSPs through a set of relationships mediated with the stakeholders. As noted elsewhere, translation of integrative research concepts into practice often relies on the way that individual actors mobilise and adapt approaches as they encounter challenges (Swan et al., 2010). The CSP became the agents of co-innovation in their own case study settings, countries and languages and they interpret WP protocols and guidelines into concrete activities, demonstrating different levels of agency as they

do, as observed in different contexts (Fielke et al., 2017).

As CSPs interacted with the research team, they expressed varying levels of commitment to engage in participatory methods, monitoring and reflection using Dynamic Research Agenda and challenged and expressed some skepticisms about the methodology. Significantly they struggled with the imposed iterative framework ("sometimes you have to stop because you need to give answers instead of keep asking questions"), and negotiated meanings, tasks and activities with the research team across the many meetings. Variability in facilitator interpretation and delivery is a recurrent feature of participatory approaches (Neef and Neubert, 2011) particualry in managing collective engagement in problem solving and social learning (Leeuwis et al., 2002b), however the translation of a research project introduces new dimensions.

5.4.2. CSP as intermediaries

The significance of the intermediary role of CSP is clear. In mobilising the co-innovation approach they take on different roles and exercise and encounter different levels of agency (Giddens, 1984), in that they have the ability and the resources to negotiate and adapt interests during the evolving process of co-learning. The strategies and approaches CSP use to establish and mediate a dialogue with the stakeholders are contingent on the contextual situation of the case study, both in terms of the stakeholders' conditioned responses and their own personal, professional and institutional identities and background (Klerkx et al., 2017; Turner et al., 2020). Dialogue within the research team is equally contingent on the project context and the project partner assigned roles.

5.4.3. Managing expectations - playing different roles

CSP manage expectations of both the WP and the stakeholders. As project partners they have a responsibility to deliver tasks according to project parameters and timetables. At the same time they have to develop and maintain a relationship with stakeholders, ("it is difficult to cope with project requests and daily work life"). They are at the forefront of managing disillusionment amongst practitioners, stakeholders and researchers when solutions are not forthcoming and idealised outcomes of co-innovation are not realised. Boon et al. (2011) noted that intermediaries have to manage an ongoing balancing act between diversifying knowledge types while also aligning knowledge production towards a coherent shared goal (Klenk and Meehan, 2015).

As part of this balancing act, CSP play different roles. They act as negotiators as they strive to overcome interruptions to the flow of information when feedback loops are not progressed as quickly as imagined in the WP design, for example, by inviting technical experts to the meetings by way of compensation. Such negotiation processes, have been observed in other participatory research which encounters mismatched expectations (Pohl et al., 2010; Hochman et al., 2009).

The CSPs also acknowledge that they steered the identification of innovation issues towards those with pragmatic solutions as a strategy to meet project deadlines and protect the interests of, and their relationship with, stakeholders. The CSPs can thus short-cut the iterative process and impart their own interpretation of what is considered useful and answerable by science. This adaptive behavior ensures project outcomes but can maintain the boundaries of the innovation topic by reducing the options for more extensive exploration of new knowledge, and current practices and norms.

CSPs also find themselves in the role of gatekeepers, both mediating and controlling the flow of information between the stakeholder community and the research team. Although assigned the role of boundary crossers by the WP coordinators in order to connect and facilitate,[9] they also play the role of gatekeeper, understood, according to the communication studies, as "one who protects the walls and gates" (Barzilai-Nahon, 2008), since they determine when and how project activities occur in case studies. In this respect, there is also a tendency for CSP to become the spokesperson for the stakeholders, representing their needs from a position of understanding and familiarity. Here the influence of the gatekeeper's moral and normative values on the decision-making process is apparent. The difficulty of maintaining a neutral position as an 'honest broker' (Pielke Jr, 2007) is clear when CSP need to remain legitimate and credible both in the eyes of the project and of the stakeholders, as a project partner and a professional adviser respectively. Others have noted that defending one's own interests prevents neutral facilitation (Van De Kerkhof and Wieczorek, 2005) and that "there is no such thing as a neutral, detached, value-free facilitator" (Campbell, 1997 p147).

In such circumstances the CSP take on a hybrid role as they find themselves in a situation of divided identity, as observed by Ravetz (2001 p391) who remarked that "co-production of knowledge interferes with conventional practices and self-conceptions and roles of actors involved". Felt et al. (2016) support this, noting that any single actor can actually hold multiple roles in the course of one research project.

6. Conclusions- lessons for enacting co-innovation in research projects

This research sought to understand how co-innovation is enacted in a research project with multiple case studies and case study partners. It confirms other findings that, in mobilising co-innovation, contextual forces and facilitation processes are important, but also reveals how their complex interplay shapes the co-innovation processes of joint framing, exploration and testing of solutions and new knowledge, and requires an adaptive approach to research design and management. It also identifies and conceptualises the roles and processes in the interface space between these main building blocks (Fig. 1) in Fig. 2. Specifically two key insights can be gained about this pivotal space.

Firstly, the significance of the CSP's role as project partners is clear. While the researchers are the 'architects' of co-innovation in the sense that they designed and operationalised case study activities, ultimately the act of co-innovating is carried out by the individual actors within the project. It is important to recognise the agency of the such actors who mediate co-innovation processes with stakeholders; their ability to take action and make a difference as they negotiate tensions and power dynamics can significantly determine outcomes. Enacting co-innovation also requires them to manage hybrid positions and to temporarily develop different identities, roles and routines (Klerkx and Leeuwis, 2008).

These roles have been categorised and examined through a number of lenses each emphasising different functions, for example, facilitators enabling social learning (Ernst, 2019) or enabling innovation by negotiating social capital (King et al., 2019), or innovation intermediaries acting as agents to improve connectivity, build networks, or initiate change (Howells, 2006; Agogué et al., 2017). However, the field is still largely theoretically fragmented and practice-oriented with diversity in intentions, epistemological and theoretical assumptions (Koutsouris, 2012). Groot and Maarleveld (2000)'s framing of facilitation as strategic or communicative rationality according to power relations (Habermas, 1984), provides some theorisation relevant to the interface space. The CSP role as project partners can be framed by strategic rationality, as, in delivering research tasks, they are constrained by pre-set objectives and act within pre-determined boundaries. However, there are tensions with the expectations of the project's methodology which assigns a case study role more in line with a communicative rationality framing, where the CSP facilitate stakeholders' learning and adaptation through iterative participation. CSPs reconcile these tensions as the project progresses with CSP and stakeholders' reassessing and rearticulating problems and building problem solving capabilities, although whether this achieves the project's' intended co-innovation outcomes or will lead to unexpected 'real' innovation, is not clear (Fig. 2).

[9] an interpretation of the gatekeeper's role as understood in management studies (Barzilai-Nahon, 2008).

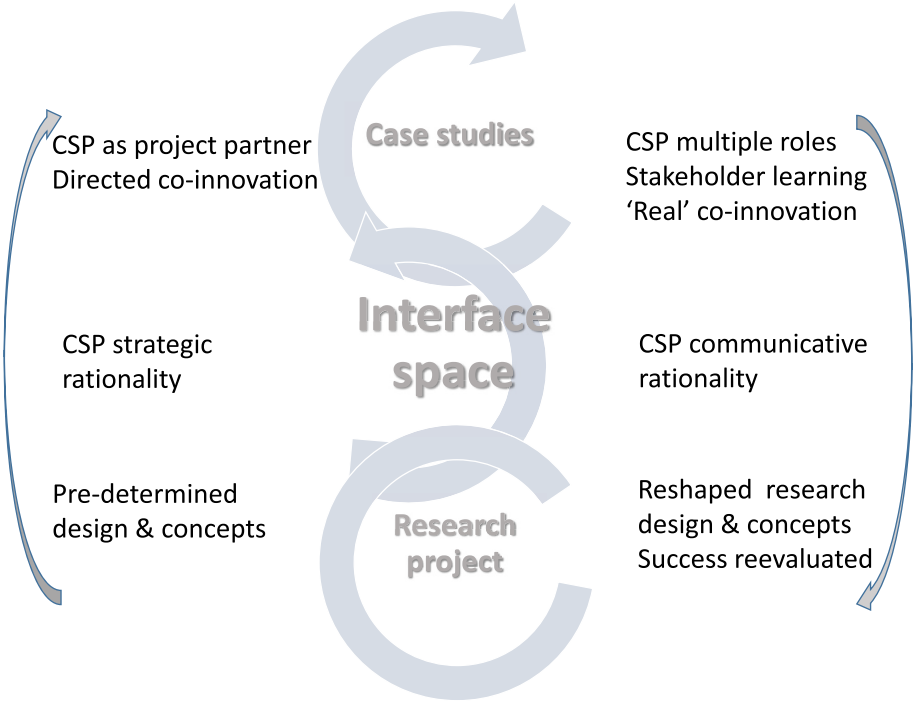

Fig. 2. Conceptualisation of the interface space roles and processes.

Although it has been recognised that co-innovation in more demand driven AIS creates new roles that need to be institutionally supported and properly resourced (Klerkx and Nettle, 2013; Nettle et al., 2018), the multiple and sometimes conflicting roles required in research projects impose a particular demand for project partners. With the continued emphasis on time limited multi-actor approaches in European and international research programmes, this is an important consideration (King et al., 2019). Furthermore, facilitation of multi-actor groups and innovation brokering are now throught to be core competencies of extension agents more widley (Macken-Walsh, 2019; Gorman, 2019).

Secondly, the interface space allows for dialogue between practice and research which shapes and informs the research. Co-innovation is a dynamic process, researchers can only design co-innovation research to some extent, since the processes are continually evolving. As with similarly diffuse integrative concepts underpinned by Mode 2 approaches, where knowledge is generated 'in a context of application', unpredictability is an inherent part of the research process and developing a project culture which allows for some uncontrollability and a shared understanding of concepts can help to manage this uncertainty (Jahn et al., 2012; Schäfer and Kröger, 2016). Where this culture can allow contestation and negotiation in the interface space, the research design can be reviewed, the concepts and measures of success reevaluated.

Commentators have suggested that it is unproductive to try to structure and control interactive social learning processes by means of detailed plans and schedules, and that the focus should be on generating and valuing variation, rather than trying to impose a generic template per case study. However, given the projectivisation of research, which imposes temporary organisational and temporal boundaries (Godenhjelm et al., 2015), striking a balance between the two is often necessary. This point is significant with respect to continued interest in transdisciplinary and multi-actor approaches. Both are framed by pragmatic and normative claims about the benefits for such interaction. However, this research reveals that such benefits will not be achieved unless researchers design and manage the process flexibly to account for complex interactions between context and facilitation. How the prescriptive approaches of international research projects, which impose what Felt et al. (2012) calls the 'temporalities of participation', can accommodate such management is a question that needs deliberation.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jrurstud.2020.06.003.

Author statement

Julie Ingram is the lead author, she undertook the conceptualisation and analysis and drafted and finalised the paper. Pete Gaskell collected and analysed data throughout the project, mediated with case study partners, provided critical insights into the conceptualisation and analysis for the paper and contributions to the text. Jane Mills collected and analysed data throughout the project, mediated with case study partners, provided critical insights into the analysis for the paper. Janet Dwyer collected and analysed data throughout the project, mediated with case study partners, provided critical insights into the analysis for the paper.

References

Agogué, M., Berthet, E., Fredberg, T., Le Masson, P., Segrestin, B., Stoetzel, M., Wiener, M., Ystrom, A., 2017. Explicating the role of innovation intermediaries in the "unknown": a contingency approach. Journal of Strategy and Management 10, 19–39.

Akpo, E., Crane, T.A., Vissoh, P.V., Tossou, R.C., 2015. Co-production of knowledge in multi-stakeholder processes: analyzing joint experimentation as social learning. J. Agric. Educ. Ext. 21, 369–388.

Allen, W., Ogilvie, S., Blackie, H., Smith, D., Sam, S., Doherty, J., Mckenzie, D., Ataria, J., Shapiro, L., Mackay, J., 2014. Bridging disciplines, knowledge systems and cultures in pest management. Environ. Manag. 53, 429–440.
Barzilai-Nahon, K., 2008. Toward a theory of network gatekeeping: a framework for exploring information control. J. Am. Soc. Inf. Sci. Technol. 59, 1493–1512.
Berthet, E.T., Barnaud, C., Girard, N., Labatut, J., Martin, G., 2016. How to foster agroecological innovations? A comparison of participatory design methods. J. Environ. Plann. Manag. 59, 280–301.
Berthet, E.T., Hickey, G.M., Klerkx, L., 2018. Opening Design and Innovation Processes in Agriculture: Insights from Design and Management Sciences and Future Directions. Elsevier.
Boon, W.P., Moors, E.H., Kuhlmann, S., Smits, R.E., 2011. Demand articulation in emerging technologies: intermediary user organisations as co-producers? Res. Pol. 40, 242–252.
Botha, N., Klerkx, L., Small, B., Turner, J.A., 2014. Lessons on transdisciplinary research in a co-innovation programme in the New Zealand agricultural sector. Outlook Agric. 43, 219–223.
Botha, N., Turner, J.A., Fielke, S., Klerkx, L., 2017. Using a Co-innovation Approach to Support Innovation and Learning: Cross-Cutting Observations from Different Settings and Emergent Issues. SAGE Publications Sage UK, London, England.
Brown, J.S., Collins, A., Duguid, P., 1989. Situated cognition and the culture of learning. Educ. Res. 18, 32–42.
Campbell, A., 1997. In: Lockie, Vanclay, F. (Eds.), Facilitating Landcare: Conceptual and Practical Dilemmas *S*, Critical Landcare. Wagga Wagga, Australia: Centre for Rural Social Research. Charles Stuart University, pp. 143–152.
Charmaz, K., Belgrave, L.L., 2007. Grounded theory. The Blackwell Encyclopedia of Sociology.
Chesbrough, H.W., 2003. Open Innovation: the New Imperative for Creating and Profiting from Technology. Harvard Business Press.
Coutts, J., White, T., Blackett, P., Rijswijk, K., Bewsell, D., Park, N., Turner, J.A., Botha, N., 2017. Evaluating a space for co-innovation: practical application of nine principles for co-innovation in five innovation projects. Outlook Agric. 46, 99–107.
De Vente, J., Reed, M., Stringer, L., Valente, S., Newig, J., 2016. How does the context and design of participatory decision making processes affect their outcomes? Evidence from sustainable land management in global drylands, 21. Ecology and Society.
Dogliotti, S., García, M., Peluffo, S., Dieste, J., Pedemonte, A., Bacigalupe, G., Scarlato, M., Alliaume, F., Alvarez, J., Chiappe, M., 2014. Co-innovation of family farm systems: a systems approach to sustainable agriculture. Agric. Syst. 126, 76–86.
Eastwood, C., Chapman, D., Paine, M., 2012. Networks of practice for co-construction of agricultural decision support systems: case studies of precision dairy farms in Australia. Agric. Syst. 108, 10–18.
Eastwood, C., Klerkx, L., Nettle, R., 2017. Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: case studies of the implementation and adaptation of precision farming technologies. J. Rural Stud. 49, 1–12.
Ekboir, J., Rajalahti, R., 2012. Coordination and collective action for agricultural innovation. Agricultural Innovation Systems.
Ernst, A., 2019. Review of factors influencing social learning within participatory environmental governance. Ecol. Soc. 24.
Felt, U., Igelsböck, J., Schikowitz, A., Völker, T., 2016. Transdisciplinary sustainability research in practice: between imaginaries of collective experimentation and entrenched academic value orders. Sci. Technol. Hum. Val. 41, 732–761.
Felt, U., Igelsboeck, J., Schikowitz, A., Voelker, T., 2012. Challenging participation in sustainability research. The Journal of Deliberative Mechanisms in Science 1.
Felt, U., Wynne, B., Stirling, A., Callon, M., Goncalves, M.E., 2007. Science and Governance: Taking European Knowledge Society Seriously.
Fielke, S., Nelson, T., Blackett, P., Bewsell, D., Bayne, K., Park, N., Rijswijk, K., Small, B., 2017. Hitting the bullseye: learning to become a reflexive monitor in New Zealand. Outlook Agric. 46, 117–124.
Fielke, S.J., Botha, N., Reid, J., Gray, D., Blackett, P., Park, N., Williams, T., 2018. Lessons for co-innovation in agricultural innovation systems: a multiple case study analysis and a conceptual model. J. Agric. Educ. Ext. 24, 9–27.
Flyvbjerg, B., 2006. Five misunderstandings about case-study research. Qual. Inq. 12, 219–245.
Foran, T., Butler, J.R., Williams, L.J., Wanjura, W.J., Hall, A., Carter, L., Carberry, P.S., 2014. Taking complexity in food systems seriously: an interdisciplinary analysis. World Dev. 61, 85–101.
Gibbons, M., Limoges, C., Nowotny, H.S., Schwartzman, S.S., Scott, P., Trow, M., 1994. The New Production of Knowledge: the Dynamics of Science and Research in Contemporary Societies.
Godenhjelm, S., Lundin, R.A., Sjöblom, S., 2015. Projectification in the public sector–the case of the European Union. Int. J. Manag. Proj. Bus.
Gorman, M., 2019. Becoming an agricultural advisor–the rationale, the plan and the implementation of a model of reflective practice in extension higher education. J. Agric. Educ. Ext. 25, 179–191.
Greve, H.R., 2007. Exploration and exploitation in product innovation. Ind. Corp. Change 16, 945–975.
Groot, A., Maarleveld, M., 2000. Demystifying Facilitation in Participatory Development. IIED.
Habermas, J., 1984. The Theory of Communicative Action: Jurgen Habermas. *Trans. by Thomas McCarthy*, Heinemann.
Hall, A., Bockett, G., Taylor, S., Sivamohan, M., Clark, N., 2001. Why research partnerships really matter: innovation theory, institutional arrangements and implications for developing new technology for the poor, 29. World development, pp. 783–797.
Hall, A., Mytelka, L., Oyeyinka, B., 2006. Concepts and Guidelines for Diagnostic Assessments of Agricultural Innovation Capacity. UNU-MERIT (Maastricht Economic and social Research and training centre on Innovation and Technology).
Hall, A., Sulaiman, V.R., Clark, N., Yoganand, B., 2003. From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research. Agric. Syst. 78, 213–241.
Hessels, L.K., Van Lente, H., 2008. Re-thinking new knowledge production: a literature review and a research agenda. Res. Pol. 37, 740–760.
Hochman, Z., Van Rees, H., Carberry, P., Hunt, J., Mccown, R., Gartmann, A., Holzworth, D., Van Rees, S., Dalgliesh, N., Long, W., 2009. Re-inventing model-based decision support with Australian dryland farmers. 4. Yield Prophet® helps farmers monitor and manage crops in a variable climate. Crop Pasture Sci. 60, 1057–1070.
Hoffmann, V., Probst, K., Christinck, A., 2007. Farmers and researchers: how can collaborative advantages be created in participatory research and technology development? Agric. Hum. Val. 24, 355–368.
Howells, J., 2006. Intermediation and the role of intermediaries in innovation. Res. Pol. 35, 715–728.
Ingram, J., Dwyer, J., Gaskell, P., Mills, J., de Wolf, P., 2018. Reconceptualising translation in agricultural innovation: A co-translation approach to bring research knowledge and practice closer together. Land Use Pol. 70, 38–51.
Jahn, T., Bergmann, M., Keil, F., 2012. Transdisciplinarity: between mainstreaming and marginalization. Ecol. Econ. 79, 1–10.
Johnson, N.L., Lilja, N., Ashby, J.A., 2003. Measuring the impact of user participation in agricultural and natural resource management research. Agric. Syst. 78, 287–306.
Kilelu, C.W., Klerkx, L., Leeuwis, C., 2013. Unravelling the role of innovation platforms in supporting co-evolution of innovation: contributions and tensions in a smallholder dairy development programme. Agric. Syst. 118, 65–77.
King, B., Fielke, S., Bayne, K., Klerkx, L., Nettle, R., 2019. Navigating shades of social capital and trust to leverage opportunities for rural innovation. J. Rural Stud. 68, 123–134.
Klenk, N., Meehan, K., 2015. Climate change and transdisciplinary science: problematizing the integration imperative. Environ. Sci. Pol. 54, 160–167.
Klerkx, L., Aarts, N., Leeuwis, C., 2010. Adaptive management in agricultural innovation systems: the interactions between innovation networks and their environment. Agric. Syst. 103, 390–400.
Klerkx, L., Jansen, J., 2010. Building knowledge systems for sustainable agriculture: supporting private advisors to adequately address sustainable farm management in regular service contacts. Int. J. Agric. Sustain. 8, 148–163.
Klerkx, L., Leeuwis, C., 2008. Matching demand and supply in the agricultural knowledge infrastructure: experiences with innovation intermediaries. Food Pol. 33, 260–276.
Klerkx, L., Leeuwis, C., 2009. Establishment and embedding of innovation brokers at different innovation system levels: insights from the Dutch agricultural sector. Technol. Forecast. Soc. Change 76, 849–860.
Klerkx, L., Nettle, R., 2013. Achievements and challenges of innovation co-production support initiatives in the Australian and Dutch dairy sectors: a comparative study. Food Pol. 40, 74–89.
Klerkx, L., Seuneke, P., De Wolf, P., Rossing, W.A., 2017. Replication and translation of co-innovation: the influence of institutional context in large international participatory research projects. Land Use Pol. 61, 276–292.
Koutsouris, A., 2012. Facilitating agricultural innovation systems: a critical realist approach. Studies in Agricultural Economics 114, 64–70.
Leeuwis, C., Leeuwis, C., Ban, A., 2004. Communication for Rural Innovation. Wiley Online Library.
Leeuwis, C., Pyburn, R., Boon, A., 2002a. Concluding Reflections on Social Learning: Tadpoles, Lilypads and lotus Flowers.
Leeuwis, C., Pyburn, R., Röling, N., 2002b. Wheelbarrows Full of Frogs: Social Learning in Rural Resource Management: International Research and Reflections. Koninklijke Van Gorcum.
Lemos, M.C., Morehouse, B.J., 2005. The co-production of science and policy in integrated climate assessments. Global Environ. Change 15, 57–68.
Lundy, M., Gottret, M.V., Ashby, J., 2005. Learning Alliances: an Approach for Building Multistakeholder Innovation Systems.
Macken-Walsh, Á., 2019. Multi-actor co-design of extension interventions: paradoxes arising in three cases in the Republic of Ireland. J. Agric. Educ. Ext. 25, 245–265.
Mcnie, E.C., 2007. Reconciling the supply of scientific information with user demands: an analysis of the problem and review of the literature. Environ. Sci. Pol. 10, 17–38.
Medema, W., Wals, A., Adamowski, J., 2014. Multi-loop social learning for sustainable land and water governance: towards a research agenda on the potential of virtual learning platforms. NJAS - Wageningen J. Life Sci. 69, 23–38.
Menconi, M.E., Grohmann, D., Mancinelli, C., 2017. European farmers and participatory rural appraisal: a systematic literature review on experiences to optimize rural development. Land Use Pol. 60, 1–11.
Nederlof, E.S., Wongtschowski, M., Van DER Lee, F., 2011. Putting Heads Together: Agricultural Innovation Platforms in Practice. KIT publishers, Amsterdam.
Neef, A., Neubert, D., 2011. Stakeholder participation in agricultural research projects: a conceptual framework for reflection and decision-making. Agric. Hum. Val. 28, 179–194.
Nerbonne, J.F., Lentz, R., 2003. Rooted in grass: challenging patterns of knowledge exchange as a means of fostering social change in a southeast Minnesota farm community. Agric. Hum. Val. 20, 65–78.
Nettle, R., Crawford, A., Brightling, P., 2018. How private-sector farm advisors change their practices: an Australian case study. J. Rural Stud. 58, 20–27.
Nowotny, H., Scott, P., Gibbons, M., 2001. Re-thinking the relations between texts and contexts in science. Sci. Publ. Pol. 28, 484–486.

O'kane, M., Paine, M., King, B., 2008. Context, participation and discourse: the role of the communities of practice concept in understanding farmer decision-making. J. Agric. Educ. Ext. 14, 187–201.
Pannell, D.J., Marshall, G.R., Barr, N., Curtis, A., Vanclay, F., Wilkinson, R., 2006. Understanding and promoting adoption of conservation practices by rural landholders. Anim. Prod. Sci. 46, 1407–1424.
Pielke JR., R.A., 2007. The Honest Broker: Making Sense of Science in Policy and Politics. Cambridge University Press.
Pohl, C., Rist, S., Zimmermann, A., Fry, P., Gurung, G.S., Schneider, F., Speranza, C.I., Kiteme, B., Boillat, S., Serrano, E., 2010. Researchers' roles in knowledge co-production: experience from sustainability research in Kenya, Switzerland, Bolivia and Nepal. Sci. Publ. Pol. 37, 267–281.
Prokopy, L.S., Carlton, J.S., Haigh, T., Lemos, M.C., Mase, A.S., Widhalm, M., 2017. Useful to useable: developing useable climate science for agriculture. Climate Risk Management 15, 1–7.
Quaghebeur, K., Masschelein, J., Nguyen, H.H., 2004. Paradox of participation: giving or taking part? J. Community Appl. Soc. Psychol. 14, 154–165.
Ravetz, J., 2001. Science advice in the knowledge economy. Sci. Publ. Pol. 28, 389–393.
Reed, M.S., 2008. Stakeholder participation for environmental management: a literature review. Biol. Conserv. 141, 2417–2431.
Reed, M.S., Vella, S., Challies, E., De Vente, J., Frewer, L., Hohenwallner-Ries, D., Huber, T., Neumann, R.K., Oughton, E.A., Sidoli Del Ceno, J., 2018. A theory of participation: what makes stakeholder and public engagement in environmental management work? Restor. Ecol. 26, S7–S17.
Rossing, W., Dogliotti, S., Bacigalupe, G., Cittadini, E., Mundet, C., Aguayo, V.M., Douthwaite, B., Alvarez, S., Cordoba, D., Lundy, M., 2010. Project design and management based on a co-innovation framework: towards more effective research intervention for sustainable development of farming systems. Building sustainable rural futures: the added value of systems approaches in times of change and uncertainty. In: 9th European IFSA Symposium, Vienna, Austria, 4-7 July 2010. BOKU-University of Natural Resources and Applied Life Sciences, pp. 402–412.
Rowe, G., Frewer, L.J., 2000. Public participation methods: a framework for evaluation. Sci. Technol. Hum. Val. 25, 3–29.
Rule, P., John, V.M., 2015. A necessary dialogue: theory in case study research. Int. J. Qual. Methods 14, 1609406915611575.
Schäfer, M., Kröger, M., 2016. Joint problem framing in sustainable land use research: experience with Constellation Analysis as a method for inter-and transdisciplinary knowledge integration. Land Use Pol. 57, 526–539.
Sewell, A., Gray, D., Blair, H., Kemp, P., Kenyon, P., Morris, S., Wood, B., 2014. Hatching new ideas about herb pastures: learning together in a community of New Zealand farmers and agricultural scientists. Agric. Syst. 125, 63–73.
Spielman, D.J., Ekboir, J., Davis, K., 2009. The art and science of innovation systems inquiry: applications to Sub-Saharan African agriculture. Technol. Soc. 31, 399–405.
Stringer, L., Dougill, A., Fraser, E., Hubacek, K., Prell, C., Reed, M., 2006. Unpacking "participation" in the adaptive management of social–ecological systems: a critical review. Ecol. Soc. 11.
Sumberg, J., 2005. Systems of innovation theory and the changing architecture of agricultural research in Africa. Food Pol. 30, 21–41.
Sumberg, J., Heirman, J., Raboanarielina, C., Kaboré, A., 2013. From agricultural research to'product development': what role for user feedback and feedback loops? Outlook Agric. 42, 233–242.
Sumberg, J., Okali, C., Reece, D., 2003. Agricultural research in the face of diversity, local knowledge and the participation imperative: theoretical considerations. Agric. Syst. 76, 739–753.
Swan, J., Bresnen, M., Robertson, M., Newell, S., Dopson, S., 2010. When policy meets practice: colliding logics and the challenges of 'Mode 2'initiatives in the translation of academic knowledge. Organ. Stud. 31, 1311–1340.
Thompson, M.A., Owen, S., Lindsay, J.M., Leonard, G.S., Cronin, S.J., 2017. Scientist and stakeholder perspectives of transdisciplinary research: early attitudes, expectations, and tensions. Environ. Sci. Pol. 74, 30–39.
Triomphe, B., Floquet, A., Kamau, G., Letty, B., Vodouhe, S.D., Ng'ang'a, T., Stevens, J., Van Den Berg, J., Selemna, N., Bridier, B., 2013. What does an inventory of recent innovation experiences tell us about agricultural innovation in Africa? J. Agric. Educ. Ext. 19, 311–324.
Turner, J.A., Allen, W., Fraser, C., Fenemor, A., Horita, A., White, T., Chen, L., Atkinson, M., Rush, M., 2020. Navigating institutional challenges: design to enable community participation in social learning for freshwater planning. Environ. Manag. 65, 288–305.
Turner, J.A., Klerkx, L., Rijswijk, K., Williams, T., Barnard, T., 2016. Systemic problems affecting co-innovation in the New Zealand Agricultural Innovation System: identification of blocking mechanisms and underlying institutional logics. NJAS - Wageningen J. Life Sci. 76, 99–112.
Van De Kerkhof, M., Wieczorek, A., 2005. Learning and stakeholder participation in transition processes towards sustainability: methodological considerations. Technol. Forecast. Soc. Change 72, 733–747.
Van Mierlo, B., Regeer, B., Van Amstel, M., Arkesteijn, M., Beekman, V., Bunders, J., De Cock Buning, T., Elzen, B., Hoes, A., Leeuwis, C., 2010. Reflexive Monitoring in Action. A Guide for Monitoring System Innovation Projects. Communication and Innovation Studies, WUR. Athena Institute, VU.
Vereijssen, J., Srinivasan, M., Dirks, S., Fielke, S., Jongmans, C., Agnew, N., Klerkx, L., Pinxterhuis, I., Moore, J., Edwards, P., 2017. Addressing complex challenges using a co-innovation approach: lessons from five case studies in the New Zealand primary sector. Outlook Agric. 46, 108–116.
White, D.D., Wutich, A., Larson, K.L., Gober, P., Lant, T., Senneville, C., 2010. Credibility, salience, and legitimacy of boundary objects: water managers' assessment of a simulation model in an immersive decision theater. Sci. Publ. Pol. 37, 219–232.
Wiek, A., 2007. Challenges of transdisciplinary research as interactive knowledge generation–experiences from transdisciplinary case study research. GAIA-Ecological Perspectives for Science and Society 16, 52–57.
Williams, B.K., Brown, E.D., 2014. Adaptive management: from more talk to real action. Environ. Manag. 53, 465–479.