Understanding inclusive innovation processes in agricultural systems: A middle-range conceptual model

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Understanding inclusive innovation processes in agricultural systems: A middle-range conceptual model

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ABSTRACT

Inclusive innovation as a strategy for inclusive development has received increased attention from development policymakers, practitioners, and scholars in recent years. What these processes entail in practical terms, however, remains contested and under-theorized. This paper addresses the scarcity of mid-level analysis and models of inclusive innovation processes within complex systems, which are needed to enable a coherent empirical research agenda and to inform program theory-building, implementation, and evaluation. Looking to smallholder-oriented agricultural systems in the Global South, where the majority of inclusive innovation implementation and research has been located, this paper proposes that it is possible to identify the essential features and causal logic of these processes to create an empirically-derived, middle-range model with cross-context applicability. Drawing on methods from realist evaluation and social inquiry, I conducted a theory-driven, cross-case synthesis of three studies of inclusive innovation processes in agricultural systems, with one case each from South America, Southeast Asia, and Africa. I find that despite significant diversity in project designs, facilitation approaches, and local contexts, the three inclusive innovation processes unfolded in strikingly similar ways, and that this *modus operandi* can be modeled as a middle-range theory of change. In each case, I find that a consistent set of activities and processes changed the local context for the inclusive innovation initiative. These altered contextual factors interacted with ongoing programmatic activities in consistent ways to trigger processes of social learning, social capital strengthening, collective cognition, and consensus formation, which acted as causal mechanisms responsible for producing the intermediate outcomes that led to technical, organizational, and institutional system innovation. The middle-range model enables cross-context insights into how inclusive innovation processes work and what capacities are needed to facilitate them. It can also guide the adaptive management and assessment of these processes, while offering testable hypotheses to guide future empirical work and evaluation.

1. Introduction

1.1. Towards inclusive approaches to innovation for development

Over the past decade, a growing number of multilateral organizations, donor agencies, national governments, development organizations, and scholars have focused on inclusive innovation as a strategy for more inclusive and sustainable development (George et al., 2012; Heeks et al., 2014; Pansera and Owen, 2018, Santiago, 2014). Two trends in global development have contributed to the interest in this topic: on the one hand, the failure of economic growth in absolute terms to eliminate persistent and in some cases worsening inequality within and between nations (Gupta, Pouw, & Ros-Tonen, 2015; OECD, 2013) and on the other, the uncoupling of economic growth from social and ecological wellbeing (Chataway et al., 2014). As a driver of economic growth, innovation as conventionally practiced has been criticized as contributing to these trends (Chataway et al., 2014; Heeks et al., 2014; Lazonick and Mazzucato, 2013; Schillo and Robinson, 2017).

In this context, a "new" approach to innovation has been called for, one that explicitly benefits the least well-off in terms of process and outcomes, and which can therefore contribute to development that is more inclusive (Heeks et al., 2014; Papaioannou, 2014). It has been noted that this "new" approach is not in fact so new; that "pro-poor innovation," "grassroots innovation," "below-the-radar innovation," and related concepts have been well-documented since the 1990s (Berdegué, 2005; Chataway et al., 2014; Smith et al., 2014). What has emerged as new in the

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past decade, however, is the framing of these and related concepts in terms of "inclusive innovation," and the adoption of inclusive innovation by agenda-setting development organizations and national governments as an objective in its own right and a strategy for inclusive development (Heeks et al., 2014).

As inclusive innovation has moved to the forefront of the development agenda, scholarly output on this topic has increased exponentially (Heeks et al., 2014). Yet despite the growth in volume, work in this area remains fragmented across disciplines, with contested definitions, conceptual framings, practical meanings, and methods (Gupta, Pouw, & Ros-Tonen, 2015; Heeks et al., 2014; Pansera and Owen, 2018; Papaioannou, 2014). It has been noted that research on inclusive innovation remains predominantly descriptive and prescriptive (Heeks et al., 2014), and that additional analytical, explanatory, and theory-building work is needed to inform focused and coherent academic inquiry, policy-making, and practice (Pansera and Owens, 2018).

Actors such as donors and larger development organizations that intervene across diverse contexts have a particularly pressing practical need to look beyond the details of specific, contextually-tailored approaches to identify in more general terms what is required for successful implementation of inclusive innovation processes (USAID, 2018). This wider view necessitates an understanding of what these processes involve in terms that are generalizable across geographic and project contexts, yet still reflective of local realities. The task of developing this mid-level characterization of inclusive innovation processes is the central aim of this paper and the research project to which it belongs. The project seeks to develop testable, middle-range theory that can guide subsequent empirical studies and implementation efforts focused on inclusive innovation in the context of local systems change, also known as systems innovation. This latter term refers to the development, introduction, and mainstreaming of new ways of doing things that alter how a system functions (Elzen and Wieczorek, 2005; van Mierlo et al., 2013).

As an initial step in the task of building mid-level theory of inclusive system innovation processes that is generalizable across distinct system types, this paper starts with model development within a discrete system context. Specifically, the paper focuses on inclusive innovation processes within agricultural systems in regions facing development challenges related to poverty and natural resource management. This context was chosen because the majority of existing cases of inclusive innovation are located within it, and much of this work has been explicitly framed from a system perspective, therefore lending itself to the type of complexity-informed analysis employed in this paper.

1.2. Learning from inclusive innovation in agricultural systems

Within the context of agricultural systems, much of the evidence on inclusive innovation processes has been generated through case studies at the site or project level, which detail how particular system innovation processes have unfolded. (Devaux et al., 2011; Douthwaite et al., 2015; Kilelu et al., 2013; Triomphe et al., 2013). Studies such as these provide insights into the dynamics that have contributed to bringing about inclusive innovation in specific contexts and domains, such as crop production, animal husbandry, natural resources management, and value chain development. However, as noted by Jiggins et al. (2016), it is not advisable to extract broadly generalizable lessons or recommendations from these highly context-specific case studies.

Recognizing the need to learn across contexts, several recent studies have conducted cross-case analyses of inclusive agricultural innovation processes that were first documented at the site level (Devaux et al., 2009; Douthwaite et al., 2015; Faure et al., 2018; Hounkonnou et al., 2018; Jiggins et al., 2016; Triomphe et al., 2016). These analyses have compared inclusive innovation processes across diverse geographic contexts and innovation domains, identifying common features and, in some instances, common outcomes of the cases. These analyses permit the identification of some cross-cutting features of inclusive innovation processes in agricultural systems, albeit at a high level. They show that inclusive innovation processes can be triggered by a variety of different circumstances—including challenges, opportunities, and externally-funded projects—and that these processes unfold in unpredictable, nonlinear ways over time (Elzen et al., 2004; Faure et al., 2018; Triomphe et al., 2016; van Mierlo et al., 2013). They also find that stakeholders play a variety of roles and engage

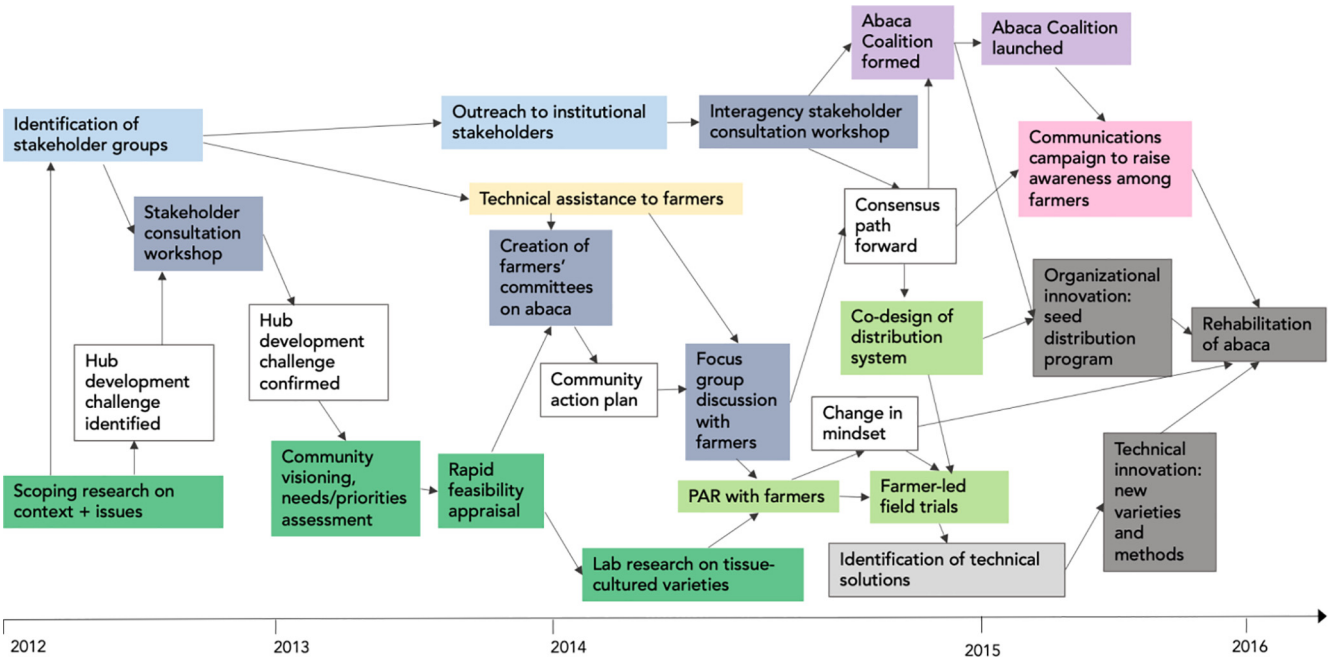

Fig. 1. Case-level process diagram for the abaca rehabilitation case in the Philippines (RinD).

in a wide range of activities that evolve over the course of the innovation process (Faure et al., 2018; van Mierlo et al., 2013).

These analyses have identified that inclusive innovation processes involve a mix of subprocesses that interact with each other in complex ways and that often unfold in tandem or in mutually-reinforcing sequences (Triomphe et al., 2016). In a cross-case assessment of 13 cases conducted under the JOLISAA (Joint Learning about Innovation Systems in African Agriculture) project, researchers found that processes of technological, organizational, and institutional change were "bundled" together, and that these processes induced each other in dynamic cycles over time (ibid.). Given the complex nature of the interactions and processes required to produce inclusive innovation in the agricultural sector, a growing number of agricultural researchers contend that the innovation process itself in these contexts demonstrates the properties of complex, adaptive systems (Klerkx et al., 2012, 2010). It has therefore been argued that inclusive agricultural innovations—particularly at the system level—cannot be planned but are the emergent results of numerous intentional and unintentional actions and interactions of many actors (van Mierlo et al., 2013, p. 30).

Nevertheless, these processes can be guided and facilitated, and the cross-case analyses reviewed for this study indicate the fundamental importance of skillful facilitation in successful inclusive innovation processes. Facilitation of meetings, workshops, and other events conducted by skilled and trusted (sometimes referred to as "neutral") parties enables constructive dialogue between stakeholders with diverse interests, prevents the perception and the reality of process co-optation by factions, and contributes to building trust between participants in the process (Douthwaite and Hoffecker, 2017, Jiggins et al., 2016). Facilitation also plays a pivotal role in several of the other key processes highlighted in the literature, including the co-generation and sharing of information between diverse actors (Jiggins et al., 2016) and the building of alliances and coalitions among stakeholder groups (Biggs and Smith, 1998).

While existing cross-case analyses have therefore yielded general insights with cross-context applicability, these analyses have remained at the macro level, characterizing features of inclusive innovation processes overall rather than describing how they work causally. Apart from observing that multiple processes interact with each other to produce inclusive innovation, there have been few attempts to specify across contexts what these processes are and how they interact to produce innovation—that is, what the underlying causal mechanisms might be. Similarly scarce are attempts to develop what Pawson, building on Sayer (1992, p. 89), calls "reusable conceptual platforms" from these empirical studies, which specify the "core sets of process that will occur in that class of program" (Pawson 2013, p. 92).

1.3. Aims and organization of the paper

The development and elaboration of this "missing middle" in our understanding of what inclusive innovation involves is the aim of this paper. Specifically, this paper offers a necessary step in the process of building middle-range theory for inclusive innovation by proposing a reusable, mid-level causal model for inclusive innovation processes in the context of agricultural systems transformation. Following Merton (1967), Pawson and Tilley (1997), Pawson (2013), and Westhorp (2012), this model is built at the mid-level of analysis using existing middle-range theories as causal mechanisms.

Middle-range theories are particularly useful for program implementers, donors, and policymakers because they enable the identification of common causal mechanisms that produce predictable outcomes across diverse settings (Douthwaite and Hoffecker, 2017; Pawson, 2013). Douthwaite and Hoffecker (2017) call for the development of middle-range theories (and particularly theories of change, or ToC) that are "complexity-aware," and thus well-suited to understanding processes of multi-stakeholder innovation in agricultural systems, which are by nature complex. They develop a mid-level model across two geographically and culturally distinct cases belonging to the same program and facilitated using the same participatory approach. This paper extends this line of inquiry by widening the analysis to cases that were implemented by different organizations using distinct facilitation approaches.

The guiding research questions were: do processes of inclusive innovation within agricultural systems share a common, underlying way of working, or *modus operandi* (Scriven 1974), irrespective of specific, contextually-targeted facilitation approaches or methodologies? And, if so, can this be represented at the level of a middle-range model in the format of a complexity-aware ToC? To explore these questions, I conducted a cross-case synthesis of previously documented cases (Yin, 2018) of inclusive innovation that met selection criteria described in the methodology section of this paper. Following the analytical approach employed by Douthwaite and Hoffecker (2017), I analyzed three in-depth cases of inclusive innovation and identified the major processes, intermediate outcomes, and outcome pathways that contributed to bringing about innovations in each case.

Moving beyond existing analyses in this area, I analyzed processes that were spearheaded by different organizations using distinct methodologies for innovation support and facilitation. These included the Research in Development (RinD) approach as designed and implemented by the CGIAR Research Program on Aquatic Agricultural Systems, the Participatory Market Chain Analysis (PMCA) approach as implemented by Papa Andina, and a multi-stakeholder solution co-design approach created and implemented by the organic waste team at the French Agricultural Research Center for International Development (acronym in French: CIRAD).

Despite significant diversity in project models, facilitation approaches, and local contexts, the analysis revealed that the three inclusive innovation processes unfolded in strikingly similar ways. The analysis identified a set of shared process components (what Pawson (2013, p. 92), drawing on Sayer (1992, p. 89), calls "internal or necessary relations" of the intervention) and consistent patterns of causal relationships between these components, which, following realist inquiry, can be understood in terms of contextual factors, mechanisms, and outcomes. Using these existing analytical categories, it was possible to identify a common *modus operandi* across the three cases, despite significant ground-level differences in the respective interventions and local contexts. This paper describes that *modus operandi* and the conceptual model that has been developed to represent it, which is formulated as a complexity-aware, middle-range theory of change. This theory is represented graphically in two versions of middle-range abstraction, one slightly more detailed than the other.

The following section (Section 2) describes the theoretical and conceptual foundations that informed the research design and case selection criteria. Section 3 provides more details on the research methodology, general analytic strategic, and the specific methods that were used for selecting and a cases, as well as conducting analysis within and between them. This section also provides a brief introduction to each of the cases that were selected. Section 4 presents the results of the cross-case analysis, describing the middle-range model and detailing its components and overall causal logic. Section 5 discusses the usefulness and implications of this model for project planning, learning, monitoring, and evaluation, and Section 6 concludes by exploring the model's implications in terms of the capacities needed to effectively support and facilitate inclusive innovation processes in agricultural systems.

2. Conceptual foundations

2.1. Realist approaches to causal research in complex systems

In seeking to develop a middle-range causal model for inclusive innovation processes, this paper draws conceptually and methodologically from critical realist approaches to social research broadly and evaluation research specifically (Maxwell, 2012; Pawson, 2013; Pawson and Tilley, 1997; Sayer, 1992; Westhorp, 2012). This paper does not seek to evaluate specific inclusive innovation programs, but it shares the realist evaluator's focus on disentangling patterns of complex causality to understand how a particular type of process works to bring about particular kinds of outcomes. The task is to identify what Scriven calls the *modus operandi* of inclusive innovation processes, "the associated configuration of events, processes, or properties, usually in time sequence, which can often be described as the *characteristic causal chain* (or certain distinctive features of this chain) connecting the cause with the effect" (Scriven, 1974, p. 71).

In this paper, the "effect," or the ultimate outcomes of the process, is the production and adoption into use of inclusive institutional, organizational, and/or technical innovation within agricultural systems. This kind of effect is often most clearly observable ex post, that is, from the tail end of the process looking backwards, as an innovation only becomes so after having been incorporated into use within a given system of interest (Assefa et al., p 38, 2009; Devaux et al., p. 32, 2009; Frankelius, p. 49, 2009; Leeuwis and van den Ban, 2004; Spielman et al., p. 75, 2009). The research task of identifying the factors within that process that contributed to bringing about the eventual innovation(s) resembles the task of an evaluator seeking to understand how a complex, multi-faceted program intervention "worked" to bring about a set of successful outcomes.

The branch of evaluation research that concerns itself most directly with these causal questions, particularly in the context of complex interventions within complex systems, is "realist evaluation," a well-established subfield that traces its philosophical roots in critical realism to Bhaskar ((2008) [1975]), and its development in the context of evaluation research initially to Pawson and Tilley (1997) and subsequently to a growing community of realist evaluators and researchers (Astbury and Leeuw, 2010; Emmel et al., 2018; Westhorp, 2012; Wong et al., 2016). At the heart of critical realism and realist evaluation is a focus on the role of causal mechanisms in bringing about outcomes of interest, or, as Pawson (2013) notes more broadly, "empirical regularities" (p.4). Causal mechanisms are often unobservable (at least directly), but when triggered by program activities or other actions, these mechanisms interact with elements of their context to produce outcomes that can be experienced directly and measured empirically (Astbury and Leeuw, 2010; Pawson, 2013; Westhorp, 2012).

From the burgeoning literature in realist evaluation, this paper understands that the "characteristic causal chain" (e.g., the *modus operandi*) of inclusive innovation processes will necessarily include causal mechanisms, and that attempts to describe this *modus operandi* should be attentive to the nexus between contextual factors, mechanisms, and outcomes, or what realists call "context-mechan ism-outcome (CMO) configurations" (Pawson and Tilley, 1997). These CMO configurations can be described at the level of changes in individual program participants' reasoning and behavior, as is typically the case in realist program evaluations (Astbury and Leeuw, 2010, p. 375, Pawson, 2013), or at higher levels of abstraction to identify how certain features of programs work to bring about consistent types of changes in particular populations (Owusu-Addo et al., 2020; Westhorp, 2018). The "theory map" described by Westhorp (2012, p. 413), for example, identifies mechanisms at a mid-level of analysis, otherwise known as "middle-range theory" (Merton 1967).

Drawing on Merton (1967), both Pawson (2013) and Westhorp (2012) assert that models and theories at the middle range of analysis are best equipped to describe complex interventions (or processes) occurring in complex systems across distinct contexts and domains. Models at this level use abstraction to identify the consistent, repeating features of processes or programs that specific instances exemplify. The study of inclusive and multi-stakeholder innovation in the context of smallholder agricultural development is rich with site- and program-level case studies, but the majority of this work is descriptive, with scant discernible hypothesis testing regarding causal patterns underlying the innovation processes under study.

As cautioned by Heeks et al. (2014) in a special journal issue dedicated to addressing what they call "the analysis gap" in the study of inclusive innovation, "without an analytical foundation, there are concerns that research will not create a critical mass of understanding, and that guidance for innovation policy and practice will be sub-optimal" (p. 177). Six years later, the subfield of inclusive innovation studies remains distinctly pre-paradigmatic. As such, there is a need for the development of middle-range theories that can specify for further testing and research the consistent elements and causal mechanisms present in inclusive innovation processes across diverse contexts.

In developing the middle-range model proposed in this paper, I drew on several well-documented approaches to analysis and theory-building that have been employed in the context of agricultural innovation research: the innovation histories approach, which chronicles the key steps and turning points in the development of an innovation over time (Spielman et al. 2009); the impact pathway analysis approach, which seeks to identify and construct a causal chain of events leading to the production of innovation (Douthwaite et al., 2003; Faure et al., 2018, 2020; Springer-Heinze et al., 2003); and recent work from the evaluation research field in building realist-informed program theory, and more specifically "theories of change" (ToC), that are "complexity-aware" or "complexity-consistent" (Douthwaite et al., 2020, 2017; Douthwaite and Hoffecker, 2017; Koleros et al., 2020). This recent iteration of ToC approaches builds on a substantial existing body of work on the use of theories of change in international development research and evaluation (Funnell and Rogers, 2011; Mayne, 2015; Stein and Valters, 2012; Thornton et al., 2017).

In model-building using a ToC approach, elements of the theory are typically arranged from left to right (or bottom to top), starting with essential components of the program intervention (the internal or necessary relations) and moving sequentially from initial results through intermediate and ultimate results, typically referred to as "outcomes" (Yin, 2018; p, 186). Realist theories of change further specify the theory in terms of elements of context that interact with program activities to trigger mechanisms, which together bring about outcomes (Pawson, 2013). In this way, realist theories of change are able to account for complexity dynamics as well as changing contextual conditions that can affect outcomes (Pawson, 2013; Westhorp, 2012). Prior to describing this paper's methodological approach in more detail, it is worth pausing briefly to clarify how the term "inclusive innovation" was conceptualized for the purposes of this study.

2.2. A working definition of inclusive innovation

Unlike the term "participatory innovation," which has been in use among agricultural and development practitioners for nearly four decades, "inclusive innovation" has entered into use in the past decade and still lacks a consensus definition (George et al., 2012; Heeks et al., 2014; Opola et al., 2020; Pansera and Owen,

2018). The most widely referenced framing refers to inclusivity in terms of who benefits from innovations and innovation processes, and is focused specifically on the inclusion of poor and marginalized populations, sometimes referred to as individuals at the base of the pyramid (BoP) (Heeks et al., 2014; Foster and Heeks, 2013; George et al., 2012). Inclusivity in this regard can refer to the extent to which innovation processes address the challenges and concerns of poor and marginalized communities and the extent to which these communities benefit from the resulting innovations, either through direct uptake or because the innovations contribute to including them in systems, markets, or benefit streams from which they were previously excluded (George et al., 2012; Altenburg, 2009).

Building on this narrow view of inclusivity, a smaller body of work defines inclusion in terms of both who benefits from and who participates in processes of innovation (Swaans et al., 2015; Heeks et al., 2014; Foster and Heeks, 2013). According to this view, "inclusive innovation is the means by which new goods and services are developed for and by marginal groups (the poor, women, the disabled, ethnic minorities, etc.)" (Foster and Heeks, 2013). This view aligns with the literature and practice around participatory innovation and grassroots innovation, and stresses the importance of meaningful participation of marginalized groups in the development of "pro-poor" innovations.

A more comprehensive framing of inclusive innovation has been developed by Schillo and Robinson (2017), who contend that innovation needs to be inclusive in terms of people, activities, outcomes, and governance. They consider four dimensions to determine if an innovation process is inclusive: 1) who participates in the innovation process; 2) what kinds of activities the process entails (for example, activities that are explicitly participatory and that enable the meaningful participation of diverse stakeholder groups), 3) the results or outcomes of the innovation process and who benefits from these; and finally, 4) how and by whom the innovation system itself is governed (ibid). This framing is generally consistent with the "ladder of inclusive innovation" proposed by Heeks et al. (2014, p.177), which considers six levels of inclusion ranging from the intended impact (at the lowest level of inclusion) through actual impact, to process, structure, and "post-structure," referring to the inclusivity of the frame of knowledge and discourse within which innovation is created.

These latter, broader framings serve as the foundation upon which I have developed a working definition of inclusive innovation for the purposes of my research and this paper. This paper frames inclusive innovation as a collaborative and co-creative, multi-stakeholder approach to innovation that prioritizes the agency and leadership of groups that are traditionally excluded from innovation activities and from the benefits of economic development. Inclusive innovation processes rely upon the meaningful participation of people who are experiencing the challenges that the innovation process is intended to address, and produce results that benefit those who are disadvantaged by the existing opportunity structures in their respective contexts.

3. Methodology

3.1. Research methodology and general analytic strategy

The methodology selected for this study was a cross-case synthesis of previously published case studies (Cruzes, Dyba, Runeson, & Host, 2015; Yin 2018, pp. 194-195) of inclusive innovation processes in the context of agricultural systems that met the selection criteria described in Section 3.2 below. As noted by Yin (2018) and Pawson (2013), case studies can provide rich and detailed insights into causal mechanisms at play in a complex process (such as inclusive innovation), illuminating how, why, and under what conditions these processes produce specific sets of results. They are also frequently used in evaluation research as the starting point for conceptual abstraction and theory-building, particularly in cases where robust program-level theories have not yet been specified for a particular class of program (Pawson, 2013; Yin, 2018).

The use of cross-case synthesis on previously documented case studies is an analytical approach that has been employed for the purposes of achieving mid-level abstraction in evaluation and policy research since the 1970s (Cruzes et al., 2015; Yin, 2018). This approach was selected for several reasons. First, as previously noted, the purpose of this study is to learn from and analyze existing empirical evidence on inclusive innovation processes within agricultural systems in order to contribute to theory-building at a mid-level of abstraction that is higher than cross-case analyses within a single project intervention, but lower than the broad, cross-study generalizations that have been described in Section 1.2.

Second, conducting analysis on previously published cases permits replicability of the analysis by other researchers using the same case-level data, which is publicly available in significantly more detail than would be available for case material published for the first time in this paper. As demonstrated by Cruzes et al. (2014), when existing, previously published case studies are used as the data set for cross-case synthesis, replication of the synthesis can be performed by independent research teams using a variety of different analytical approaches, permitting the identification of similarities and differences in the findings, and strengthening the internal validity of conclusions emerging from the analysis.

Following Yin's (2018, p. 196) guide to case study research methodology, the recommended "case-based" rather than variable-based approach was employed for the cross-case synthesis. In this approach, each case is analyzed holistically on its own terms first, and then synthesis is performed by identifying any within-case patterns that replicate literally or theoretically across cases. Analysis within each case was conducted using an analytical strategy that started with a series of theoretical propositions drawn from the existing literature (ibid). These included the following propositions: 1) there was likely to be a common *modus operandi* among the cases, despite their ground-level differences; 2) that it was likely possible to model this as a complexity-aware theory of change; 3) that this ToC was likely to consist of certain familiar structural elements such as processes, intermediate results, and outcomes; 4) that within those elements, certain categories of activities, results, and outcomes were likely to be present; and 5) drawing on realist inquiry, causal connections between activities and outcomes were likely to be explained by complex interactions between program activities, contextual factors, and causal mechanisms.

These theoretical propositions were used to develop a common initial descriptive framework (Yin, 2018, p. 171) for the necessary process components of each case (Pawson, 2013, pp. 92-93), and to select the specific techniques employed for subsequent stages of analysis. Drawing on the existing literature on inclusive innovation processes in agricultural systems, the two primary analytical techniques employed for within-case analysis were both visual diagramming techniques: innovation timelines, which can be understood as a specific variant of the familiar technique of time-series analysis (Yin, 2018, pp. 181–182); and impact pathway analysis, which as noted earlier, is a specific version of the broad analytic technique of logic model construction (Yin, 2018, pp. 186-194).

These techniques were used in an iterative analytical process (Yin, 2018; Maxwell, 2005) to produce case-level syntheses, consisting of a case-level process diagram (Fig. 1) illustrating an anal-

ysis of how the key events (in white) and "necessary component processes" (in colors) of the case unfolded over time, and a case-level impact pathway analysis (Fig. 2), identifying causal connections between key elements of the case as described in the case material. During this process, I catalogued the following key dimensions of each case: 1) the activities and processes that project teams highlighted as playing a role in the innovation process; 2) the major events or turning points that contributed to advancing the innovation process; 3) intermediate results or outcomes that contributed to producing the resulting innovations; and 4) any other elements that case authors highlighted as part of the causal chain responsible for producing the eventual innovations. Figs. 1 and 2 provide examples of the case-level syntheses resulting from these analytical techniques for one of the cases included in the study, which is described in more detail in Section 3.2 below.

Building on recent work in realist-informed program theory development by Douthwaite and Hoffecker (2017), Owusu-Addo et al. (2020), and Westhorp (2018, 2012), the case-level impact pathways identified initial results (diagrammed in white boxes) that produced meaningful changes in contextual conditions—such as new stakeholder groups with enhanced capacities to participate in the process—and causal mechanisms (diagrammed in light gray boxes) that interacted with these changed contextual conditions and ongoing processes to produce intermediate and ultimate outcomes (in dark gray boxes). Following Owusu-Addo et al. (2020) and Mookherji and LaFond (2013), causal mechanisms, such as processes of social learning and collective cognition, were identified at a mid-level of abstraction and in terms that related them to existing bodies of formal theory, to enable comparison across the cases and enhance the generalizability of the resulting cross-case model.

Once a first level of synthesis was produced for each case in the form of the previously mentioned set of diagrams, the cross-case synthesis involved coding the various components of each diagram using a combination of emic codes from the case descriptions and etic codes from the initial theoretical framework guiding the analysis. Following recommendations from Yin (2018) and Mookherji and LaFond (2013), the first level of cross-case analysis involved identifying and grouping concepts with slightly different descriptive terms from the cases, framing these at a higher level of abstraction to capture their essential sameness. These uniform, more abstract codes were then reapplied to the case-level diagrams to create diagrams with consistent terms and conceptual framings (e.g., "knowledge co-production" or "relationship building and brokering").

The subsequent step of cross-case synthesis involved examining the causal relationships within each of the case-level impact pathways. An overall strategy of literal replication was used to identify consistent causal patterns that repeated themselves across the three cases. Causal patterns that were found to be consistent across cases and consistent with predicted relationships from existing theory were used as the building blocks for creating a single, cross-case model to describe how inclusive innovation took place in each of the three cases under study.

3.2. Case selection process

The analytical method of cross-case synthesis utilized in this study required a highly purposive case selection strategy focused on identifying cases that were similar enough in certain core attributes that literal replication of findings could be expected between the distinct cases (Yin 2018). To this end, the working definition of inclusive innovation presented in Section 2.2 was used to create a conceptual screen for the case selection process. Ideal cases were deemed to be cases that a) fully fit this definition of inclusive innovation, b) had produced "success" in terms of generating some combination of technical, organizational, and institutional innovation, and c) were thoroughly documented by a variety of different researchers who had been embedded in the implementation of the cases for sufficient periods of time (a minimum of three years) to be intimately familiar with the details of the case and the local context.

The following process was implemented to identify cases that fit these criteria. First, a standard literature search was conducted for literature on inclusive innovation broadly, and inclusive innovation within agricultural systems more narrowly. Within the literature on inclusive innovation in agricultural systems, a further screen identified articles that referenced or included specific case studies of inclusive innovation processes. From these articles, a longlist was generated of possible case studies for inclusion in

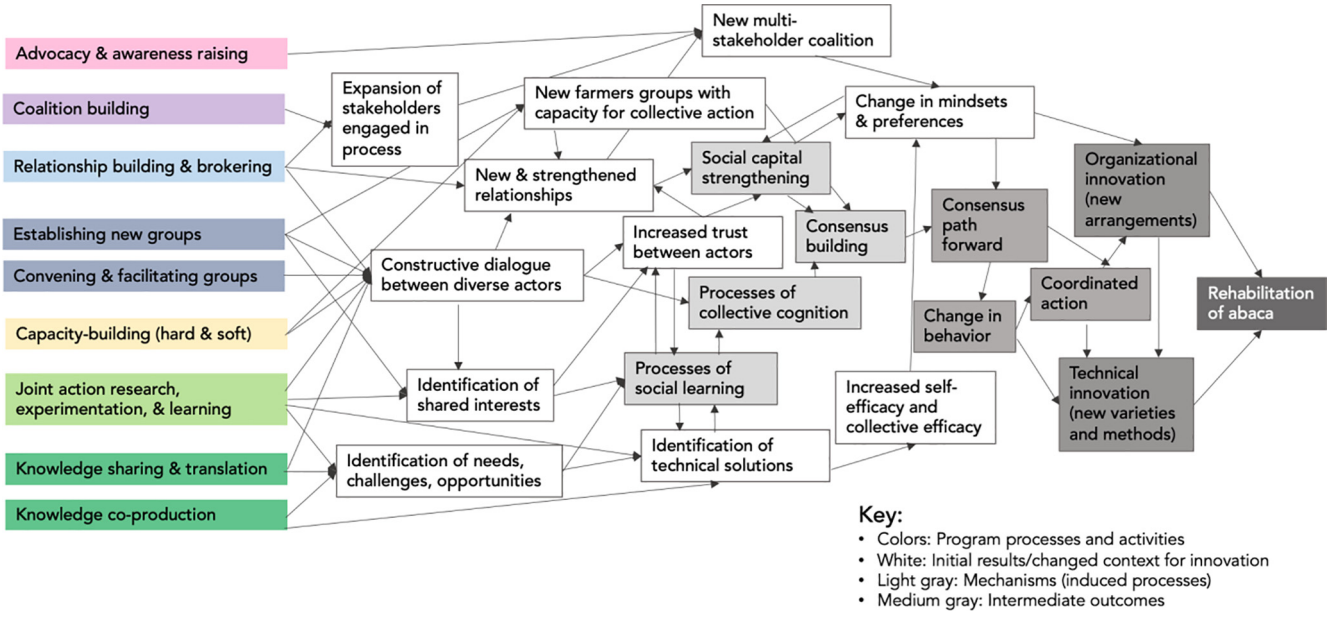

Fig. 2. Case-level impact pathway for the abaca rehabilitation case in the Philippines (RinD).

the analysis. This longlist was then passed through an initial screen to identify cases that met the following basic criteria: 1) the case appeared to be a successful example of inclusive innovation as per the definition above; 2) the innovation process was oriented towards producing local system level innovation, e.g., changing how some aspect of the local system worked, rather than simply innovating a new product or service within the existing system; and 3) the case fell within the domain of innovation related to agriculture, food systems, and/or natural resource management. This last criterion was used to provide consistency in the general domain across cases, on the hypothesis that inclusive innovation processes in agricultural systems might share certain consistent characterstics as compared to innovation processes within health systems, transportation systems, or other sociotechnical systems.

This resulted in the identification of a shortlist that was subjected to a second-level screen. At this level, all available source material was identified for each of the cases, including peer-reviewed papers, web material, and practitioner reports, the latter often referred to as "gray literature." These source materials were used to answer the following questions for each case. First, did the innovation process described in the case exhibit all of the characteristics of our definition of inclusive innovation? Specifically, was the process designed to produce solutions that benefit previously excluded or marginalized communities? Were the activities in the innovation process participatory and designed to include diverse types of stakeholders in the process, particularly those experiencing the challenge that the innovation process was designed to address? Was there evidence of agency and leadership of previously marginalized stakeholders in the innovation process? Finally, was the process successful in terms of resulting in technical, organizational, institutional, or other forms of innovation?

To this list of content criteria were added three additional feasability criteria: 1) did sufficiently detailed data and information exist on the innovation process to be able to analyze it using the analysis methods intended for the study? 2) Was data on the case triangulated and validated from several different perspectives, and therefore credible? 3) Were the researchers who documented the cases substantively involved over an extended period of time in the implementation of the case as explicit stakeholders, and therefore deeply familiar with the local context and project dynamics? This screen narrowed the list to eight cases, from which the final three cases were selected using criteria informed by the study's research question. Specifically, since the aim was to identify if common process features and causal patterns could be detected across cases facilitated using different innovation facilitation methodologies in distinct geographic and cultural contexts, the final set of cases were chosen to maximize diversity with regard to these criteria. The final set of three cases are introduced in Section 3.3 below.

The analysis of each case made use of a range of publicly available material, from peer-reviewed publications on the case, to more detailed program reports and material found on project websites. This range contributed to an understanding of each case based on multiple perspectives, as well as the clarification of case details that were omitted in some sources but present in others. The full list of sources used to inform the analysis of the three final cases is included as Appendix A.

3.3. Description of the case studies included in the analysis

The first case study focuses on an inclusive innovation process facilitated between 2010 and 2014 on the small French island of Réunion, located off the eastern coast of Madagascar in the Indian Ocean. This process was launched by CIRAD in conjunction with six other organizations, including private sector stakeholders, a group of municipalities, and the local Chamber of Agriculture (Queste and Wassenaar, 2019; Wassenaar et al., 2015). The project arose in response to growing conflicts on the island between agricultural representatives, livestock producers, municipalities, and environmental agencies over how to manage the rapidly growing volume of organic waste from agriculture, livestock, and commercial sources (Queste and Wassenaar, 2019). In response to this crisis, and to prior research indicating the potential for organic waste recycling on the island, the CIRAD team formed a project leadership group comprised of representatives from the relevant stakeholder groups and launched the GIROVAR project (Wassenaar et al., 2015).

This project set in motion a multi-actor innovation process aimed at co-designing an integrated organic waste management system, focused on the transformation of organic waste into agricultural fertilizer. The objective was to "unlock the development potential of actors concerned (crop production, livestock production, produce consumption) while increasing the system's resilience" (Wassenaar et al. 2014, p. 64). The project team developed and implemented their own multi-actor co-design process focused around the participatory design of "plausible solutions," which were developed and analyzed through scenarios and simulations (Queste and Wassenaar, 2019; Wassenaar and Queste, 2015; Wassenaar et al., 2014). This process resulted in stakeholders mobilizing around a consensus scenario, which involved the creation of an island-wide organic fertilizer production network, and implementing technical, organizational, and institutional changes required to start implementing this vision (Queste and Wassenaar, 2019). Given that the facilitation approach employed by the GIROVAR project was described using different terminology in each of the publications reviewed for the case, in this paper it will be referred to as the "multi-stakeholder solution co-design" (MSCD) approach.

The second case included in this study focuses on an innovation process aimed at rehabilitating a decimated export cash crop, abaca, which provided the primary source of income for many farming communities in the central Philippines. As documented by Douthwaite and Hoffecker (2017), over a decade of ineffective government action to eradicate a virus affecting the crop had eroded trust and basic communication between farmers and government crop technicians, while the main institutional stakeholders working on abaca viewed each other as competitors, and were not collaborating (Douthwaite and Hoffecker, 2017). In 2013, the CGIAR Research Program on Aquatic Agricultural Systems (AAS) launched a multi-stakeholder innovation process around the "shared dream" of local farming communities to rehabilitate abaca production as a poverty reduction strategy (ibid).

The AAS team used a participatory action research (PAR)-centered approach called "research in development," or RinD for short, to facilitate the innovation process (Dugan et al. 2013). Over the course of three years, this process produced a combination of technical, organizational, and institutional innovations that together made it possible for over 200 farmers across four communities to begin rehabilitating their abaca production, demonstrating a viable pathway for action that other farmers could follow. When the AAS program ended, plans were underway to begin jointly developing an inclusive value chain for abaca, an initiative that would have been implausible just three years earlier (Douthwaite and Hoffecker, 2017).

The final case included in the cross-case analysis involved a five-year innovation process to develop commercial markets for native varieties of potatoes grown in the Peruvian Andes. The project was launched in 2002 by the International Potato Center's (CIP) Innovation and Competitiveness of Peru's Potato Sector (INCOPA) Project, with the objective of exploring whether native potatoes could become a viable source of income for rural, impoverished indigenous families living in the high Andes (Devaux et al. 2009).

Using a facilitation approach called Participatory Market Chain Analysis (PMCA), the project team spearheaded a multi-year process that engaged stakeholder groups ranging from very poor indigenous families to private potato processing firms and major national supermarket chains in the development of commercial, technological, and institutional innovations, including several new potato chip products made from native potatoes; a high-quality, freeze-dried native potato product (Tunta Los Aymaras); and T'ikapapa, the first brand of high-quality, fresh, native potatoes made available throughout leading supermarkets in Peru (Ordinola et al., 2011; Devaux et al., 2009; Meinzen-Dick et al., 2009).

4. Analysis and results

4.1. A middle-range model of inclusive innovation processes in agricultural systems

The cross-case synthesis resulted in the identification of the necessary set of components required to construct a realist-informed, middle-range theory of change. Specifically, the process resulted in identification of the two essential elements of realist-informed program theories. First, the analysis identified and confirmed the "internal" or necessary components of the inclusive innovation process, which appeared consistently as predicted across the three case studies. Second, the analysis process identified the consistent causal relationships and pathways across the three cases, which confirmed the hypothesis that these cases would share a *modus operandi* despite significant differences in local context and the specific facilitation approaches employed by project teams. The middle-range model that resulted from this analysis is presented in Fig. 3 below.

The shared *modus operandi* of the three cases, as described by the model, is as follows. In each case, project teams facilitated a consistent set of initial programmatic activities and processes (Column 1 on the model), such as knowledge co-creation, capacity building, relationship brokering, and others, which, through their initial results (Column 2), contributed to changing the local context for the inclusive innovation initiative. These altered contextual factors interacted with ongoing programmatic activities in consistent and predictable ways to trigger processes of social learning, social capital strengthening, collective cognition, and consensus formation (Column 3), which acted as causal mechanisms responsible for producing the intermediate outcomes (Column 4) that led to successful technical, organizational, and institutional system innovation.

Formulated as a middle-range theory of change, the model hypothesizes that if the activities in Column 1 are facilitated in a way that produces the results in Column 2, which together comprise the "necessary internal conditions" for successful inclusive systems innovation processes, then the four specified mechanisms will be triggered and willinteract in predictable ways with the activities and contextual elements in Columns 1 and 2 to produce outcomes leading to inclusive innovation. The four mechanisms are therefore identified by the model as necessary causal conditions for the creation of a consensus path forward, the selection and development of effective solutions, the exercise of effective collective action, and the institutional and behavioral changes needed to bring about inclusive organizational, technical, and institutional innovation.

The causal relationships described in the model bring attention to several salient features of the shared *modus operandi* of the cases. First, no single project activity (such as knowledge co-production, joint experimentation, or convening groups) triggered any of the mechanisms alone. Rather, in each case several mutually-reinforcing project activities interacted with initial results (e.g., changed contextual conditions) to trigger processes of, for example, social learning or social capital strengthening. In the abaca rehabilitation case (Fig. 2), for example, interactions between eight project activities and five initial results led to processes of social learning.

A second significant feature of the *modus operandi* is that project activities contributed to triggering mechanisms through the production of initial results, which changed key elements of the context within which the activities were operating. Focusing on the mechanism of social learning, for example, processes of social learning were triggered through project activities such as joint action research or joint experimentation when those activities (and others) were contributing to initial results, such as the identification of shared priorities, the building of increased trust between actors, and the facilitation of constructive cross-boundary dialogue (which formed the key contextual factors nec-

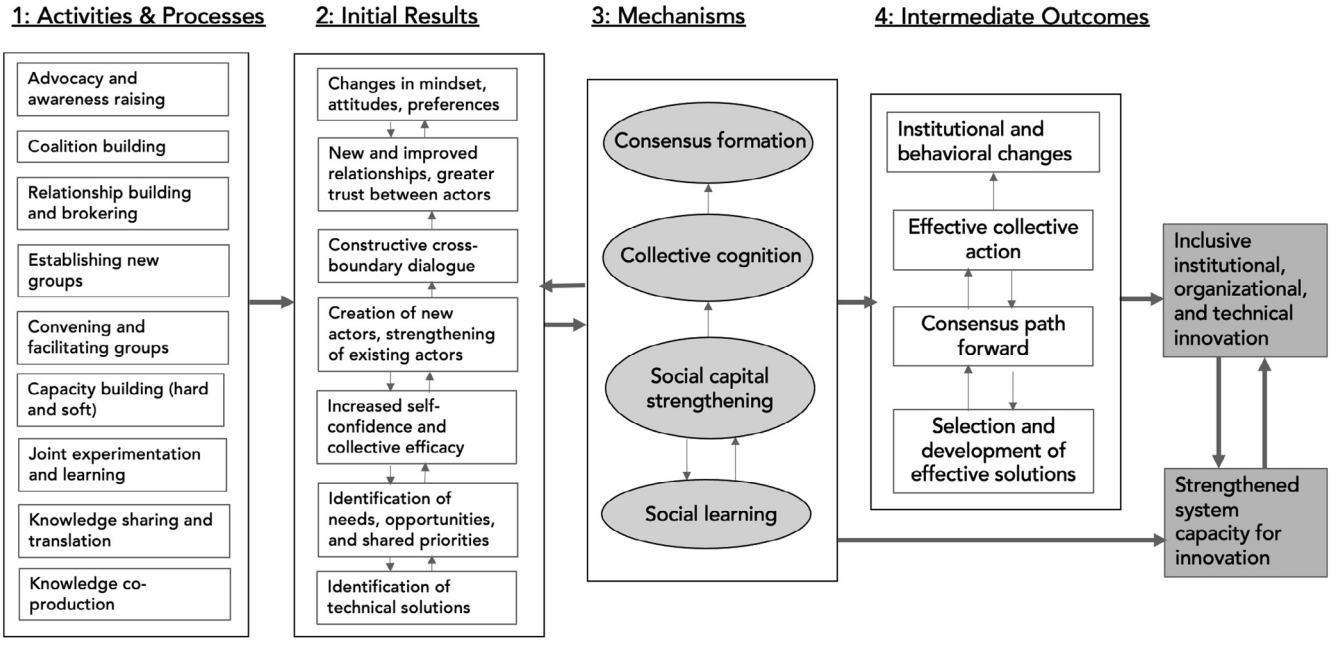

Fig. 3. Middle-range model for inclusive innovation processes.

essary for triggering the mechanisms). In none of the cases did social learning, social capital strengthening, collective cognition, or consensus formation result directly from project activities without the changed contextual conditions highlighted in Column 2 of the model.

Related to this is a third significant feature of the *modus operandi*: while some causal connections are linear (new multi-stakeholder groups producing changes in mindsets and preferences of group members, for example), many are circular, functioning as feedback loops. This feature is depicted vertically within components of the model and horizontally across them. For example, reinforcing feedback loops existed among several of the initial results, and also between initial results and causal mechanisms: processes of social capital strengthening, for example, resulted from successful initial efforts to build trust and improve relationships between diverse stakeholders, and—once set in motion—contributed to these efforts as well.

4.2. Description of model components

The cross-case synthesis resulted in the identification and literal replication across cases of the component processes of the three inclusive systems innovation initiatives. The relevance of this result lies in the role that identification of these processes plays in the enterprise of successful middle-range theory building (Pawson, 2013, pp. 88-93). Once these necessary components are identified, the empirical task in subsequent case study research, evaluations, and program theory development exercises becomes more focused and concrete. There is no longer a need to investigate, track, or measure every conceivable aspect of a program; rather, the researcher or evaluator can focus on testing, refining, and building theory from an existing, well-defined conceptual framework. The model's components are briefly described in this section to facilitate this kind of subsequent use.

4.2.1. Common activities and processes

The cross-case analysis resulted in the identification of nine common processes (Fig. 3, Column 1) that were highlighted by case authors as playing a significant role in bringing about inclusive innovation in each case. These processes were set in motion and sustained through activities implemented and facilitated by the project teams that catalyzed (and initially led) each of the innovation processes. These processes are described briefly below:

1) Knowledge production and co-production, including laboratory research, applied scientific research, modeling and various forms of analytic research, and community-level research on local issues, context, needs, opportunities, and priorities;
2) The sharing and translation of knowledge between different stakeholder groups and stakeholder types, particularly stakeholders on different sides of occupational, geographic, cultural, class, ethnic, or other "boundaries" (Queste and Wassenaar, 2019).
3) Processes of joint experimentation and co-learning, such as participatory action research (PAR), farmer-researcher joint field trials, iterative co-design sessions, and scenario co-development with diverse stakeholders;
4) Processes of capacity building, focusing on both "hard" technical capacities (related to the domain of innovation and the innovation process) and "soft" capacities (related to working effectively in groups, leadership skills, organizational skills, public speaking and advocacy, and the like);
5) Convening and facilitation of groups at different levels, ranging from community-level farmers' groups to regional, multi-actor stakeholder groups and platforms;
6) The establishment of new groups and decision-making bodies—particularly farmers' or producers' groups in cases in which they were not previously organized—as well as multi-stakeholder steering committees, associations, platforms, and coalitions;
7) Processes of relationship building and brokering, including facilitating the formation of new relationships among diverse stakeholders and strengthening existing relationships through the facilitation of more frequent and/or different forms of interaction, such as through the activities related to convening groups (number 5 above);
8) The building of formal and informal multi-stakeholder coalitions around a shared vision, agenda, and set of priorities; and finally,
9) Advocacy and awareness-raising activities designed to build public awareness around specific aspects of the innovation initiative, change opinions and mindsets, and influence behaviors or actions of specific target groups (producers, consumers, local decisionmakers, and/or legislators and policymakers).

While some of these processes were consistently implemented towards the beginning of interventions and others tended to appear in later phases, at least three (and often more) processes were unfolding simultaneously at all points in time across all three cases (see Fig. 4 below and Fig. 1 above for an illustration of how these activities were sequenced in two of the cases). Data from the within-case analysis indicated that it was not the activities or processes themselves, but rather the interactions between them, that produced initial results, which in turn created the contextual conditions necessary to trigger the causal mechanisms responsible for bringing about inclusive innovation.

4.2.2. Common initial results

In each of the three cases, the interactions between the different processes produced a consistent set of initial results, which changed the local context for inclusive innovation. These initial results were: 1) changes in mindsets, attitudes, and preferences among key stakeholders; 2) new and strengthened relationships between stakeholders and members of the relevant local systems, including greater trust between stakeholders; 3) constructive dialogue between diverse actors; 4) the creation of new actors in the system (such as new groups, bodies, or associations) and the strengthening of existing actors; 5) increased self-confidence and self-efficacy within individuals, and collective efficacy within groups; 6) the identification of needs, opportunities, challenges, and shared priorities; and 7) the identification of relevant technical solutions to shared challenges.

The causal relationships between project activities and initial results are represented graphically through the case-level impact pathway diagrams (see Fig. 2 above and Fig. 5 for examples). The nine common processes are listed on the left, clustered by color. Arrows are drawn from processes to the initial results (white boxes) and mechanisms (light grey boxes) that were triggered by the dynamic interactions between these processes and initial results. In the abaca rehabilitation case (Fig. 2), for example, the identification of shared interests and priorities was achieved through a combination of community-based research (needs identification, community visioning, and surveys), joint action research (PAR and iterative focus group discussions with farmers), and the formation and facilitation of new groups, including community-level farmers' groups and a multi-stakeholder, regional abaca coalition.

Likewise, the ability to achieve constructive dialogue between the various project stakeholders in the abaca case resulted from no less than six processes, including the establishment, convening,

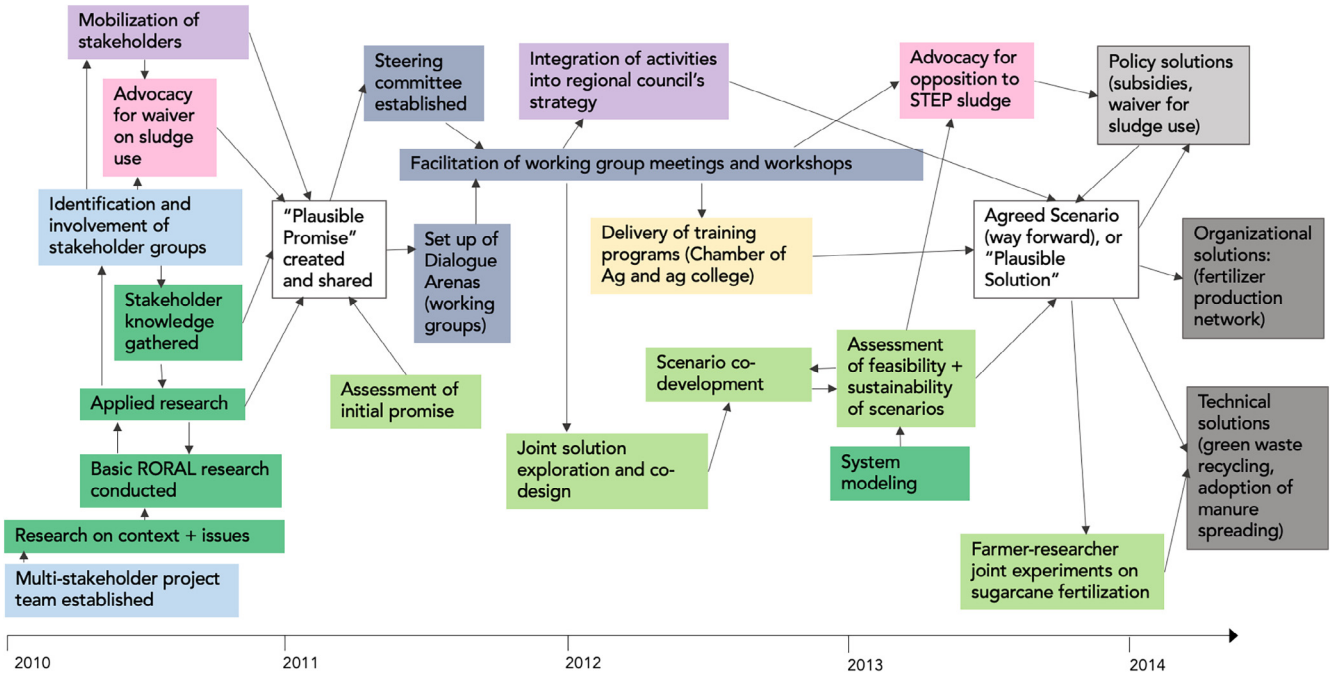

Fig. 4. Case-level process diagram for the organic waste recycling case on Réunion Island (MSCD).

and facilitation of new groups; the capacity building of members of these groups (particularly of farmers); and the production, sharing, and translation of scientific and practical knowledge between different types of stakeholders, specifically farmers, research staff, and institutional stakeholders. This initial result, in turn, played a key role in achieving a series of intermediate outcomes—including strengthening relationships and building trust between actors—that contributed to triggering the higher-level processes described in the next section. A similar pattern of causality can be observed in the impact pathway diagram for the organic waste recycling process on Réunion Island (Fig. 5).

In this case, a combination of initial processes, including relationship building and brokering with stakeholders; establishing, convening, and facilitating groups; and translating and sharing the results of basic and applied research, contributed to generating constructive dialogue among diverse stakeholders. This constructive dialogue contributed to processes of social learning, collective cognition, and the strengthening of social capital among stakeholders. This strengthened social capital, in turn, positioned stakeholders to be able to take effective, mutually beneficial collective action, such as advocating for changes to rules governing waste disposal. The ability to engage in joint advocacy and coordinated action is even more noteworthy in this case, given that key stakeholders were locked in conflict with each other at the outset of the case (Queste & Wassenaar, 2019). The next section describes how mid-level concepts such as social capital and collective cognition are used in the model, and describes the importance of these processes for bringing about inclusive innovation.

4.2.3. Common causal mechanisms

The cross-case analysis identifies four processes that were triggered by interactions between the project-facilitated activities and the initial results these activities were producing, functioning as causal mechanisms in the inclusive innovation process. These higher-level processes were social learning, social capital strengthening, collective cognition, and consensus formation among the diverse stakeholders engaged in the innovation process. Fig. 6 presents a simplified version of the middle-range model at a level of abstraction that is one step higher than that in Fig. 3, to draw attention to these causal mechanisms and the role they play in bringing about inclusive innovation.

Koelen and Das (2002) define social learning as the process through which groups of people learn by jointly defining problems, searching for and implementing solutions, and assessing the value of solutions for specific processes. Under the right conditions, social learning can take place when groups of diverse stakeholders engage in joint experimentation, action research, scenario co-design, and other activities that typically occur as part of participatory design, research, and/or innovation programming. In the three analyzed cases, processes of social learning started to unfold once several contextual conditions (initial results) had been established. These included the creation of constructive dialogue between diverse stakeholders, which enabled them to learn about challenges and opportunities from distinct perspectives; the identification of shared challenges, needs, and priorities, which enabled stakeholders to relate to each other and identify mutually relevant solutions; and the joint identification of plausible technical solutions, which built participants' confidence in the process and stimulated commitment to remain engaged in further joint research, experimentation, and co-learning.

Once processes of social learning were underway, they contributed to building social capital among participants and creating conditions necessary for collective cognition. Social capital refers to resources such as information, trust, and norms of reciprocity that exist within a group or social network (Woolcock, 1998). These resources make it easier for group members to connect effectively with each other (known as bonding capital) and with other individuals or groups (bridging capital). Both of these connection types play important roles in processes of inclusive innovation. Uphoff and Wijayaratna (2000) further develop the concept of social capital to identify "structural" and "cognitive" forms of social capital. Structural social capital includes roles for decision-making, resource mobilization, communication, and conflict resolution, as well as rules, procedures, and social networks that serve to structure ongoing patterns of social interaction (ibid). Cognitive social capital includes "norms, values, attitudes and beliefs that predispose people to cooperate" (ibid., p. 1876).

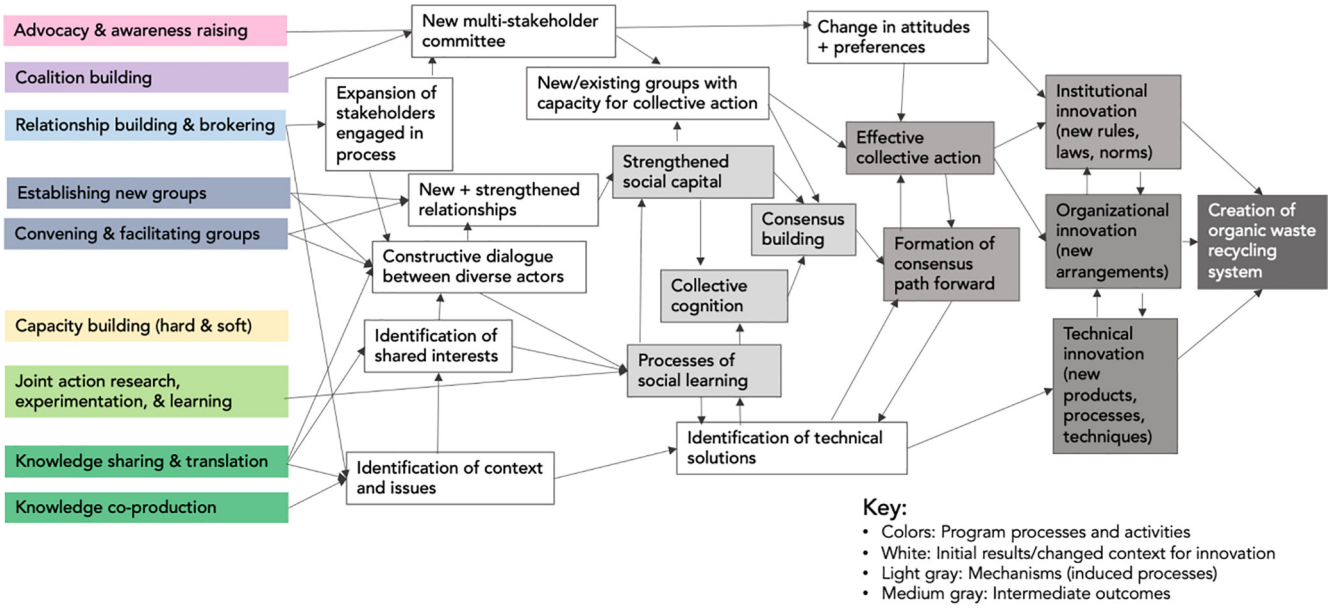

Fig. 5. Case-level impact pathway for the organic waste recycling case on Réunion Island (MSCD).

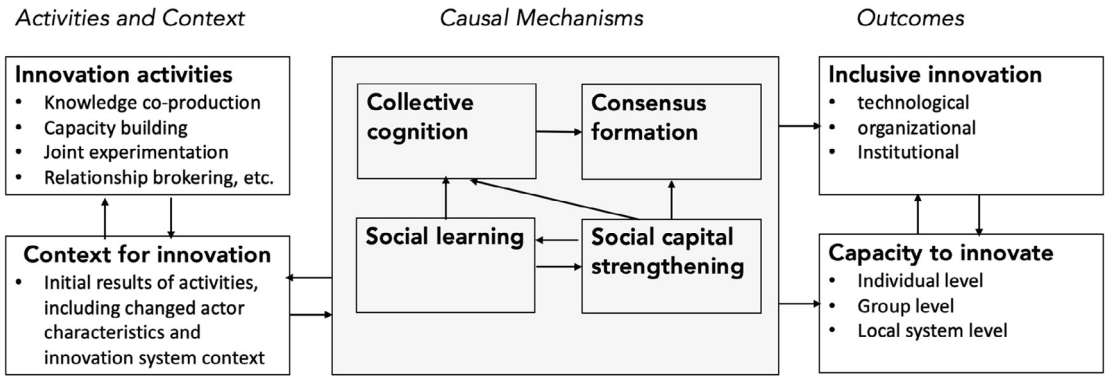

Fig. 6. Middle-range model of inclusive innovation processes at the level of context, mechanisms, and outcomes.

These cognitive forms of social capital, combined with experiences of social learning, create the conditions for collective cognition to occur. Collective cognition refers to the process through which individuals with diverse initial viewpoints and perceptions of reality develop shared perspective, insights, and values, particularly in terms of their understanding of the current situation, challenges, and opportunities for change (Devaux et al. 2009). In processes of inclusive innovation, in which stakeholder groups are diverse and situated on different sides of occupational, cultural, language, and other boundaries, processes of collective cognition contribute to generating a consensus understanding of potential pathways for technical, organizational, and institutional change.

This consensus understanding, in turn, is an essential ingredient in processes of consensus formation, which also require the convening and facilitation of stakeholder groups with the capacity for effective decision-making. In each of the three analyzed cases, processes of consensus formation preceded a turning point in the innovation process, in which diverse stakeholders were able to agree on what I call a "consensus path forward," consisting of a shared vision, consensus scenario, or joint action plan. The process of consensus formation, therefore, when combined with strengthened relationships and relationship infrastructure (social capital), make possible what Uphoff and Wijayaratna (2000) call mutually beneficial collective action (MBCA), one of the four intermediate outcomes that, in each case, were necessary ingredients for bringing about inclusive innovation.

4.2.4. Common intermediate outcomes

Once a consensus path forward was agreed upon, this path contributed to stakeholders' ability to take effective collective action, as noted above, and to their ability to select relevant innovations to adopt from among the various options that previous processes of research, experimentation, and learning had identified. In the case of organic waste recycling in Réunion, once the various stakeholders had agreed on a shared scenario (termed "Plausible Solution"), which narrowed down the potential sources and uses for organic waste, farmers and researchers began joint experiments on options for fertilizing sugarcane fields with organic waste (technical innovation), and a group of business stakeholders took action to create a fertilizer production network (organizational innovation) (Queste and Wassenaar, 2019). In the case of native potato commercialization in Peru (Fig. 7) once a strategic vision was agreed upon, stakeholders were able to prioritize additional technical research, which led to the development of new potato products, a new brand for native potatoes, and the identification of new markets and marketing methods (Devaux et al. 2009).

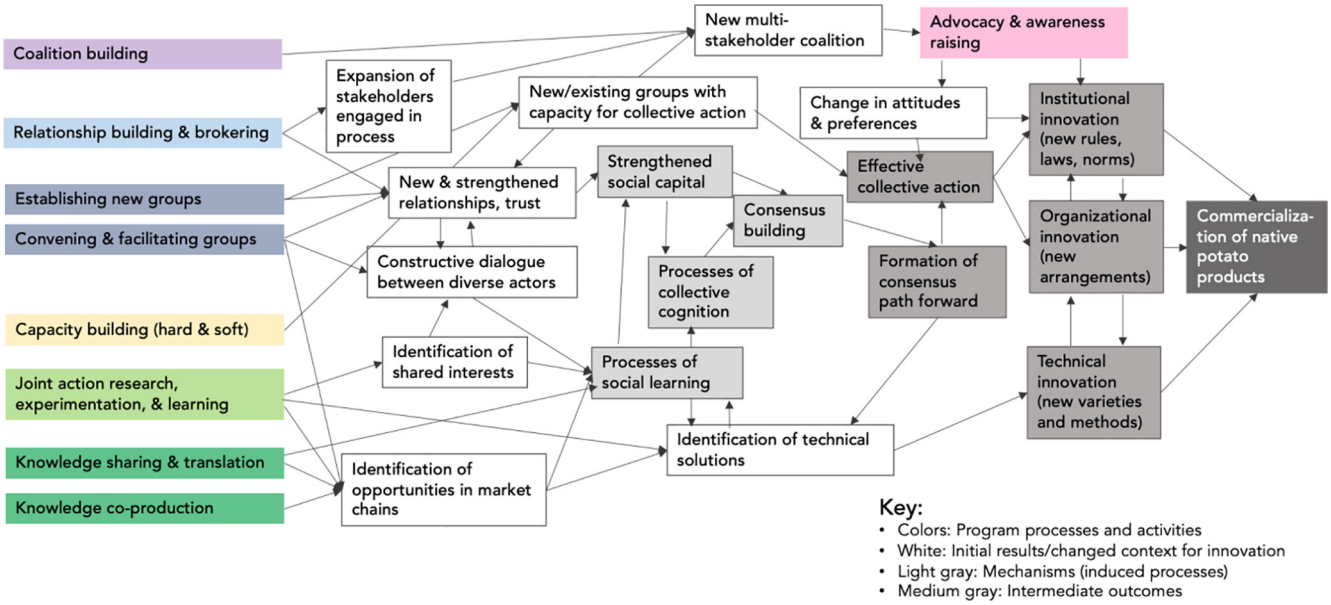

Fig. 7. Case-level impact pathway for the potato commercialization case in Peru (PMCA).

5. Discussion

5.1. Implications for project learning, monitoring, and evaluation

The middle-range model developed from the cross-case synthesis offers insight into how inclusive innovation processes unfold in the context of agricultural systems, adding concrete theoretical propositions to more general observations from the existing literature. Where previous studies noted that inclusive innovation processes involve interlinked activities that unfold in unpredictable and mutually reinforcing ways (Triomphe et al., 2016), this synthesis uncovered what those processes were in the context of three specific cases, and how they interacted to produce technical, organizational, and institutional innovations.

This analysis identified that processes and project activities do not interact with each other to directly produce innovation; rather, they interact with each other to produce initial results, which change important aspects of the local system context for inclusive innovation. These changed contextual factors interact dynamically with each other and with ongoing project activities to trigger additional higher-level processes (mechanisms like collective cognition and consensus formation) that are of fundamental importance to producing inclusive innovation in smallholder-oriented agricultural systems. The identification of intermediate results in the inclusive innovation process enables us to look beyond the specific facilitation methodologies or techniques that are used in any given project, to what those techniques are producing and the mechanisms they are triggering.

Regardless of whether a project facilitates cross-boundary dialogue using co-design activities or participatory research activities or field trials or scenario development, for example, the middle-range model suggests that what matters is that activities are implemented in a way that leads to the necessary intermediate results, such as effective dialogue between diverse stakeholder groups. The model enables a shift in focus from the particular, locally-adapted activities that are implemented in a project—and the specific methodologies used for facilitating them, which can vary across organizations and projects—to the results those activities produce, and whether these results are triggering the necessary mechanisms. This, in turn, can provide project teams with a consistent, replicable framework to understand and assess their innovation processes, while maintaining the flexibility to choose highly specific, locally adapted facilitation approaches as needed.

5.2. Limitations, reflections, and directions for further research

The cross-case synthesis and resulting middle-range model presented in this paper offer a point of departure for building a realist theory of change for inclusive systems innovation processes in the context of smallholder-oriented agricultural systems in the Global South. Several additional steps would be useful to develop that theory into a fully testable proposition for future research. Following realist analytical methods, the current model as depicted in Fig. 6 specifies overall causal patterns between contextual factors (C), mechanisms (M), and outcomes (O), but does not offer more specific CMO configurations from within the model. Further realist synthesis conducted on a larger number of cases is needed to identify these more granular CMO configurations for subsequent empirical testing.

A second limitation and area for subsequent analysis relates to further specifying which of the programmatic components of the model are necessary for success under different initial contexts. This specification could be accomplished by replicating the analysis conducted for this paper on a larger number of cases selected according to the same criteria (for literal replication); by seeking theoretical replication through selecting cases of inclusive innovation processes in other complex systems, such as health systems or local education systems; or by combining these strategies in a single study (Yin, 2018).

The need for this additional model-testing and model-specifying work points to a a third limitation of this paper, which is its relative silence on the meta-question of how the analytical approach employed to middle-range model development can itself be assessed and refined in subsequent studies. While a full discussion of this point is outside the scope of this paper, some initial reflections are warranted. With regard to Scriven's (1974) concept of *modus operandi,* for example, this concept proved useful as a general methodological signpost to orient the research towards identifying common causal patterns across the cases, but did not offer a sufficiently specific or practical approach for actually doing so. Instead, this approach was identified within the realist evalua-

tion literature, specifically in realist approaches to building middle-range theories of change.

The realist evaluation literature provides ample guidance on general approaches towards the development of middle-range theories of change, which offered a more concrete path towards identifying the shared causal patterns across the cases. Some ambiguity is nevertheless present in this literature on how to construct a middle-range theory of change that incorporates multiple CMO configurations, rather than a theory of change for each CMO grouping. This paper therefore made several methodological leaps in applying the general realist guidance in a specific way that was tailored to existing theory and conceptual frameworks within the agricultural innovation systems (AIS) literature. A more detailed methodological note on how this approach could be replicated, refined, and utilized in future studies would be valuable.

6. Conclusions

The model developed in this paper therefore offers a starting point, rather than an end, to building middle-range theories of change for inclusive innovation processes. This current articulation nevertheless addresses the conceptual gap in the inclusive innovation literature noted in the introduction, and yields practical implications for both the research and practice of inclusive innovation. In terms of the existing literature on inclusive innovation in general, and inclusive innovation in agricultural systems in particular, this paper specifies a model of these processes at the level of abstraction necessary to enable its empirical testing, validation, and refinement. This stands in contrast to descriptions of inclusive innovation processes that are either too general or too specific to the details of particular cases to facilitate their use as a starting hypothesis for subsequent case study research or evaluations of inclusive innovation processes.

In terms of the realist evaluation literature from which this paper draws theoretically, conceptually, and methodologically, the development of the middle-range model provides an illustration of the applicability of concepts and analytic methods, such as theories of change and CMO configurations, outside the scope of formal evaluations where they have typically been utilized. This paper demonstrates that these concepts, methods, and analytical tools can be employed fruitfully in ex post research of complex processes that are not strictly conceived of as programs, and by researchers who are not formally evaluating these processes, but rather conducting causal research for other purposes.

Finally, in the domain of practice, this model has implications for project planning, monitoring, and evaluation as noted in Section 5.1, and yields concrete recommendations with regard to the capacities required to successfully lead and facilitate inclusive innovation processes. The paper confirms recommendations from previous works (Douthwaite and Hoffecker, 2017; Faure et al., 2018; Grovermann, 2017; Leeuwis et al., 2014; Klerkx et al., 2009; Triomphe et al., 2016) stating that facilitators of innovation processes must possess diverse skillsets and capacities, as there is a need to support processes ranging from those typically associated with innovation initiatives, such as knowledge production and the facilitation of joint experimentation, to processes more commonly associated with collective action initiatives, social movement building, and community organizing.

The model presented in this paper offers not only a list of specific processes that need support and facilitation, but also a theory about how these processes relate to each other to produce innovation. The complex and mutually reinforcing relationships identified by the model lend further support to recommendations from the literature suggesting that teams facilitating inclusive innovation processes must possess skills related to adaptive management (Devaux et al., 2011; Klerkx et al., 2012; Klerkx et al., 2010). Key among these is the capacity of project teams to learn in real time and to translate and share that learning with different types of stakeholders engaged in the project. In the context of inclusive innovation processes, in which stakeholders are often positioned with widely varying levels of privilege and access to information and resources, the ability of a project team to effectively translate knowledge and lessons learned in a timely way is essential, as highlighted by the Papa Andina team in their reflections on overarching factors that contributed to the success of their project (Devaux et al., 2011; Thiele et al., 2007).

Despite growing evidence on the fundamental importance of adaptive management for inclusive innovation processes, prominent development actors—ranging from international research institutes and non-governmental organizations to major international donor agencies and foundations—continue to operate with and often require ex ante logframe- and workplan-driven project planning approaches that substantially constrain the flexibility required to manage adaptively (Schurman, 2018). A complexity-aware, middle-range theory of change, such as the one presented in this paper, can provide implementers and donors with a practical framework for structuring their interventions that, while still predefined, focuses on detecting and managing towards emergent results. As such, it has the potential to function as a "boundary object" (Queste and Wassenaar, 2019) that "makes sense to people on both sides of the boundary" (ibid, p. 4) and can be used to build shared understanding of what constitutes meaningful results.

The model presented in this paper therefore offers a promising middle path between the top-down, strategy-driven project planning approaches favored by some of the "new philanthropists" driving international agricultural development (Schurman, 2018) and the emergent "flexible, open-ended, iterative approaches" advocated by Triomphe et al. (2016), van Mierlo et al. (2010) and other agricultural researchers, who have concluded that these processes are so complex that they simply "cannot be planned from the outset" (Triomphe et al., 2016, p. 179). Middle-range theories of change offer a bridge between these two largely incompatible positions. As such, they promise a practical path forward for those needing to navigate between requirements for project planning and accountability, and the kind of flexible, adaptive process facilitation that is required to bring about inclusive local systems innovation.

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8. Submission declaration

I affirm that the work in this paper is entirely original work which has not been published previously in any format or source, and that it is not under consideration for publication elsewhere. I further affirm that the publication of this paper is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other

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CRediT authorship contribution statement

Elizabeth Hoffecker: Conceptualization, Funding acquisition, Project administration, Investigation, Methodology, Formal analysis, Visualization, Writing - original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Table of sources for cases included in the cross-case analysis

SOURCE CITATION	SOURCE TYPE
Case #1: Organic waste recycling on Réunion Island (MSCD)	
Faure, G., Barret, D., Blundo-Canto, G., Dabat, M., Devaux-Spatarakis, A., Le GuerrouÕ, J.L., MarquiÕ, C., MathÕ, S., Temple, L., Toillier, A., Triomphe, B. & Hainzelin, E. (2018). How different agricultural research models contribute to impacts: Evidence from 13 case studies in developing countries. Agricultural Systems. 165: 128136.	Journal article
Faure, G., Blundo-Canto, G., Devaux-Spatarakis, A., Le GuerrouÕ, J.L., MathÕ, S., Temple, L., Toiller, A., Triomphe, B. & Hainzelin, E. (2020). A participatory method to assess the contribution of agricultural research to societal changes in developing countries. Research Evaluation. 29(2): 158170.	Journal article
Queste, J. & Wassenaar, T. (2019). A practical dialogue protocol for sustainability science to contribute to regional resource management: implementation in Réunion. Natural Resources Forum 43: 316.	Journal article
Wassenaar, T. & Queste, J. (2015). Co-designing organic residue recycling chains in off-balance regions. Conference Proceedings of the 5th International Symposiums for Farming Systems Design. Montpellier, France. pp. 227228.	Conference paper
Wassenaar, T., Queste, J. & Barret, D. (2015). Co-design of regional organic residue recycling scenarios. ImpresS Case Study Card. CIRAD. Accessed 10/29/19 at: https://impress-impact-recherche.cirad.fr/ex-post/case-studies/organic-residue-recycling	Program web resource
Wassenaar, T., Doelsch, E., Feder, F., Guerrin, F., Paillat, J.M., Thuries, L. & Saint Macary, H. (2014). Returning Organic Residues to Agricultural Land (RORAL)- Fueling the Follow-the Technology approach. Agricultural Systems. 124: 6069.	Journal article
Case #2: Abaca rehabilitation in the Philippines (RinD)	
Douthwaite, B., Apgar, M., Schwarz, A., McDougall, C., Attwood, S., Senaratna Sellamuttu, S. & Clayton, T. (2015). Research in development: learning from the CGIAR research program on aquatic agricultural systems. In: Penang: CGIAR Research Program on Aquatic and Agricultural Systems. Working Paper. AAS-201516.	Program report
Douthwaite, B. & Hoffecker, E. (2017). Towards a complexity-aware theory of change for participatory research programs working within agricultural innovation systems. Agricultural Systems. 155: 88102	Journal article
Dugan, P., Apgar, M. & Douthwaite, B. (2013). CGIAR research program on aquatic agricultural systems. Penang, Malaysia. In: Working Paper, Retrieved on 20 December 2019 from http://aquaticcommons.org/11247/1/AAS-RIND-Approach.pdf	Working paper
Paz-Ybarnegaray, R. (2015). Outcome Evidencing Report 2014: VisMin Hub, Philippines AAS CRP. CGIAR research program on aquatic agricultural systems. Penang, Malaysia.	CGIAR AAS evaluation report provided by B. Douthwaite
Paz-Ybarnegaray, R. & Douthwaite, B. (2017). Outcome evidencing: a method for enabling and evaluating program interventions in complex systems. American Journal of Evaluation. 38(2): 275293.	Journal article
Case #3: Native potato commercialization in Peru (PMCA)	
Albu, M. & Griffith, A. (2006). Mapping the market: participatory market-chain development in practice. Small Enterprise Development. 17(2):1 222.	Journal article
Anonynous. (2008). Farming families benefit from Peruvian potato project. Appropriate Technology; 35;1, 3536.	News piece re-published in Appropriate Technology

Appendix A (*continued*)

SOURCE CITATION	SOURCE TYPE
Antezana, I., Bernet, T., Lœpez, G., & Oros, R. (Eds.) (2008). Enfoque Participativo en Cadenas Productivas (EPCP): GuÚa para capacitadores. Centro Internacional de la Papa, Lima, Peru.	Electronic book
Devaux, A., Ordinola, M. & Horton, D., (Eds.) (2011). Innovation for Development: The Papa Andina Experience. International Potato Center, Lima, Peru.	E-book compiling a previously published peer-reviewed articles, working papers, and other pieces by Papa Andina collaborators.
Devaux, A., Horton, D., Velasco, C., Thiele, G., Lopez, G., Bernet, T., Reinoso, I. & Ordinola, M. (2009). Collective action for market chain innovation in the Andes. Food Policy. 34: 3139.	Journal article
Meinzen-Dick, R., Devaux, A. & Antezana, I. (2009). Underground assets: potato biodiversity to improve the livelihoods of the poor. International Journal of Agricultural Sustainability. 7(4): 235248.	Journal article
Ordinola, M., Devaux, A., Manrique, K., Fonseca, C. & Thomann, A. (2011). Strengthening competitiveness of the potato market chain: An experience in Peru. Pp. 151160 in Devaux, A., Ordinola, M., Horton, D., (Eds.). Innovation for Development: The Papa Andina Experience. International Potato Center, Lima, Peru.	Chapter in e-book
Thiele, G., Devauz, A., & Horton, D. (2007). Horizontal Evaluation: Fostering Knowledge Sharing and Program Improvement Within a Network. American Journal of Evaluation. 28(4): 493508.	Journal article

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Devaux, A., Horton, D., Velasco, C., Thiele, G., Lopez, G., Bernet, T., ... Ordinola, M. (2009). Collective action for market chain innovation in the Andes. *Food Policy, 34*, 31–39.

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Faure, G., Blundo-Canto, G., Devaux-Spatarakis, A., Le GuerrouÕ, J. L., MathÕ, S., Temple, L., ... Hainzelin, E. (2020). A participatory method to assess the contribution of agricultural research to societal changes in developing countries. *Research Evaluation, 29*(2), 158–170.

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