Agricultural Water Management 212 (2019) 181–192

Contents lists available at ScienceDirect

Agricultural Water Management

journal homepage: www.elsevier.com/locate/agwat

Research idea to science for impact: Tracing the significant moments in an innovation based irrigation study

M.S. Srinivasan[a,*], C. Jongmans[a,b], D. Bewsell[c,1], G. Elley[a]

[a] National Institute of Water and Atmospheric Research Limited, Christchurch, New Zealand
[b] Wageningen University, Wageningen, The Netherlands
[c] AgResearch Limited, Lincoln, New Zealand

ARTICLE INFO

Keywords:
Irrigation
Weather forecast
Co-innovation
Co-learning
Stakeholder management

ABSTRACT

Uptake of irrigation scheduling tools by New Zealand (NZ) farmers has remained static for many years and some researchers consider the use of linear, tech-transfer approaches as the main reason for this. To understand the controls and drivers that influence the uptake of these tools and to evaluate the effectiveness of a co-innovation approach in improving their (tools) uptake, a team of biophysical (hydrologists) and social researchers undertook a pilot study in an irrigation scheme in the South Island of NZ. Co-innovation offers a multi-directional, multi-level, multi-actor approach, in which input from stakeholders is valued in every part of the process, from problem definition to solution adoption. In this study, we focused on the adaptive aspect of co-innovation that allows stakeholders to periodically review their actions and respond to it in a way that is inclusive others' views and reflective of feedback received. The pilot study activities were analysed retrospectively to develop a systemic view to the implementation of a co-innovation-based multi-stakeholder hydrology project. While implementing a co-innovation approach, five chronologically-distinct yet overlapping phases emerged in the project: 1. *concept development*, where the hydrologists came up with the research idea and seed concept; 2. *trust building*, where researchers (hydrologists and social) interacted with key on-farm stakeholders in developing and implementing the research idea into a pilot field study; 3. *knowledge synthesis,* where researchers collected on-farm biophysical and behavioural data to record practice change; 4. *extended outreach,* where stakeholders, including researchers, devised pathways to sustain the lessons learned and practices changed, and disseminated the learnings to the wider irrigation community; and 5. *project legacy,* where the researchers, after the development of the seed concept into a practice change, evolved an exit strategy. Apart from core research activities, such as data collection on irrigation water use and changes in irrigation scheduling practices, each one of the five phases included actions that were unique to that phase as well as to achieving the wider pilot study goal of improving water use efficiency. This paper discusses the learnings from these phases, including insights, and key identifiers and indicators of pilot study progression during each phase, which may serve as an example to other biophysical studies that propose to employ co-innovation-based multi stakeholder approach.

1. Introduction

"Our wellbeing, economy and environment will all benefit from greater application of new scientific knowledge by businesses, government agencies, communities and other end-users. As well as uncovering new opportunities, science is central in brokering the balance between the use of our rich but finite natural resources, for the benefit of New Zealanders today, and kaitiakitanga[2] *of this inheritance for the future."* (Joyce, 2015; page 4). This statement from New Zealand's Minister of Science and Innovation reflects the need to focus the science research agenda towards practical, stakeholder-relevant science application, a sentiment expressed by Gibbons (2000); Hessels and van Lente (2008) and many other researchers in the past. Research projects increasingly face not only intellectual but also ethical, social, economic and political criteria for science evaluation (Gibbons et al., 1994; Gibbons, 2000). Context-sensitive, stakeholder-inclusive Mode 2 research has been put forward as an alternative to traditional Mode 1 research where "problems are set and solved in a context governed by the, largely academic, interests of a

* Corresponding author.
E-mail address: ms.srinivasan@niwa.co.nz (M.S. Srinivasan).
[1] Current address: Red Meat Profit Partnership, Christchurch, New Zealand.
[2] A *kaitiaki* is a guardian, and the process and practices of protecting and looking after precious natural resources (land and water) are referred to as kaitiakitanga.

https://doi.org/10.1016/j.agwat.2018.08.045
Received 3 January 2018; Received in revised form 27 August 2018; Accepted 30 August 2018
0378-3774/

specific community" (Gibbons, 2000; pg. 159).

Yarwood (2015) and Williams et al. (2015) analysed the role of innovation in New Zealand (NZ) primary sector (agriculture, horticulture and forestry) and concluded that innovation often end up `below the radar,' failing to generate learning about the conditions under which science investments deliver impact. Technological innovations fail when they fail to account for ethical, social, management, organisational and institutional barriers, many of which may lead to unexpected impacts (Smits, 2002). For example, when the successful drip irrigation technology from Israel was imported to sub-Saharan Africa, it failed as researchers failed to consider the African context and suitably alter the technology (Garb and Friedlander, 2014). The absence of infrastructure to transfer pressurised water through the irrigation system, clogging of filters by sediment-laden water, and chewing of driplines by wild animals, all contributed to technological failure in the sub-Saharan Africa (Garb and Friedlander, 2014; Friedlander et al., 2013).

In the context of complex problems, the idea of innovation as a linear process of technology transfer, or a linear sequence of production, diffusion and adoption, has received considerable criticism (Leeuwis and Aarts, 2011; Boyce et al., 2018). Alternative ways of thinking such as the Innovation System approach and Agricultural Innovation Systems emphasize the need to consider not only the technological (e.g. tools or software) but also the social, economic and political contexts of innovation (e.g. policies, cultural norms, consumer preferences and others). Furthermore, these alternative approaches highlight the importance and influence of people and organisations within this innovation context, and their (inter)actions (Röling, 2009; van Mierlo et al., 2010; Klerkx et al., 2012; Botha et al., 2014). Accordingly, a 'system innovation' is seen as a complex, unpredictable process which lies beyond the control of small groups, such as scientists as practiced in Mode 1 research (van Mierlo et al., 2013).

A large selection of co-innovation based case studies are available in Nederlof et al. (2011) and the World Bank (2007). A few examples of primary-sector based studies that are similar in context or setting to the pilot study described in this paper are reviewed here, to highlight the challenges to co-innovation approach. Albicette et al. (2017) who examined the ways of improving the sustainability of livestock family farms in Uruguay, considered co-innovation at three different levels, farm, region and institution: at a farm level, they reported co-innovation practices increased the net income by 56%; at a region level, co-innovation enabled a participatory approach to planning, monitoring and evaluation; and at an institutional level, co-innovation strengthened inter-institutional networks and development of a common vision. Dogliotti et al. (2014) applied a co-innovation approach to adopting agricultural practices that were identified by researchers as economically profitable and environmentally sustainable, in fourteen family farms in South Uruguay, and reported that co-innovation resulted in improved farm economy (per capita family income increased by 50% in 13 out of 14 farms) and reduced soil erosion by 50%.

Based on a comparative study of five NZ-based primary sector projects, Vereijssen et al. (2017a) concluded that co-innovation requires an adaptable mind-set rather than strict adherence to one approach. Srinivasan et al. (2017) applied a co-innovation approach to improve water use efficiency in an irrigation scheme in NZ (pilot study described in this paper) and concluded that on-farm water management decisions are influenced by both on-farm controls and off-farm (stakeholder) values and perspectives, particularly those linked to environment, economy and regulations. Srinivasan et al. (2017) focussed on the on-farm implementation aspect of co-innovation process, while the work described here covers the entire journey- from the inception of a research idea to its implementation and exit strategy- of co-innovation in practice.

Park et al. (2015) analysed the NZ-based Apple Futures programme that was tasked to develop and implement practices to growing ultra-low residue fruit. They concluded that the programme was a success in terms of adaptation and impact. Williams et al. (2015) credited the co-innovation approach used in Apple Futures programme elevated stakeholders to one of participants in a genuine partnership, thereby enhancing and sustaining the impact delivered by agricultural R&D investments.

Not all research programmes gain from impact-oriented, stakeholder-centred co-innovation principles. Context is important for the application of co-innovation. Vereijssen et al. (2017b) evaluated the applicability of co-innovation principles in a fundamental bio-protection research programme addressing challenges to potato production and concluded that where basic science knowledge gaps are substantial and the time required to address them are significantly large, setting up impact expectations may adversely affect the programme.

Even in projects where co-innovation principles are appropriate, it is important to recognize all perspectives and practices. When disseminating a technology or an approach to address a problem, the tendency might be to identify those failing to adopt as "failures." However, a study of farmers in Ireland indicated that even those who were regarded as "laggards" had adopted innovative practices but not those recommended by the researchers and extension specialists, and hence should not be discarded as failures (Leeuwis, 1989).

The objective of co-innovation is to be inclusive of all perspectives and practices. Klerkx and Nettle (2013) summarised that implementation of a co-innovation approach means alignment of different mind-sets and competencies; creation of incentives leading to linkage building and collaboration; and adaptation of research, extension, and innovation agenda-setting and funding mechanisms to enable innovation co-production. It has been acknowledged that co-innovation in practice is context-specific, and the practitioners need to be adaptive (Klerkx et al., 2010; Neef and Neubert, 2011). In our study, we focused on the adaptive aspect (termed as adaptive mind-set of stakeholders by Vereijssen et al., 2017a earlier) of co-innovation and how it can be implemented in a hydrological project that previously has been dominated by tech-transfer approaches.

Innovation-focused science projects face limited time frames, thus there is a need for planned action. Various principles, frameworks and guidelines have been developed to understand and facilitate innovation, such as 'guidance of the search' and 'socio-technical landscapes' (e.g. Geels, 2002; Wieczorek and Hekkert, 2012). However, these theoretical discourses are too abstract for biophysical researchers and practitioners who work on a more practical level with end-users and stakeholders and have real wicked problems to solve. Using an example pilot study, this paper attempts to provide practical insights into the implementation of co-innovation principles in a hydrology project. The paper builds on a five-year long *Water Use Efficiency* (WUE) pilot study in which hydrologists worked together with social researchers, farmers, industry professionals, business, communication and marketing managers, regulators and irrigation scheme managers to enable pro-active irrigation management. Here we discuss the stakeholders involved, actions performed (e.g., on-farm monitoring of irrigation; farmer workshops), resources employed and insights gained during the pilot study and link those back to theoretical discourses to innovation management. Our objective in this paper was to draw lessons from the WUE pilot study that can be applied in planning and implementing other similar innovation-focused biophysical studies. Therefore, the focus of this paper is on analysing the co-innovation activities that shaped and guided the pilot study rather than on analysing the biophysical data collected during the project. However key biophysical results from the WUE project are available in Srinivasan et al. (2017) and Vereijssen et al. (2017a).

2. Methodology

2.1. Water use efficiency pilot study

In 2012, a team of hydrologists and social researchers launched a