Reflecting on an Integrated Approach to Understanding Pathways for Socially Inclusive Agricultural Intensification

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ABSTRACT Large investments in Research-for-Development (R4D) have occurred around agricultural intensification to improve social and economic outcomes for poor small and marginal farmer households. Mixed evidence for sustained and socially just impacts from these investments reflects that projects aimed at achieving social change are inherently complex and the pathways from intervention to impact are deeply uncertain. R4D projects are increasingly drawing on integrative approaches to explore solution spaces for these complex social-agroecological problems; albeit integration science is not yet mainstream in R4D. We reflect on one approach (integrated assessment, IA) in a project on socially inclusive agricultural intensification, namely on how the project team embraced integration tools and research approaches, translated knowledge and learnings of the community and broader research team into systems frameworks, and ensured that social inclusion and justice concepts were central to the IA tools and process. IA was valued for its participatory focus and for lessening ‘silo thinking’ in the design of community interventions and research activities. We argue that complexity-aware integration approaches like IA are needed to support the design, monitoring and evaluation of R4D projects to enhance outcomes and achieve sustained impact.

KEYWORDS: Research for development (R4D); integrated assessment (IA) frameworks; transdisciplinary research; social inclusion; agricultural intensification

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1. Introduction

Research-for-development (R4D) is a bridge between traditional research that focuses on scientific outputs and development practice which is motivated by outcomes and impacts (Thornton et al., 2017). R4D programmes and projects are increasingly promoting sustainable agricultural intensification as a pathway to achieving the dual outcomes of poverty alleviation and food security (Struik & Kuyper, 2017; Westengen & Banik, 2016). For example, the Australian government invests in R4D through its aid programmes because it views agricultural intensification and improved market systems as a path towards better livelihood, income and well-being outcomes (DFAT, 2020). Often the intent of government or donors is to support smallholder farmers to shift away from subsistence farming to high value crops or more intensive production. These farmers subsequently use the extra income for education, to purchase assets or to invest in livelihood diversification, and in due course can shift to off-farm employment if desired; this is referred to as market-oriented intensification (Dawson, Martin, & Camfield, 2019).

Small and marginalised farmers must be included and advantaged by agricultural intensification interventions if impacts such as pathways out of poverty are to be achieved. Projects or programs often report increased production of cash crops and gross incomes aggregated across the project area, but these metrics can obscure other impacts (Rasmussen et al., 2018). In their assessment of market-oriented intensification policies in Rwanda and Laos that were deemed successful based on reported economic impacts, Dawson et al. (2019) concluded that intensification actually exacerbated marginalisation and poverty through various forms of land tenure insecurity. Similarly, in a review of 53 papers reporting on the ecosystem services and human well-being outcomes of agricultural intensification, Rasmussen et al. (2018) found that improved well-being impacts are generally captured by wealthier individuals. The affluent are able to net the benefits of intensification and are less disadvantaged by any loss of ecosystem services than more vulnerable groups who generally have a higher dependence on these services for their livelihoods. These examples illustrate that the pathways to impact are highly uncertain, a characteristic that Douthwaite, Mayne, McDougall, and Paz-Ybarneagaray (2017) attribute to the typical complexity of programs across the international aid and R4D sectors (including agricultural research).

A broad range of interrelated constraints occurring at multiple scales – from individual, household, and community, through to state and national – need to be overcome to achieve equitable outcomes for the ‘target’ communities. These need to be considered in the design and implementation of R4D and there is growing recognition from researchers and donors of the need to change how projects are planned, conducted, monitored and evaluated. Dawson et al. (2019), for example, argues that to catalyse a shift to a norm of agricultural development that is socially just and sustainable, requires more ‘holistic, contextually-relevant and disaggregated evidence of social impacts’. Explicit Theory of Change (ToC) and Monitoring, Evaluation and Learning (MEL) processes can help target common gaps such as a lack of socially differentiated outcomes (Rasmussen et al., 2018) or aid the translation and dissemination of research outputs (Thornton et al., 2017). For now, the pathways from intervention(s) to outcomes are not consistently tracked or tend to narrowly focus on the intervention without explicitly considering the broader context that can magnify or constrain impacts.

Purely disciplinary methodologies fail to capture this broader context and are inadequate for understanding the complex phenomena that emerge in rural communities in developing countries, namely poverty, gender and social inequality, and food insecurity (Butler et al., 2017). Recognising this, integration sciences are progressively being used to explore solution spaces for complex social-agroecological problems (Aravindakshan et al., 2021; Butler et al., 2017; Douthwaite, Mayne, et al., 2017; Ha, Bosch, Nguyen, & Trinh, 2017). With this orientation, integrative research methods and framings draw from multiple disciplines and inter-or-
transdisciplinary interactions within the project team and with others who inform, use or are impacted by the research (Blundo-Canto et al., 2019).

Numerous collaborative ‘research integration’ approaches or methods exist that aim to redress the limitations of disciplinary research tackling complex real-world problems (Bammer et al., 2020). In this paper, we reflect on the adoption of one such approach, integrated assessment (IA), in the Promoting Social Inclusion in Agricultural Intensification (SIAGI) project, funded by the Australian Centre for International Agricultural Research (ACIAR). IA is introduced and positioned within the broader spectrum of integrative research approaches in Section 2. Section 3 provides background on the SIAGI project, the role of IA in the project and an overview of the IA process and frameworks. Section 4 elicits reflections from the SIAGI project team on their engagement with the IA process and identifies conditions for effective integrative research. We argue in Section 5 for integration approaches to play a greater role in complex R4D.

2. Positioning IA within the spectrum of integrative research

Integrative research approaches have emerged over the last few decades from a wide range of disciplines dealing with complex problems. This includes interdisciplinary and transdisciplinary research, integrated assessment, action research, sustainability science and systems thinking (Bammer et al., 2020). We refer to these as approaches, noting that there does not seem to be a clear delineation of these as modes of research, types of sciences, or problem-solving methods or processes. The commonality across integrative approaches is their recognition that complex societal and environmental problems transcend disciplinary boundaries and require different forms of knowledge, data and tools from multiple disciplines to be understood and addressed. Different integrative approaches may emphasise slightly different parts of the systems or different tools for integration (see Supplementary Appendix 1). For example, systems dynamics, a form of systems thinking, focuses on the interactions and feedback loops between system components to reveal the structure of the system, whereas sustainability science tends to focus on human-environment interactions to understand how they affect the future resilience, adaptation and transformation of coupled human-environment systems (Bammer et al., 2020).

In this study, we adopt integrated assessment (IA), an approach that has gained popularity in climate science (Morgan & Dowlatabadi, 1996; Parson & Fisher-Vanden, 1997), water resources management (Jakeman & Letcher, 2003) and environmental health (Briggs, 2008). IA has also been applied in studies interested in capturing aspects of the social complexity of agricultural systems, including in the international development context (Britz, van Ittersum, Oude Lansink, & Heckelei, 2012; Giller et al., 2011; Nicholls et al., 2016). IA has a particular emphasis on the development of integrated frameworks, including conceptual frameworks and models, that synthesise information from various knowledge domains (Rotmans & Van Asselt, 1996). With the large overlap in principles and tools adopted by the various integrative approaches, it is acknowledged that the approach used in this study may be labelled by others as systems thinking, interdisciplinary research or another integrative approach. Many of the learnings from this study do apply across the broad range of integrative approaches.

3. Project background

3.1. The SIAGI project

The SIAGI project centred on six case study villages – two each in the Eastern Gangetic Plains and the East India Plateau of West Bengal, and two in the south-western coastal zone of Bangladesh. Prior to the commencement of the project in 2016, landless, tenant, smallholder and women-headed households (collectively termed marginalised households from here-on-in)
in the case study villages were not generating enough agricultural produce to meet their needs. Most households only produced one paddy crop in the wet season as production in other seasons was constrained in part by freshwater scarcity in the dry season. Early in the project, marginalised households across all the study communities shared their frustration of inequitable outcomes of past agricultural interventions and that they generally did not feel empowered to engage with agricultural intensification opportunities. SIAGI conducted institutional, social, market and integration research to investigate how investments and interventions in agricultural intensification could be designed to lead to increased social inclusion with fewer unintended consequences for marginalised peoples. SIAGI partnered with two other ACIAR funded projects that led on-farm research to test new or improved agricultural practices, with a focus on dry season cropping (https://aciar.gov.au/project/lwr-2012-079; https://aciar.gov.au/project/lwr-2014-073, accessed 13 November 2020).

![Diagram](https://example.com/diagram.png)

**Figure 1.** The SIAGI project co-designed interventions with community, underpinned by ECE led by NGO partners, conducted research across four main domains, and knowledge integration activities (italicised text – data collection methods; bold text – activities with community; underlined text – activities within the team; thick arrows – information flows between levels; circular arrows – information flows and within levels.)
The schematic in Figure 1 illustrates the multi-level nature of the SIAGI project, the various data collection and analytical methods employed (italicised text), activities with community (bold text) and within the team (underlined text), and the information flows between (thick arrows) and within levels (circular arrows). In reality, distinctions between activities across the levels of the project, and between activities and data collection methods, are fuzzier than the delineation depicted in the figure. For example, visits to farmers or villages provided data for the NGO and research partners and provided community members with opportunities to exchange ideas and learn from people outside the village and build their confidence and capacity to try new things on their land or at market. Similarly, at times NGO partners facilitated discussions between community and external agencies to influence program design and implementation.

The outer circle represents the interventions designed to empower individuals and groups to participate in agriculture and achieve livelihood outcomes. Three higher-level interventions were co-developed by the marginalised households (and their community) and the three ACIAR sister projects, facilitated at each study village by the SIAGI NGO partners:

- **Group formation and facilitation** to foster collective action and greater empowerment, self-efficacy and agency among the women self-help groups, water user groups, tribal minorities and farmer collectives to co-create opportunities to benefit from agricultural intensification,

- **Co-creating and managing physical assets** including water infrastructure such as irrigation assets (groundwater pumps, tanks, and canals) and low-cost green houses for vegetable production, ensuring the development of local water management and farmer institutions, and facilitating the communities’ shift towards inclusion and collective action through the development of protocols to support the equitable use and management of resources, and

- **Building community connections with external agencies and institutions** to enable and empower the community to access government entitlements and market services and engage with researchers and private sector actors on their terms.

The Ethical Community Engagement (ECE) process developed and adopted by the team (Mishra, Ray, Mihra, Ghosh, & Majumdar, 2018) underpinned the interventions. ECE takes a complexity-aware approach (Douthwaite & Hofmecker, 2017) to engagement and positions community members as partners, collaborators and innovators (not research subjects) with their own perspectives, wisdom and priorities, and the power to exert influence on the design and implementation of research activities. ECE proved the catalyst for establishing multi-actor activities (examples of which are shown in the bold text in the outer circle of Figure 1) and partnerships throughout the life of the project. The approach taken in SIAGI shares much with Research in Development (RinD; AAS, 2011; Douthwaite, Apgar, et al., 2017) – the learning-based Participatory Action Research (PAR) paradigm developed at the CGIAR – in that the research was embedded in ongoing engagement processes to initiate and sustain change.

ECE also guided the data collection methods employed by the SIAGI project team across the project’s research domains. The second circle in Figure 1 denotes the four SIAGI research domains: distilling the principles and practices of ECE (all villages), improving the knowledge of women self-help groups around nutrition security in the context of homestead and community agricultural production (in the East India Plateau villages), inclusive value chain analysis (IVCA; all villages) and bioeconomic modelling (in the Bangladesh and Eastern Gangetic Plains villages). The adoption of ECE near the end of the first year of the project (Carter, Cosijn, Williams, Chakrabory, & Kar, 2021) meant that the project team redesigned the research activities outlined in the project proposal which had included numerous discrete and intensive (extractive) data collection tasks. Instead emphasis was given to largely qualitative
methods (italicised text in Figure 1) to create ongoing dialogue with farmers, co-develop ideas, interventions and plans, and record the information needed by researchers. Information flows between the research domains and the ECE are represented by the thick blue arrows.

The inner circle in Figure 1 represents the knowledge integration and project management aspect of SIAGI; the major components being the IA research and the MEL processes. Information flows between the knowledge integration, research domains and the ECE are represented by the grey arrows. The iterative activities undertaken at this level – conceptual modelling, project reporting, and reflective team meetings for adaptive learning and management – were largely undertaken within the SIAGI project team although drew on knowledge developed through engagement with community and informed changes to interventions and activities with community. Over time, the project team also engaged with policy stakeholders to influence policy and program design, for example affecting change in how agencies engage with marginalised households and women.

3.2. An overview of the integrated assessment process and its role within SIAGI

In the SIAGI project, we used IA as both a process and a methodology to help the project team synthesise, and reflect on, the data and knowledge gained from the participatory research with the communities. The methodological contribution of IA to the project was to develop a systems thinking tool that explicitly synthesised the knowledge, data, theories and methods gained from the project case studies. IA as a process provided a structure to help the project team think through pathways to intended outcomes and possible unintended consequences of interventions. This section outlines the IA process detailed in Hamilton et al. (2019) and summarises key outputs and outcomes from the work.

A schematic of how the SIAGI research and engagement learnings inform the IA activities is shown in Figure 2. The focus of the IA work for the first half of the four-year SIAGI project was to synthesise the livelihood risks and opportunities of agricultural intensification for marginalised farmers using a qualitative conceptual modelling approach. Conceptual models provide a schematic of how a group (or individual) understands a system to work. Argent et al. (2016), amongst

Figure 2. Overview of how the data collection methods, research analyses and outputs undertaken by the SIAGI project team (grey boxes) informed the development and application of IA frameworks.
others, advocate for them to be used as a platform to generate shared understanding and learning amongst groups. In SIAGI, conceptual modelling activities enabled us to qualitatively synthesise the developing knowledge from the ECE and research activities summarised in Figure 1 and highlighted the interwoven nature of issues related to social inclusion and agricultural intensification in our case studies. This work reinforced that SIAGI interventions needed to be multi-faceted and attentive to the context of the people they intended to help.

In the second half of the SIAGI project, the IA activities developed and applied systems thinking tools to explore opportunities for agricultural intensification and strategies to manage associated risks. For context, the full frameworks are included in Supplementary Appendix 2 to demonstrate the core concepts and relationships; it is not in the scope of this paper to detail these frameworks. The three interlinked and iteratively developed frameworks drew on the aforementioned synthesis and the evolving understanding and observations from the parallel ECE and research.

Once developed, the frameworks were applied in three ways. Narratives were used to document change in individuals or groups over time in relation to the project interventions implemented with the case study communities. Narratives were used to document change in individuals or groups over time in relation to the project interventions implemented with the case study communities (see Hamilton et al., 2020). Secondly, the frameworks were translated into a form of semi-quantitative models called fuzzy cognitive maps (FCM; Özsesmi & Özsesmi, 2004) using the Mental Modeler software (Gray, Gray, Cox, & Henly-Shepard, 2013) to analyse the relative importance of concepts in the frameworks and the strength of incoming and outgoing connections, and explore the possible effects of interventions and system changes (Hamilton et al., 2019). Thirdly, the frameworks were used to support scenario visioning (Alcamo, 2008), which was applied by the team to develop plausible stories of how the future might unfold and workshop what actions were needed to progress towards the desirable future, or conversely to avoid or mitigate risks to the communities.

We chose not to co-develop or use the IA frameworks directly with community members to manage the demands placed on them by the whole project. However, the IA outputs were developed from the learnings and outcomes synthesised from the participatory activities shown in the bold text in Figure 1. When we did discuss the IA frameworks with community, these were facilitated discussions between community members, NGO partners and researchers where concepts in the frameworks were discussed to (for example) elicit individuals or farmer groups’ motivations to make a change in their cropping activities, document how the interventions of our NGO partners had helped participating farmers build their self-efficacy to make the changes they wanted and track farmers progress toward the outcomes they wanted.

The intended outcomes of the IA work were (1) to develop frameworks to formalise the project team’s understanding of the system(s), including incorporating informal knowledge sourced from collaborating farmers, and (2) to use the frameworks as discussion and learning tools for the project team to test implications of system interventions or perturbations. The reflection in Section 4 highlights further outcomes from the IA in that it proved to be a mechanism that ensured the team applied transdisciplinary principles in the way inclusion issues in the agricultural communities were considered, and how project activities and interventions were planned and assessed. Although the project team did not explicitly set out to embed the IA and MEL, the synergies of these processes emerged over time (Figure 3). The IA process in the SIAGI project contributed to evaluation and monitoring steps in the Theory of Change for Monitoring and Evaluation of Douthwaite, Mayne, et al. (2017).

4. Reflecting on the process of IA in SIAGI

The SIAGI project team consisted of over 30 researchers and practitioners from six research institutions and three non-government organisations (NGO) working in the study areas.
The two lead authors (the ‘IA specialists’) led the IA component of the project and for this paper developed a survey for the team to reflect on the IA process in SIAGI. The delivery of the survey and collection of responses was done by an intermediary team member, with the option of anonymity. 16 completed surveys were received from the 32 persons contacted, including four Australian researchers [AR], eight researchers from Bangladesh or India [BIR], and four NGO practitioners from Bangladesh or India [NGO]. With IA a core component of SIAGI to which all team members contributed, team members who completed the survey were invited to be authors of this paper.

The questions designed to guide partners’ reflections on the IA process in the SIAGI project are listed in Table 1. The reflections of the IA specialists are similarly framed in terms of the challenges and opportunities posed by the IA process and how the SIAGI experience has shaped how they think about IA (Section 4.2).

4.1. Opportunities and challenges posed by the IA process

The opportunities and challenges posed by the IA process can be broadly related to exposure to new tools and approaches to research (Section 4.1.1), translating diverse and rich knowledge into IA frameworks (Section 4.1.2), and making social inclusion, equity and justice central to the IA process and frameworks (Section 4.1.3). Select quotes from the team are provided in the text with supporting quotes in Table 2.

4.1.1. Exposure to new tools and approaches to research. Many of the challenges raised by the team related to their initial lack of familiarity with the tools or the IA research approach. The participatory approaches and tools utilised in IA research (e.g. focus group discussions) are common to the domains of action-research and community development, and so were familiar to the NGO and most research partners. However, most of the team had no past exposure to
the modelling and analytical tools that the IA specialists were considering for use in the project. Integration in the project was an equally challenging experience for the IA specialists who applied and needed to communicate a modelling approach new to them (FCM), one that required more in-depth analysis and use of qualitative data than they had experienced before. The IA specialists also had little prior exposure to many of the issues SIAGI was exploring including value chain analysis, social justice and inclusion, and nutrition sensitive agriculture.

From the outset, the project leader was aware of the limited exposure of many in the team to transdisciplinary research and IA, as well as the varying familiarity with MEL processes and disciplines of the SIAGI research. Thus, early resources were put into developing the teams’ capacity to contribute as needed to all dimensions of SIAGI. Nonetheless, early in the project team members struggled to understand: how IA tools could be used to functionally integrate qualitative and quantitative information from across the different strands of SIAGI research [AR1, NGO3], the process for their use in transdisciplinary research [AR4], and how they as an individual could contribute to the IA process or support others to do so [AR1, AR4, NGO1, NGO3].

From the perspective of the project leader, this variance in the familiarity with integration science and systems modelling within the team was a critical research management challenge that was specifically addressed through his (and others) efforts to motivate and encourage all partners to engage in IA activities over the life of the project. Largely, he felt that this challenge was resolved, estimating that about 80 per cent of team members fully comprehended the essence and value of IA by the project’s end. This he attributed to the team allowing themselves to co-learn as well as the systematic steps undertaken to familiarise the team with key concepts along the journey. The embedded reflexivity in the SIAGI project was key to building individual and collective understanding and capacity to contribute to the dimensions of the research that were outside each individuals’ comfort zone.

Over time, the iterative approach to IA helped the team systematically define its scope and purpose more broadly in the project, and then specifically the IA frameworks and FCM [AR1]. For some this adaptive and reflexive process seemed like a lack of focus or clarity in IA methods and approach which was not resolved. To BIR8, the IA process felt more like ad hoc changes in methodology that were attempting to find the purpose of the activity rather than as a continual process to find the common focus. Others felt that the IA process and methods were adapted to suit the project’s changing knowledge base and values, and over time the purpose of IA and its role as a tool to synthesise insights and learnings from the team about the studied systems became clearer [AR1, BIR6, NGO2].

Table 1. Questions to guide reflection on the IA process in the SIAGI project.

Guiding project team reflections
1. What is your main host institution (NGO, Research)?
2. What is your past exposure to integration research (None, Limited, Regular)? Provide summary of previous experience
3. What were the major challenges for you in contributing to IA activities?
4. How did these challenges change over time (did they resolve, get worse)?
5. Did IA introduce you to new tools or processes that you have used (or will use) in your work? If so, give examples of what these are and how you used them (or plan to).
6a. [For researchers] Did IA introduce you to new tools or processes that you have used (or will use) in your work? If so, give examples of what these are and how you used them (or plan to).
6b. [For NGO practitioners] Did the IA experience in SIAGI change how you think about and engage with communities? If so, how?
7. Do you have any further comments on what you liked or disliked about IA, or about its potential use in R4D projects or other areas of work?
Making social inclusion, equity and justice central to IA

‘… I’ve never seen something that so genuinely tried to capture things like power, governance, beliefs in a model to understand cause and effect.’ [AR3]
While the space for reflexivity that is critical for transdisciplinary projects can sometimes challenge the focus or commitment to achieving a shared goal (Thompson, Owen, Lindsay, Leonard, & Cronin, 2017), this was not the case in SIAGI. Rather, it provided the flexibility to learn and adapt the project activities and planned outcomes (Bracken, 2012) to address some of the immediate needs of our partner communities and also build capacities within the project team and their institutions, as well as community institutions, to facilitate longer-term impact. From an IA perspective, this reflexivity ensured that we developed methods and tools that supported and added to the broader SIAGI research and practice.

4.1.2. Translating diverse and rich knowledge into IA frameworks. The IA frameworks developed in SIAGI are forms of conceptual models or system diagrams that identify and connect the core elements of social inclusion in agricultural intensification. Over time they helped the team to capture, structure and critically assess its observations and learnings on how SIAGI and sister project interventions led (or failed to lead) to outcomes for community and marginalised actors. The issues that SIAGI were exploring were broad and drawing systems diagrams was highlighted as a serious challenge, particularly in the first half of the project, with specific challenges cited as how to cognitively relate the multiple social, economic and environmental factors [NGO2] and disentangle factors in order to define cause or effect [BIR1].

Some of the challenges I observed was just how to bring a large and diverse group of people along together on the discussion. In some of the earlier workshop discussions I think it was hard for the group to wrap their heads around what the diagrams were getting at and how to translate their rich knowledge into the mapping of connections, effects and feedbacks. [AR3]

The first two years were in the problem formulation and scoping phases of the IA (Hamilton, El Sawah, Guillaume, Jakeman, & Pierce, 2015) where the team were ‘determining what needs to be in or out’ [AR1]. This was the phase where the IA specialists were exploring the boundaries of the problem and the range of approaches and tools that might be useful, while explicitly attempting not to lock the IA into a particular development path (which might turn out to be inappropriate). In parallel, the team were redefining their component research in the context of community needs and our commitment to ECE, and were increasingly becoming aware of the complexity (interconnectedness) and breadth of issues around social inclusion in the communities and the potential implications of agricultural intensification interventions. Oughton and Bracken (2009) refer to this phase of interdisciplinary or transdisciplinary research as ‘finding the common focus’, noting it is a careful process to define what is to be investigated and what is not, requiring determination of the spatial, temporal and institutional limits to the research. In SIAGI, it was a negotiated process where specific topics of research were shaped to fit with the projects development agenda, akin to the RinD approach that Douthwaite, Apgar, et al. (2017) reflect upon.

To ‘find our common focus’ the IA specialists iteratively worked with the team (e.g. through workshop, brainstorming sessions, one-on-one discussions, field trips) to try and gain the clarity across disciplines to develop a common and deeper understanding of social
inclusion in the context of agricultural intensification. As the learnings from the component research emerged, the team was better equipped to discuss the IA in greater depth, including what concepts and interactions to address in IA (the system boundaries). Over time, most team members realised that they did not have to be fully versed in IA or modelling to be able to contribute meaningfully to the development and application of the frameworks, and were increasingly more comfortable with the use of integrative approaches to synthesise their knowledge [BIR1]. This increased comfort was important because systems thinking can help break down traditional disciplinary silos, allowing for more successful integration of knowledge types, and systems approaches explicitly facilitates the identification of the social, institutional, biophysical and other elements of the system. Both of these points are necessary for achieving the transdisciplinarity that we argue is critical for impact in complex development projects aiming to achieve social change.

A critique of transdisciplinary research projects has been that ‘scholars’ may use the knowledge of their ‘non-academic partners’ for the methodological aspects of the research (e.g. design and implementation of interventions) but not in the synthesis and integration of knowledge generated from the research (Defila & Di Giulio, 2015). In SIAGI, our NGO partners were instrumental in both the methodological aspects (e.g. the pivot to ECE and qualitative data collation and analytical methods) and the synthesis aspects (e.g. capturing social inclusion and cognitive concepts in the IA). Our in-country NGO and research partners played a critical role in the integration research through their documentation of interventions and activities conducted with the communities and the observed changes, and also through their input in developing, testing and refining the frameworks and their applications.

4.1.3. Making social inclusion, equity and justice central to IA. The impassioned call from NGO partners early in the project to re-design interventions and supporting mechanisms, so that they gave power to the community and marginalised farmers, challenged the IA specialists to give weight to social processes and concepts in the IA frameworks and applications. This distinguishes our research from much of the IA and systems modelling literature where focus is still placed on the physical, ecological, and/or economic systems and any reported discussions around social processes and concepts such as inclusion, equity, justice and empowerment (if they happen at all) occur when considering the implications of model outputs (Stojanovic et al., 2016; Zare, Elsawah, Iwanaga, Jakeman, & Pierce, 2017). Castillo, Bullen-Aguiar, Peña-Mondragón, and Gutiérrez-Serrano (2020) contend that moving social science to the centre facilitates improved articulation amongst socio-ecological research teams, and is necessary to develop local solutions and policy design. The IA experience in SIAGI supports this argument; bringing social science to the centre of IA actively engaged NGO partners in the co-production of knowledge and the IA outputs [NGO1], pushed model-based integration research beyond the current state-of-practice [AR3], and helped to document progress towards the outcomes that marginalised farmers wanted from the co-designed project interventions (see Section 3.2 and for more detail Carter et al., 2021). We contend that the central position of social concepts and processes will facilitate project teams to explicitly consider these dimensions if the frameworks are used to guide the design, monitoring and evaluation of interventions in projects with a similar context to SIAGI.

4.2. How has IA shaped how the team will plan and conduct future research or community engagement?

IA in SIAGI has influenced how team members plan to conduct future research or engagement activities with community (Table 3). Beyond exposure to new tools or techniques that they can use in their research or practice, the process of integration was also valued for its participatory
focus and potential to break ‘silo thinking’ in the design of future research projects and community interventions.

The FCM approach, and the Mental Modeler software, was considered a useful tool by a number of researchers approach to facilitate the uptake of qualitative approaches in future projects [AR1, BIR1] and one PhD scholar in the team had adopted FCM for their on-going research on cropping behaviour and water conservation [BIR4, BIR5]. There was also interest in using IA and FCM approaches in ToC development [AR1] and as part of a rigorous MEL system [AR4]. Embedding IA with MEL is an explicit research activity in a new project, led by SIAGI team members, on inclusive value chains in the Philippines. The scenario visioning activity, loosely based on Alcamo’s Story And Simulation (SAS) method (Alcamo, 2008), offered one researcher [AR4] a potential way to extend the scenario planning that they were familiar with ‘beyond the picture and into something that can support decisions around options’ [AR4]. It was also an interactive exercise that encouraged discussion and creativity amongst the team, challenged people to think beyond the life of the SIAGI project, and was thought to have potential value for other complex systems research domains [AR2] and for engaging with communities to think about future uncertainties and risks of interventions [NGO1]. Some SIAGI researchers indicated they would like to explore more quantitative or dynamic modelling approaches in future project [BIR4, BIR6]. Primarily qualitative methods were the most
appropriate method for SIAGI and proved to be scientifically rigorous and critical to the broader project [AR1]. However, the deliberative process of scoping and designing IA research and practice is key to selecting the appropriate methods in a new project. IA as a meta-discipline stems from (environmental) modelling and there are a vast range of qualitative and numerical modelling and analytical approaches to draw on.

The broader lens encouraged by SIAGI as a project and IA as a process gave both NGO and research partners an enhanced appreciation for ‘complexity aware’ approaches to their current and future work [BIR1, NGO2]. IA provided an opportunity for NGO practitioners to reflect on how they and others in their organisation engage with community and how this might influence the impact of any interventions [NGO1, NGO2].

In all these years I used to struggle to understand why poor people are poor… At times my colleagues along with me would get easily frustrated with community not taking up initiatives on their own and always depending on us. This IA experience has helped me to understand the complexities in life in which these poor communities live in and a huge number of factors that interplay between each other to achieve a particular outcome. It also helped me to understand that often our interventions operate in silos without taking a comprehensive view so gains by altering one factor gets easily nullified by other factors. [NGO1]

For the IA specialists, observing the NGO partners’ ECE practices and interactions with the community provided learnings for future IA processes, namely around structuring discussions without leading questions, observing body language and managing power relationships within groups, designing interactive and engaging activities to motivate community participation and co-produce knowledge, and culturally appropriate engagement.

4.3. Recognising the conditions for effective integrative research

Integrative research is a powerful tool for exploring solution spaces for complex systems and so lends itself to agricultural R4D projects where pathways to impact for marginalized farmers and community are the intent. In SIAGI, IA proved to be a mechanism to guide and inform the progress and decisions of the broader project and ensured that the team applied transdisciplinary principles in the project.

The thing which I liked the most is the people with unique expertise and versatile experiences have mingled together for this work. It was really a brainstorming and collaborative journey with multiple actors. Another thing I liked is the approach and perspective of analysing, synthesising and co-relating with multiple things in a very comprehensive manner. [BIR2]

We use to do things in a particular way which have been learned from engagement with other community maybe in a little different context. Placing ourselves as a co-traveler and co-learner with the community was missing. Now we are more reflective as well as keen to explore dimensions in the community to collaborate with them for finding the possible solutions. [NGO2]

Ultimately, SIAGI project leads and IA specialists were able to nurture within the team a culture of collaboration, creativity and integration, and develop individual and group capacity to contribute to integration. This was due in part to the ongoing capacity development activities but also the commitment and attitudes of the team members, and the relationships developed over the project. The importance of the team dynamics and the attitudes of individuals within large multidisciplinary teams was critical to the success of the SIAGI project (Table 4), and is well recognised in the literature (Bracken, 2012; Castillo et al., 2020; Douthwaite, Apgar, et al., 2017).

To be successful, integration research requires careful planning and resourcing throughout the life of the project to overcome the inevitable institutional hurdles. The SIAGI project faced
The spirit of collaboration within project teams and partners

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‘IA approach has great potential for R4D research. The only risk is, the researchers has to be very skilled in applying the tools and explaining the results … It is better if a group of colleagues discuss the approach, how it should be applied and whether the explanations are in right track, it can ensure the proper use of IA. This is especially true for the beginners who want to apply IA in their research.’ [BIR7]

‘I think some researchers still expect that they lead the initial thinking work and then bring others along at some point (usually at the end when the window to influence is next to zero). And that this way of working is integration. [Rubbish!].’ [AR2]

Investing properly in integration research

‘Integration projects need to plan sufficiently for integration, both in terms of time lines and resources, as well as it being explicit in the project ToC’. [AR1]

‘The IA collaborative group processes has affirmed for me why some things work and others don’t (in terms of group co-production of knowledge). Organizational aspects like adequate time, energy, space, facilitation, etc are critical to the process yet almost always overlooked and undervalued … Along the way through there are the usual disciplinary hierarchies, gender relations, etc to work through but working through these needs to happen early and continuously.’ [AR2]

‘… [trade-offs] are natural consequences of meetings where international travellers converge – they are intense, time-poor, tiring events with multiple pressures …. I think these processes need fresh minds and lots of uninterrupted time, plus some tolerance for all involved. While it’s a logistical issue primarily, I do think it influences significantly on the quality of participation in the process and therefore the outcome.’ [AR2]

‘We never seemed to have enough time to really get our heads around the IA as it was normally one of the last sessions of the in-country team meetings when our brains were already quite saturated. I think also because there was often a 6 month gap between interactions on IA this made it hard.’ [AR4]

‘It was always going to take time, and opportunities, to think, reflect and come back to you with more questions and really embed an understanding for people in their own minds … [and demonstrate IA] was something the whole team was contributing to, rather than it being an academic exercise for the whole team.’ [AR3]

The need for integration experts and facilitation

‘Beyond knowing the mechanics of how to use tools like Mental Modeler, IA requires a particular set of skills in facilitation, communication and in systems thinking that is not common in researchers; in terms of project design (choice of team), it means placing greater emphasis in sourcing such skills, or explicitly developing them as part of the project.’ [AR1]

‘There is a lot I can’t control in projects – timeframes, which disciplines or people are involved – but I can control my own approach. Watching the IA team and how they facilitated, asked, listened to what people were saying and were able to incorporate that into their framework, and capture it in the model was really humbling. That’s not to say they just uncritically put everything in the framework – there is a way of having discussions and translating that into the work that they’re really skilled at. It’s something I’d like to be more aware of and work towards.’ [AR3]

‘[The IA specialists] read all the project documents and translate them into concept/phenomenon. They were so flexible/open to accept the comments and suggestions coming from the project members including me. After incorporating all suggestions, IA became so many dimensions but finally they nicely managed them by incorporating all of them into the model. It was really tough task.’ [BIR1]

the usual hurdles of group-based international R4D work, including language challenges, values conflicts, varying experience with group work, gender and/or power dynamics [AR2], and the need to build relationships with communities whose past experience with research projects had not been rewarding to them. Several members of the team highlighted that the time available to tackle IA in the SIAGI project was a constraint that was not fully resolved [AR2, AR4, BIR1], which meant that although some research partners saw the value in IA, they were not confident in their abilities to adopt and promote an IA approach within their research and institution [BIR1, BIR7], or they would need to source that expertise in future projects [AR1, AR3].
It would be difficult for me to use these tools or processes – I’d need [the IA specialists] to do that but it did give me a different understanding of integration, and a more ambitious goal of what it means and what it looks like. It made me look at some of my previous efforts in integration and realise that I didn’t have the right people (knowledge) in the room to work towards integration. So in that way, I guess you could say that it has given me a different understanding of integration and the time, mindsets, and skills required to work towards it, and I will try and bring that into other projects. [AR3]

Project leads and IA specialists may have to argue for the ongoing and embedded role of integration expertise in project and convince the team as well as boundary partners or stakeholders. Within SIAGI, this argument was largely achieved with the project team (Table 4). Bammer et al. (2020) argue that to persuade stakeholders of the need for such expertise requires a clear articulation of what the expertise constitutes and that it is both accessible and useable. The explicit use of IA to operationalise MEL processes planned in the new Philippines inclusive value chain project—across the planning, monitoring and evaluation steps in Figure 3—will provide boundary partners and donors with evidence of value of investing in integration as a core element of R4D or complex socio-agroecological projects.

5. Synthesis

Agricultural intensification is often seen as a pathway to alleviating poverty within communities and achieving the development and agricultural production goals of governments or agricultural aid donors. Tempering the achievements that have been made over recent decades is the recognition that many people struggle to engage beneficially, if at all, in intensification. In this context, the SIAGI research project set out to identify how R4D investments could be better designed to facilitate socially inclusive agricultural intensification, and thus improve outcomes for small and marginalised farmers. IA proved critical to the SIAGI team understanding our underlying mental models and bridging conceptual differences, synthesising and structuring the team’s collective knowledge and research, and incorporating knowledge held by collaborating farmers and community members into the integration outputs. IA and other integrative approaches (see Supplementary Appendix 1) are well-suited to R4D and other research domains that address socially-relevant, complex, rapidly changing and uncertain problems (e.g. biosecurity, food systems, health).

The IA work in SIAGI pushed team members outside their comfort zones by challenging them to use new tools, think about the agricultural intensification from a systems perspective (beyond their disciplines), and acknowledge and explore divergent views. The integration challenges experienced by the team are not unique and would occur in most international R4D projects tackling such complex socio-agroecological problems. Nonetheless, as the team developed their system understanding, and was able to find the ‘common focus’ for the project, ideas started converging and there was increased buy-in of IA by the team. Subsequently, most team members gained increased understanding and awareness of not only the issues addressed in the SIAGI project but also other complex issues they deal with in other projects. The team’s experience with the IA process and transdisciplinary research highlights that: (1) integration takes time (years) and resources, including expertise to facilitate the process, (2) integration requires a team culture that is respectful of others’ knowledge and ideas, and where individuals are open in their willingness to learn and potentially challenge their own thinking, (3) given the complexity of problems involved in integration and transdisciplinary research, projects require flexibility in their design that allows the research path and methods to be adapted as new learnings are realised, and (4) the benefits of effective integration to team dynamics and group learning to project teams and partners justifies the investment needed to do integration well.

The IA process in SIAGI demonstrated that a key way in which integration can contribute to R4D projects is as a boundary object to facilitate conversations between people
from different sectors and disciplines to understand interventions and impacts in a more holistic and systemic way. Using IA in SIAGI to help with understanding the inter-connect-edness of factors that can constrain or magnify impacts on marginalised individuals or groups, and framing and co-developing solutions to complex problems, complements the push for wider adoption of complexity-aware theories of change and evaluation of R4D projects. Calls for the fostering of transdisciplinary communities of practice (Cundill, Roux, & Parker, 2015) and efforts of agricultural research institutions like CIRAD to shift towards a culture of impact (Blundo-Canto et al., 2019), demonstrate a growing acceptance by researchers and donors that reflective and holistic modes of research are needed to achieve socially just outcomes and sustained impact.

**Ethical approval**

The CSIRO Ethics Clearance reference for the SIAGI project is 083/15.

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