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Metaorganizing Collaborative Innovation for Action on Grand Challenges

Lisa Callagher , Stefan Korber, Frank Siedlok , and Ziad Elsahn

Abstract—Grand Challenges are complex issues that require collaborative innovation among heterogeneous actors who draw upon contradictory institutional logics. While existing literature shows how social enterprises and individual organizations reconcile tensions between economic and environmental logics, scholars know less about how and when a broad set of actors adopt practices and priorities that balance economic and environmental values. This article explores how three agricultural cooperatives act as metaorganizations and facilitate collaborative innovation and sustainable transitions to address grand challenges regarding land use. We find that the cooperatives stimulate awareness of environmental challenges and local experimentation, orchestrate collaborative solutions by enrolling and engaging a broad set of actors, and coordinate the diffusion of novel practices across the institutional field. We add new insights into producer cooperatives' role as metaorganizations in facilitating the creation, validation, and diffusion of practices that balance business and sustainability. Based on our findings, we argue that by metaorganizing, producer cooperatives can galvanize field-level shifts in institutional logics through framing, knowledge sharing, and knowledge brokering mechanisms.

Index Terms—Agriculture, collaborations in technology management, collective action, environmental issues in technology management, innovation management, knowledge management, knowledge transfer.

I. INTRODUCTION

LARGE, complex issues with a global impact, referred to as grand challenges (GCs), pose societal, technological, and developmental tensions that require unconventional approaches to resolve them [1], [2]. Land use, the focus of this article, is a GC faced by agricultural organizations involved in land-based food production [3]. Industrialized agriculture has exacerbated land degradation by draining natural aquifers for farming, polluted land and water with effluent run-off, and

creating food safety concerns through residues [4]. Extreme weather events that cause droughts and soil erosion further intensify these issues and damage other biological ecosystems, including ocean health, freshwater, and food security [5], [6]. To address GCs, a wide range of heterogeneous actors [1], [7], [8] must collaborate to develop innovative solutions that integrate and reconcile environmental and economic interests [9]–[12].

Scholars have used institutional logics [13]–[15] to theorize the conflicts and tensions between environmental and economic aspects central to GCs. While this literature constitutes a valuable starting point to understand the mechanisms that allow organizations to reconcile competing logic in the face of complex societal problems [1], [16], research has focused predominantly on how this is achieved within newly established organizations (e.g., social- and eco-entrepreneurship). In contrast, we know less about the processes of hybridization, in which mature organizations “*move early to embrace a previously unfamiliar institutional logic [such as] environmentalism*” [17, p. 5]. Further, in focusing on how logics are reconciled within individual organizations [18], extant research has said little about how novel practices that are beneficial from an economical and an environmental perspective are collaboratively developed and diffused across organizations. Recent literature points to the importance of metaorganizations for the development and diffusion of such practice and their mechanisms to assemble relevant actors, align their conflicting interests and values, and facilitate collaboration [7].

Metaorganizations are organizations-of-organizations that share system-level goals, which members jointly produce, monitor, and sanction [18], [19]. This interdependence among legally autonomous entities positions them to facilitate fruitful interactions among “*organizations with competing logics*” [5, p. 3] and enables dialogue across heterogeneous organizations that facilitates collaborative development [20]. Metaorganizations can diffuse new meanings and practices that span different logics and enable coordinated, large-scale responses to significant issues [21]–[23]. Producer cooperatives are a form of metaorganization [24] that can “*meta organize*” for land-use GCs as they can offer an established way of reconciling environmental and commercial interests [25]–[28]. However, tensions related to conflicting logics often remain strong and prevent producer cooperatives from achieving environmental and economic goals [29]. Existing literature suggests that coordination efforts of producer cooperatives among their members can lead to the development and adoption of new, innovative practices [30].

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Such collective action that leads to collaborative innovation is essential as cooperative members usually lack the resources to innovate independently [31]. But it remains unclear how producer cooperatives can metaorganize for the emergence of such new practices that address GCs [7], [24], [32]. Thus, we ask: How do producer cooperatives metaorganize the development and diffusion of practices that address GCs?

To address this question, we focus on the role of knowledge coordination in attempts to metaorganize collaborative innovation in the face of GCs. Knowledge coordination refers to how fragmented forms of localized knowledge are mobilized and integrated [10]. Organizations coordinate knowledge through sharing and brokering activities, including transcoding or translating knowledge between different domains [9], [33]–[35]. We analyze the knowledge mechanisms used by three producer cooperatives as they sought to develop new practices in response to land-use GCs. Our findings reveal that metaorganizing facilitates awareness of environmental challenges and local experimentation, involves and engages a broad set of actors to develop solutions collaboratively, and diffuses and endorses novel practices across the institutional field.

The rest of this article is organized as follows. The following section reviews existing literature on institutional logics, focusing on hybridization processes, and introduces producer cooperatives as metaorganizations. It sets out knowledge coordination as a useful approach for understanding how metaorganizations develop new practices. We then outline our empirical approach and present findings of the collaborative development and diffusion of novel agricultural practices within the metaorganization. Finally, we discuss our findings in light of extant theory and conclude by outlining their practical implications.

II. THEORETICAL BACKGROUND

We integrate insights from three theoretical perspectives to understand how producer cooperatives develop and diffuse practices that reconcile economic and environmental concerns to address GCs. First, we provide an overview of the institutional logics literature that argues that addressing GCs requires reconciling contradictory institutional logics through hybridization processes that balance economic and environmental sustainability. But for such responses to be impactful in addressing GCs, they need to diffuse beyond single organizations into the wider field. We, therefore, turn to the literature on metaorganizations, which illustrates how metaorganizing enables collective action by facilitating collaborative innovation among many actors through the orchestrated development and adoption of new practices that span contradictory logics. Central to collaborative innovation is knowledge coordination that aligns actors' diverse goals, perspectives, and abilities and facilitates knowledge sharing among actors to develop, adopt, and diffuse new practices. We, therefore, turn to the knowledge coordination literature to provide an overview of these knowledge mechanisms.

A. Institutional Logics and Processes of Hybridization

Ferraro *et al.* [1], p. 364] noted that solutions to GCs necessitate “a form of institutional change” where societal values, practices, and priorities shift from economic considerations to

environmental concerns. Scholars increasingly invoke institutional logics to theorize this shift [15]. Institutional logics refer to societal “rules of the game,” such as collective values and norms that “shape individual preferences and organizational interests as well as the repertoire of behaviors” [36], p. 232]. For instance, Lee and Lounsbury [14], pp. 851, 856] described an emerging “proenvironmental” logic that is “based on enduring environmental beliefs and practices” and a “commitment to protect or improve the natural environment as well as its willingness to act or pay to achieve its objective.” Fuenfschilling and Truffer [13], p. 781] identified a “water sensitive logic” to theorize the increased regulatory focus “on environmental[ly] sustainable development, mainly regarding the introduction of environmental water allocation and restoration of water health.”

There is, however, an inherent tension between sustainability-oriented logic and economic-centered logic that privilege practices directed toward profit maximization [13], [15]. Literature on private collective action and nonhierarchical management of common-pool resources explores these logics' tensions [37]. It finds that the processes of integrating and reconciling contradictory logics, so-called hybridization, involve three distinct but overlapping phases.

- 1) Enhancing actors' understanding of the problematic aspect of practices associated with a dominant logic and exposing them to emerging alternative institutional logics can trigger reflective actors' awareness and enable the experimentation with alternative practices [38], [39].
- 2) Collaborative development of novel practices that reconcile conflicting logics (e.g., environmental and economic sustainability) skillfully nurture and integrate the knowledge and priorities of diverse actors [1], [40], [41].
- 3) The diffusion of novel practices beyond the collaborative context in which they are developed requires the adoption and endorsement of a broad range of stakeholders who position new practices “as the natural and appropriate arrangement” [38], p. 61].

Most of this literature focuses on how small-scale initiatives, usually within single organizations, achieve hybridization [42]–[44]. Yet, more impactful responses to GCs depend increasingly on collective action where a broader range of organizations abandon principles associated with a dominant, economic-centered logic and embrace values and practices related to an emerging environmental logic [1], [17], [25]. Recent literature highlights the importance of metaorganizations, such as producer cooperatives, in facilitating the collaborative development and collective adoption of new practices that span contradictory logics [21]–[23].

B. Producer Cooperatives as Metaorganizations for Aligning Logics

Regarding land-use GCs, producer cooperatives may be able to “metaorganize” the development and diffusion of scalable solutions [24], [25], [27]. Producer cooperatives consist of members that maintain “control over the use and benefits of their labor power by establishing collective title to the means of production” [45], p. 373]. They operate on the principles of collective ownership, democratic member control, and member

economic participation [27]. These principles position them to develop and diffuse sustainable practices that effectively balance economic, social, and environmental concerns [24], [26], [28], [46], [47]. Nonetheless, it is challenging for producer cooperatives to develop innovative environmental practices because they experience conflicts between logics [29], [48]. For instance, the cooperative's environmental sustainability decisions might be incongruent with individual member producers' business practices and goals [49], [50]. While producer cooperatives might be able to align business and cooperative goals, achieve significant growth, and lead sustainable practices across global value chains [48], our understanding of how cooperation across organizations might embrace and reconcile these tensions remains limited [51]. We turn to the literature on metaorganizations, as these share a range of similarities with producer cooperatives.

Metaorganizations comprise member organizations that share system-level goals; they are bound by rules jointly produced, monitored, and sanctioned by their members rather than by formal authority [18], [19]. Metaorganizations can facilitate a broader transformation of norms and values [7] and respond to nonparadigmatic changes in innovative ways [22]. Berkowitz and colleagues suggested that metaorganizations are suited to addressing GCs because they provide an “*inter-organizational space for dialogue*” and act as “*knowledge brokers, meaning that they facilitate information sharing, production and diffusion, networking, and collective learning*” [5, p. 2]. Yet, their members' characteristics, goals, and strategies constrain them. Conflicting interests or values among and between members and the metaorganization are common and usually reflect the differences in members' size, power, and growth ambitions. Differences in how members identify with the metaorganization and its goals increase these tensions, especially if it alters how members operate or perceive themselves [18], [52]. Adopting new quality norms or sustainable practices can be particularly challenging because they require members to adopt new practices at odds with what they know and how they see themselves. As metaorganizations lack formal authority, they must rely on persuasion and consensus to reconcile these conflicts and tensions.

From their members' perspective, metaorganizations can enhance collaboration to achieve system-level goals [23]. More and less powerful actors must be equally invested [21]. However, persuasion and consensus are often insufficient to influence less powerful members [18], [19]. Their disinterest might stem from a lack of capabilities or understanding of the issues at hand [53]. Thus, metaorganizations must develop additional means to achieve goals that challenge existing practices and knowledge of diverse members. There are several ways to increase members' involvement. These include making structural changes toward more equitable participation in metaorganization decision-making [23], creating spaces for continuous interactions and dialogue among members [21], and purposefully rotating members' roles to avoid inertia and increase the potential for “creative tensions” to arise [22]. Such ongoing interactions can help reset and maintain common expectations and understandings [21] and facilitate learning and knowledge sharing among members [53]. Further, joining expert networks can allow metaorganizations to access external knowledge

[22]. These examples highlight the importance of knowledge coordination, although metaorganizations can enable involved actors to integrate and reconcile contradictory institutional logics [54].

C. Knowledge Coordination and the Role of Sharing and Brokering for Collaborative Innovation

Collaborative innovation depends on the transfer and combination of extant ideas, knowledge, and artifacts held by various actors [11], some of which lack direct connections [9]. In interorganizational settings, like metaorganizations, the actors' different goals, perspectives, and abilities to absorb new knowledge can threaten knowledge coordination [12], [55], defined here as the process of mobilization and integration of fragmented forms of localized knowledge [10]. Extant literature confirms knowledge sharing to be crucial in developing and adopting innovative practices [30] and aligning the interests and goals of involved parties [56]. Knowledge sharing relies on various mechanisms [57], which we define as the formal and informal structures, initiatives, and processes created to enable and encourage knowledge sharing and creation among groups and individuals. Knowledge-sharing mechanisms can promote adopting new ideas and behaviors [58], [59]. Knowledge coordination, and sharing, further depend on knowledge brokers and gatekeepers, who scan, acquire, store, and manipulate knowledge to make it usable for innovation by different groups of users and to facilitate communication [9], [60], [61]. We define knowledge-brokering mechanisms as the transcoding that makes complex knowledge meaningful to other actors [9].

In summary, metaorganizations, such as producer cooperatives, can instigate collective action and large-scale change to help to address land-use GCs. This can be achieved through knowledge mechanisms that enable collaborative innovation where actors develop and adopt new practices that reconcile contradictory values and goals. Yet, our knowledge of how producer cooperatives “meta-organize” the development and diffusion of new practices that address GCs remains limited. Thus, we attempt to provide insights into knowledge coordination and the underlying mechanisms.

III. RESEARCH CONTEXT AND METHODOLOGY

The multiple qualitative case study presented here is part of a five-year study of knowledge coordination in producer cooperatives that pursue market-oriented strategies. These cooperatives are vital to New Zealand's economy [48], [62]. We noticed several initiatives to address land-use GCs in the research program and pursued this lead. Producer cooperatives are also crucial in global agriculture [29]. As metaorganizations, they can affect the farming practices of their members [5], [25]. At the same time, they are complicit in the industrialized agricultural methods that have led to land-use GCs and face increased public scrutiny for their role in environmental degradation [63].

We adopted a multiple-case approach, consistent with guidance on research designs that support process theorizing about innovation-related phenomena [64]. Related research [21]–[23] also indicates that case studies are helpful when extending existing theory.

TABLE I
CASE OVERVIEW AND DATA SOURCES

Case	Case synopsis	Land Use challenges	Implemented solutions	Interview data	Archival data
Case study 1 (MZG)	Dairy processing and marketing; established export activities in 30 countries with a recognized consumer brand; Significant capital investment in recent years. 72 members and 190 staff during data collection.	Water consumption in production Fertilizer use in production Pesticide use in production	Innovative effluent pond systems Internal code of practices that go beyond minimum requirements Environment induction training for all members, staff, and contractors Private-public treated wastewater scheme	8 Interviews: 1x chairman & member; 5x management, 1x technician (interviewed twice)	29
Case study 2 (RVG)	Dairy processing and marketing; established exports to 40 countries; 390 members and 600 staff during data collection	Water consumption in production Effluent run-off Fertilizer use in production	Implementation of on-farm carbon-capturing activities Innovative effluent pond system Internal code of practice that goes beyond minimum requirements Animal husbandry practices to remove or reduce antibiotic use	10 Interviews: 3x management, 3x technicians, 3x member (incl. 1 ex-director and ex-staff), 1x non-member supplier	23
Archival data related to land use in dairy industry case organizations:					17
Case study 3 (KFG)	Horticulture post-harvest and orchard management; focused on small-volume producers. Product sold by marketing organization (Zespri) into 50 countries. 44 members and 12 staff during data collection	Water consumption in production Fertilizer use in production Pesticide use in production	New service offerings to assist members with fertilizer and water management Implementation of pest and disease management practices	7 Interviews: 1x board member, 1x CEO, 2 management, 1x technician, 2x members	14
Archival data related to land use in horticulture industry case organizations:					18
Total number of sources				24	101 items (1161 pages)

A. Case Selection

We used theoretical sampling and selected cases that promised unusual insights regarding our research interest [64]. We identified producer cooperatives responding proactively to changing customer demands through preliminary research (e.g., conversations with key informants and desk research) and a sustainability-oriented logic. For this study, we selected three cases: two from the dairy sector and one from the horticulture sector representing different land use challenges. These cooperatives' potential to galvanize broader shifts toward sustainability, combined with the "leading" role that several key informants ascribed to them, promised valuable insights into the phenomenon of interest [7], [25]. Table I provides background and data quantification for each case.

B. Data Sources

As per related research, we relied on interviews and archival data [5], [23]. We used both concurrently and gave neither primacy. We first built our understanding of these initiatives by reviewing available documents, which informed our

interview questions. We used the interviews in a narrative style to validate, expand, and enrich our knowledge [65], which allowed us to understand the proenvironmental initiatives and recognize the critical activities related to them. We then followed up by searching for and reviewing other relevant archival data. When appropriate, we returned to our participants with additional questions or sought access to internal documents. We conducted 24 face-to-face, semistructured interviews lasting 45–125 min with various actors, including board members, senior managers, employees, and member shareholders. We conducted all interviews in pairs, where the "passive" interviewer monitors the process and follows up on relevant questions [66]. We offered transcribed interviews to participants for their review as an additional measure to ensure data accuracy and reliability. One participant clarified the transcript, and none asked us to redact the material.

We used several archival sources: internal (annual reports, constitutions, and strategic documents regarding land use) and external (e.g., newsletters, quarterly performance reports, press releases, and submissions to Government on land use); organizational documents from each case; data from government

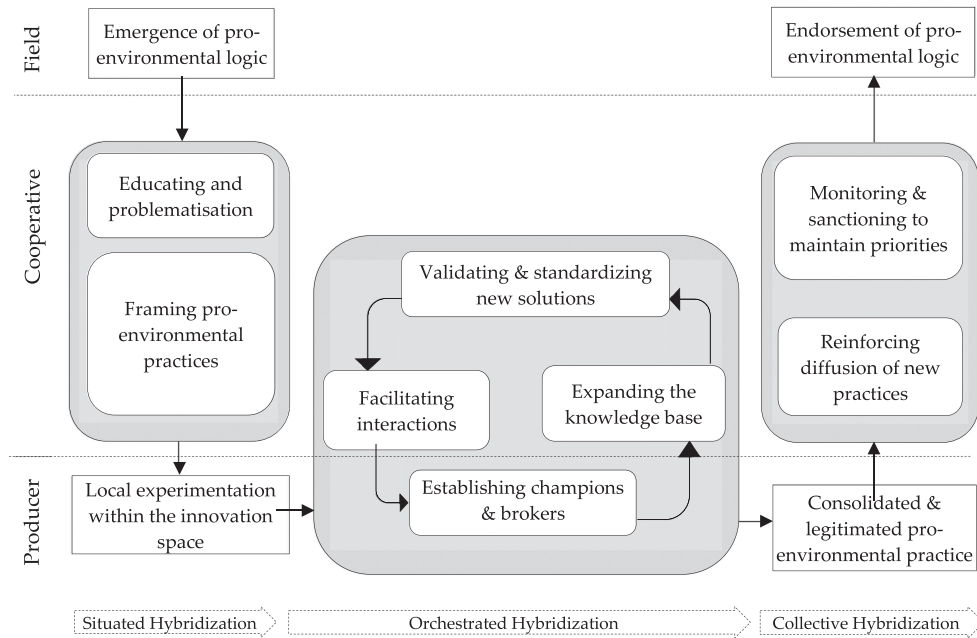


Fig. 1. Modes of hybridization that connect localized practices and field-level shifts for collective action.

agencies, stakeholder organizations, R&D providers (industry reports, white papers, and regulatory frameworks); and news articles, and academic papers related to land use in the dairy and horticultural sectors. These extend our understanding of the cooperatives’ metaorganizing knowledge mechanisms and how these galvanized broader shifts in values and practices.

C. Data Analysis

We adopted an abductive approach moving back and forth between themes from the data, concepts from the literature, and the emerging theory [67]. Initially, we stayed close to the data, utilizing codes, such as “*educating members through newsletters*,” “*organizing events to facilitate interactions*,” and “*utilizing opinion leaders*” to capture ideas. We then cross-referenced these codes with extant literature on knowledge coordination to derive more theory-informed mechanisms that the cooperatives employed (see the first column in Table II). By themselves, the knowledge sharing and brokering mechanisms remained insufficient to generate more processual insights into their interrelationships. Following Gioia *et al.*’s [68] advice, we considered our data in tandem with other theories in the third step to explore which ones best explain how the knowledge mechanisms fit together. Literature related to processes that underpin the reconciliation and integration of contradictory logics guided is to identify three modes of hybridization that differentiate between the “direction” of knowledge sharing and brokering and the outcomes produced. First, situated hybridization refers to top-down mechanisms around awareness of emerging proenvironmental institutional logics and recognizing the problematic aspects of current practices [38], [39]. These facilitate local experimentation with novel practices in an isolated fashion. Second, orchestrated hybridization refers to “horizontal” dynamics related to facilitating interaction between

a broad range of actors, embracing, championing, validating, and standardizing new solutions, and expanding the knowledge base. These enable the development of novel practices that the knowledge and priorities of diverse actors and their validation from multiple perspectives [40], [41]. Third, collective hybridization refers to the consolidation and legitimation of proenvironmental practices through “bottom up” mechanisms for monitoring and reinforcing broader diffusion. Table II summarizes these modes, the underlying knowledge mechanisms, references to existing theory, and empirical evidence.

We aggregated and abstracted our thematic codes into a theoretical framework (see Fig. 1) in the final step. The framework shows how the three modes of hybridization are enabled by distinct knowledge mechanisms and build upon each other, allowing the new logic to emerge.

IV. FINDINGS: FACILITATING PROENVIRONMENTAL PRACTICES

Our findings indicate that producer cooperatives mediate between field-level changes and their individual members’ businesses by facilitating collaborative development of practices that balance among demands of local members, the (global) market, and the (physical) environment. Reflecting the language of the context in which producer cooperatives operate, we find that these cooperatives serve three important roles, which are as follows:

- 1) planting seeds of change through situated hybridization;
- 2) selective breeding and nurturing of proenvironmental practices through orchestrated hybridization;
- 3) cultivating broader change across a broader range of stakeholders through collective hybridization.

TABLE II
CORE DYNAMICS AND KNOWLEDGE MECHANISMS

Core Concepts	Empirical Themes and Illustrative Data
<i>Situated hybridization: emergence of a pro-environmental logic</i>	Increased awareness and localized experimentation with novel practices [38], [41] in response to the emergence of a pro-environmental logic
Contextual trigger: Emergence of the pro-environmental logic	Shifts in systems of values, attention, public demand at aggregate level towards pro-environmental practices [13]–[15] Sustainability is recognized as one of the five pillars of the International Cooperative Alliance's (ICA) Blueprint for a Cooperative Decade ... the International Labour Organization (ILO), and ICA has launched an initiative on the contribution of cooperatives to sustainable development. This brief summarizes the main findings [71, p. ii] "There had been pressure building from a number of groups about run-off on farms, pollution of streams ... And it was a pretty much just sort of public pressure as much as anything. Plus, also the Government putting more pressure on regional councils to tighten regulations" (Int., GM Quality, RVG). Environmental and economic sustainability dominated debate at the second annual cooperative leaders' forum in New Zealand ... Delegates heard from representatives from the Ministry of Business, Innovation, and Enterprise; the Ministry for the Environment; and NZ Trade and Enterprise. They discussed ...key environmental issues for agri-producer co-ops. [88]
Mech1: Educating members in issues related to market and regulatory dynamics and problematization of current practices	Cooperative-level initiatives (e.g., newsletters, workshops, field days) to sensitize members to field-level (market and regulatory) changes and to highlight problematic aspects of current practice increases reflective awareness of members [9], [55]. "...we tried to say to our shareholders, 'let just go beyond our standard compliance and say we can do better than that.' Because to be frank, our customers are expecting that, because your counterparts in Ireland and France and Holland and Denmark are doing exactly that. So, we need to clearly move up that measure" (Int., Environmental Manager, RVG) "It requires people to be willing to be sensitized to the consumer needs ... [so they understand that it's not just some] green bloody, tree-hugging mother in Germany ... it's what consumers want and what the consumer is worried about" (Int., GM Strategy, MZG)
Mech2: Framing pro-environmental practices as a growth opportunity	Framing and focusing attention on future innovation developments [59] and rendering pro-environmental agricultural practices are valid and important. "That's what started the whole entrepreneurial change if you like. It was finding something unique. A sustainable value proposition from goat milk. Anybody can make cheese" (Int., Shareholder Manager, MZG) "Environmental sustainability is central to RVG's purpose: The energies we put into developing a sustainable business today ensure that we are well placed to grow into the future" (Arch., RVG)
Outcome: Local experimentation with pro-environmental practices	Innovation boundaries are re-set / expanded [58] to allow for on-farm/orchard-centered (independent) experimentation by pro-active members. "Those ideas come from fellow farmers. They're quite an innovative lot [...] I was just talking to a guy this morning. And he says: How are we going to fix this? And I said we don't need to fix it; the farmers will fix it" (Int., Chair, MZG) "That means that the green water that you're irrigating is only your wash water from the shed and your rainwater. It pretty much cuts your water use by 50%. And that's something that has come out of, you know, farmers trying to meet the minimum, but look at how they go beyond it" (Int., Farmer, RVG) "The farmers are innovative. But they're often going all over the place. And they need a little bit of direction every now and then" (Int., Chief Scientist, MZG)
<i>Orchestrated hybridization: a broader set of knowledge</i>	Further development and validation of novel practices facilitated collaboration and integration of a broader set of knowledge [40], [77].
Mech3: Facilitating interactions	Facilitating knowledge sharing and collaborative problem solving among members [57], [76] "At AGMs and special general meetings and, you know, information days and field days, there is lots of the informal interaction: What are you doing with that sort of system, how is that working. And people, you know, in smaller sort of groups, people that they've known for a little while in the co-op, are having those discussions" (Int., GM Strategy, MZG). "It's more about facilitating discussion and ideas rather than just standing up the front and giving them a lecture on this is how you should be doing it" (Int., Grower Liaison, KFG)
Mech4: Establishing champions and brokers	Scouting for and nurturing pro-active members who can champion further collaborative problem solving and engage with the broader membership [75] related to pro-environmental practices. "We'll make suggestions: I was up in Waikato and saw this guy [and thought] we could bring him down because I think he'd be really valuable here; [because he is always] thinking about the way forward and what improvements could be made" (Int., GM Quality, RVG) "Having champions amongst the cooperative has been a really good way of doing it. So those farmers who haven't quite got onto the bandwagon can talk to farmers that have because they can talk the same language. And so having champions of that is really, really important. And encouraging those champions to deliver the message" (Int., Environment Manager, RVG)
Mech5: Validating and standardizing new solutions	Selecting, evaluating, validating, and standardizing [89] novel practices from the perspective of science (e.g., environmental impact, replicability) and strategic fit. "So, we always set some small trials up. There is some money from [other sources] for things like that. \$5,000 for innovative research. And these are popular with the growers; some of them really like trying things" (Int., Orchard Manager, KFG) "That [idea] probably came from a farmer who wanted to do it or was doing it. And we took that idea, we did a lot of studies with Lincoln [University] that proved that it not only worked, but it improved cow health and it improved milk quality" (Int., GM Innovation, RVG)
Mech6: Expanding the knowledge base	Expanding open, collaborative problem solving [57] between pro-active members and outsiders expands the knowledge base [59] of pro-environmental practices. "The Farm Focus Group we call it, which is a group of members and people [staff] from here [MZG], and researchers from AgResearch [a public research organization] come along as well. We discuss new ideas and ways of improving farming practices and our farm efficiency gains and breeding and all that kind of stuff. The group holds discussion days and field days and tries to get that information out [to members]. We have newsletters. So, there's a lot of communication activity that's floating around" (Int., Chief Scientist, MZG) "[My role is] to get people involved and put in systems and processes for people to be able to contribute ... [it's about integrating] scientific knowledge, knowledge of the business, and knowledge of the people. And being able to connect science with business interests" (Int., GM Innovation, RVG)
Outcome: Consolidated & legitimated pro-environmental practices	Validated, standardized and centralized pool of best practice; enhanced visibility and trust in the solutions and reduced costs of diffusion of new ideas [55] "Written by an external auditing company with input from farming experts, MZG staff and farmers. MZG's own Code of Farm Practice also captures practical knowledge and experience with milking goats" (Arch., MZG) "A lot of farmers often see science as purely academic and not practical. So, getting the farmers' say in that whole process is vital ... so the trust thing is a very important thing. You've got to install that trust, and once you install that trust, and that's when you can start getting some results" (Int., Environment Manager, RVG)

A. *Planting the Seeds of Change: Situated Hybridization*

Food production practices in New Zealand have faced increasing scrutiny. Mass media [69] and academic publications [70] emphasize the adverse effects of agriculture and horticulture on water and soil quality (e.g., effluent run-off and extensive fertilizer use). Global trends toward increased environmental accountability call for sustainable food production [71]. Such trends reflect the emergence of an environmental logic that became visible in regulatory changes (e.g., the *New Zealand Resource Management Act* revisions), industry initiatives (e.g., the *Sustainable Dairying Water Accord* and sustainable management of natural resources), and changing customer expectations. The logic was reinforced by the *International Co-operatives Alliance* and other organizations representing cooperatives, advocating for cooperatives' role and capability in addressing environmental issues [72], [73]. Emerging regulatory and commercial challenges served as a contextual trigger for adopting novel practices, and cooperative management quickly realized the importance of those socio-economic shifts.

Yet, individual members did not share the same level of concern or understanding related to these issues. Nor did they see the need for collective action that could reduce their returns. Members also often lacked the necessary capabilities to achieve needed change.

In response, the cooperatives' management engaged in two core knowledge initiatives: educating members to understand the challenges (Mech1) and framing proenvironmental practices as a growth opportunity (Mech2). The cooperatives' management relied on existing and new tools and initiatives, including field days, newsletter articles, and information sessions to inform members and disseminate information about the regulatory changes. Concurrently, they established "*member liaison*" roles to facilitate communication with members and support them to interpret and adhere to the new regulatory requirements. This was initiated in response to the difficulty in getting the message across, often demonstrated as skepticism or low levels of member engagement. Concurrently, the cooperatives' management sought to educate their members about shifting customer expectations related to sustainable land use. This included presentations at strategy meetings, sharing performance reports, and facilitating direct exchanges between members and consumers, either through offshore market visits or bringing customers to members' farms. As management realized that the link between market trends and regulations must be conveyed to members, it began framing proenvironmental practices as opportunities for future growth rather than threats or compliance costs. While we distinguish this as a second mechanism (Mech2), it relied on similar delivery tools as Mech1.

Framing proenvironmental logic as an opportunity increased the members' understanding of the shifts in the macroenvironment. Highlighting problems with current agricultural practices helped members comprehend them from the consumer's perspective and recognize their role in addressing them. Such understandings were captured in the quote

"Europe is a market that desires that [carbon footprint] information about sustainability. And there was the issue of food miles. We

were concerned that one day somebody was going to ask us this information. So, rather than waiting for someone to ask, we wanted to have that information ourselves." —Int., Chief Science Officer, MZG

Increased reflective awareness of a need to change stimulated member-driven experimentation (e.g., novel effluent management practices) and demonstrated that individual cooperative members could take action. While they remained local and small in scale, the initiatives showed members could address regulatory requirements, align with changing market trends, and generate water and electricity savings in their operations.

B. *Selective Breeding and Nurturing of Proenvironmental Practices: Orchestrated Hybridization*

The cooperatives' management soon recognized that member involvement in developing proenvironmental practices was critical for two reasons.

- 1) Agricultural practices rely on members' practical knowledge, which must involve solutions that work in the context of members' farming practices.
- 2) Tackling environmental challenges requires external, technical, and scientific knowledge.

Regarding the former, most members developed solutions that lacked scientific evidence and rigor, making them unsuitable for diffusion across the cooperative. Regarding the latter, because external solutions were science-based, members did not understand or trust them.

First, the cooperatives facilitated collaborative problem solving and sharing (Mech3) of knowledge among members. This process encouraged and empowered members to address the issues while encouraging sharing, providing a first step to test and validate ideas that individuals developed on their farms and orchards. A related mechanism of establishing champions and brokers (Mech4) was employed to search out proactive members to champion collaborative problem solving and engage with the membership to instigate adoption and change. During organizational events (e.g., field days), members shared and discussed ideas with peers, management, and scientists. The meetings enabled members to assess ideas critically without members feeling intimidated by management or scientists criticizing or rejecting their ideas outright—an essential factor in encouraging innovation and facilitating learning.

A further mechanism, selecting, evaluating, validating, and standardizing new solutions (Mech5), was introduced to address the lack of scientific rigor in members' experiments. Disseminating unverified ideas posed several risks that the cooperatives' management recognized and attempted to mitigate by introducing several initiatives. These included selection processes and tools (akin to a Stage-Gate approach) for developing innovative solutions, establishing committees with representation from members, scientists, management, and frequent rotation of members across committees. Those methods allowed scientists, the cooperatives' management, and members to discuss their inputs while acknowledging the implications for their commercial activities and production practices. Members were also encouraged to host scientific trials on their farms, thus exposing

them to how trials should be conducted. Members participated in decisions about approving and rejecting projects. Selection processes, the assessment criteria, and the committees' terms of reference reinforced the innovation space for collaborative innovation and encouraged and nurtured member involvement in finding solutions.

Expanding the knowledge base (Mech6) was another mechanism that emerged from our analysis. Members' knowledge could go only so far. Hence, the cooperatives commissioned public research organizations to provide R&D. At the same time, scientists were invited to join committees, speak at member events, and attend field days to overcome members' resistance to adopt external knowledge (as a part of Mech3). In particular, scientists who could relate to members and could simplify their message were sought after. The cooperatives' management also translated science for members by simplifying, reducing, and contextualizing it. At the same time, cooperatives' staff were invited to provide expertise on the commercial dimensions of new initiatives and highlight how those would affect market response and opportunities. Those interactions increased members' knowledge about environmental and commercial priorities. They also sensitized the scientists and commercial staff to members' worldviews and priorities, helping both sides to develop shared understandings of what future solutions needed to achieve to be diffused across the membership.

Finally, the cooperatives' management increasingly used idea champions and knowledge brokers (Mech4) to facilitate the broader adoption of select ideas. Those individuals helped translate (transcode) between science and practical knowledge of members and used their positioning in the social network to influence members' willingness to engage with new ideas.

Ultimately, these mechanisms allowed the cooperatives to consolidate and validate the proenvironmental farming practices for broader distribution, as the following quote illustrates:

"It's almost an innovation by osmosis, and those conversations are much more organic. The guys are out there, in the field, having conversations. They find a great idea from this farmer, go, and tell the next farmer and say what they and others are doing. [Interviewer: I suppose two forms of ideas potentially come from on-farm. One is the farmer who has an idea, and the other is the farmer who has validated ideas]. And there are ways to validate it. Lincoln University has the monitor farms and [run] scientific studies. And then [we run] publicity campaigns with our shareholders to say it [the innovation] is a good thing for us because it's all the one company." —Int., General Manager, RVG

Engaging members and scientists jointly and using idea champions let them develop new practices collaboratively and diffuse systematic methods to create and select ideas. Finally, these initiatives exceeded regulatory requirements and became foundational to the future of the cooperatives' (sustainable) growth strategy.

C. Cultivating Broader Change and Harvesting the Benefits: Collective Hybridization

Building on brokering and championing mechanisms (Mech4), two knowledge-sharing mechanisms were crucial for

endorsing proenvironmental practices and priorities from members and other stakeholders. First, the cooperatives formalized and broadened brokering mechanisms to reinforce the diffusion of new practices (Mech7) and expand their reach beyond members. They did so by allocating more resources to hosting events, utilizing "*liaison officer*" roles to help members implement best-practice guidelines, and expanding communication channels to include YouTube and presentations at national (industry) conferences.

Second, all the cooperatives implemented mechanisms for monitoring and sanctioning to ensure the priority of proenvironmental practices (Mech8). Those included adopting external guidelines and procedures (e.g., from government agencies) often followed by introducing internal systems to address violations. If individual members breached requirements, the cooperatives usually brokered between them and the relevant authority to ensure they addressed any nonconforming practices. Brokering involved the cooperatives' liaison staff mediating with the monitoring agency to ensure the individual member understood the priorities and adopted the necessary changes.

Mech7 and Mech8 helped ensure broader diffusion amongst the cooperatives' members and enabled the endorsement of the proenvironmental logic at the field level. RVG also became a leader in proenvironmental farming practices and was presented in favorable terms in newspaper articles and national awards. Similarly, MZG launched a collaborative R&D project with public research organizations, indicating an additional measure of the sector's role in reducing its environmental footprint. Furthermore, proenvironmental practices and priorities spread through consortia involving other stakeholder organizations, as this excerpt illustrates:

"As a sector, we take responsibility for the care of our people, animals, and the environment. We also recognize that stewardship of the sector's reputation is every individual's equal and shared obligation in the value chain. ... Farmers who have participated in this process want to work collectively to ensure that we act responsibly and protect our reputation. They want to support other farmers who may be struggling to meet the relevant standards or regulatory requirements because of stress or other challenges. We must hold each other to account as well as all those in our value chain." —Dairy Tomorrow 2017 Report

V. DISCUSSION

Despite the need for coordination and collaboration among diverse actors to achieve GCs [1], [2], there is still little empirical evidence on how novel practices that address GCs are developed and diffused. We wanted to address this gap in understanding. In this section, we discuss our findings and our two theoretical contributions. First, we propose a model that illustrates how novel practices that balance economic and environmental concerns are developed and facilitate collective action in the face of GCs. Second, we elaborate on metaorganizing for innovation.

A. Metaorganizing New Practices for Action on GCs

Fig. 1 consolidates the three types of hybridization presented in our findings into a process model. This model illustrates how

metaorganizations, such as producer cooperatives, use different knowledge mechanisms to facilitate the adoption of a pro-environmental institutional logic and orchestrate the combination and development of existing and new knowledge into innovative solutions. In doing so, metaorganizations enable broader institutional change [1], [13], [15] as novel practices that reconcile competing logics spread beyond a single organization [41]. These findings extend our understanding of how mature organizations embrace a previously unfamiliar institutional logic in a coordinated and collaborative way [17]. Existing scholarship regards the transformation of public discourse and regulatory action towards socio-ecological sustainability [13] as an emerging “*proenvironmental*” logic at the field level [14], [15]. Similarly, literature on institutional change has shown that shifts in social values, customer demands, and regulatory policies enable actors to reflect on problematic aspects of their prevailing practices [39]. Our findings reveal two knowledge mechanisms that metaorganizations employ to expose actors to emerging logic and related issues and concerns. First, increasing members’ knowledge of proenvironmental demands creates a “*shared understanding of the problem*” [38, p. 207] among embedded actors and emphasizes problems with current practices. Framing proenvironmental practices as opportunities consistent with members’ economic interests [38], [59] allow emerging tensions between social and economic goals to be reconciled [48], [52]. This stimulates the reflective awareness needed for institutional change and encourages local experimentation with new practices that meet the demands of contradictory logics [38]. However, such situated hybridization lacks the broader involvement of actors and can lead to the development of multiple, competing, and questionable solutions if not managed. Thus, orchestrated hybridization becomes a necessity. This process simultaneously encourages validation, development, and sharing of new practices among members through collaborative innovation. In the process, new, external knowledge might be brought in, requiring some form of translation [33]. Metaorganizations are well-positioned to act as knowledge champions and brokers [74], aiding innovation [61], [75]. Three of the main knowledge mechanisms in our findings align with previous studies: idea champions and encouraging collaborative problem-solving encourage adoption of new ideas among members [57], [75], [76] facilitating interactions, which can lead to the transformation of established practices and values [40], [77], [78]. Selecting, evaluating, validating, and standardizing [81] novel practices with a scientific basis (e.g., environmental impact and replicability) and that enhance strategic fit ensures that innovative ideas are sound [38]. Integrating business, science, and farm-centered knowledge generates proenvironmental practices that are validated, standardized, and centralized. In turn, visibility and trust in the solutions are enhanced, which reduces the costs of their diffusion [55].

To stimulate the large-scale responses GCs require, knowledge related to new practices must diffuse beyond the collaborative context in which it was developed [41], [77]. Formal and informal brokering reinforces the diffusion of proenvironmental practices to a broad set of stakeholders and establishes social consensus around proenvironmental practices [39]. Further, regular audits and threats to sanction repeat nonconformance

[79] lead to accepting and endorsing behavior prescribed by a proenvironmental logic. Such collective hybridization results in shared goals between all participants [16], the generation of economic benefits, and the institutionalization of novel practices as the new imperative [38].

B. *Metaorganizing for Collaborative Innovation*

Our study helps address how metaorganizations instigate and mobilize collective action [5]. Organizing for collaborative innovation requires heterogeneous actors to be coordinated even if their goals, motivations, and knowledge are misaligned with those of the coordinating firm [11]. Our study adds to knowledge coordination between unconnected actors [9]. Drawing on arguments about formal and informal knowledge mechanisms, processes, and capabilities [34], [57], [76], [80], we argue that metaorganizations help organize collaborative innovation and highlight meso-level processes that connect member firms and their networks.

Although GCs are often met with inaction [2], and small-scale initiatives fail to diffuse [54], metaorganizations may offer an interorganizational design for sustainable development [5], [20]. Our model shows how cooperatives, as metaorganizations, mediate among interests to reset the knowledge boundaries of innovation search space [58] and encourage the incorporation of broader perspectives. Challenging problems require coordination to bridge knowledge differences, ensure sufficient expertise and communications between actors [9], [11], [12], and support efficient knowledge absorption and interest alignment [33]–[35]. While collaboration with actors who draw upon different knowledge is known to “*jump-start*” [81, p. 386] shifts in logics, we provide more nuanced insights into the knowledge mechanisms that enable the emergence, adoption, and diffusion of novel practices that balance economic and environmental sustainability. Specifically, we show how metaorganizations can act as interorganizational spaces that serve different purposes, such as creating awareness, dialogue, experimentation, diffusion, and conformance, during various stages of collaborative innovation. The ability of metaorganizations to reconfigure the purpose of interorganizational spaces enables them to mobilize different knowledge mechanisms that help orchestrate other forms of bottom-up and top-down knowledge flows as needed. Consequently, the organizational structure that provides a basic infrastructure for knowledge sharing [82] affords collaborative innovation.

Collaborative innovation, as a form of collective action, relies on knowledge sharing and learning that supports the development of a value-based mindset [28] that brings together diverse logics and related practices and goals. Indeed, recent studies have shown that cooperatives can facilitate the co-development of technical and nontechnical solutions, ranging from science-based breeding solutions [83], through to the development of natural food products [84], machine tooling [85], and to redefining the business model for renewable energy supply [86]. Our results show how producer cooperatives can metaorganize for collaborative innovation to address GCs.

VI. CONCLUSION

This article examined how producer cooperatives metaorganize to develop and diffuse practices that address GC. As complex issues, GCs require collaborative innovation among heterogeneous actors who draw upon contradictory institutional logics [1], [2]. We contribute to the GCs literature by showing that metaorganizing helps achieve situated, orchestrated, and collective practices to endorse a proenvironmental logic. Our model illustrated how new practices are developed and lead to collective action. We brought new insights about knowledge coordination between unconnected actors to the emerging discussion about metaorganizing for innovation.

A. Practical Implications

There are three practical implications of our study. First, we offer evidence supporting the claims that cooperatives can address sustainability issues [71], [87]. Second, we provide a model to inform those who struggle to connect policy aspirations and organizational action to environmental improvements [2], [20]. Moreover, we highlight mechanisms that can be scaled up and diffused across institutional fields and show how stakeholders can partner in such collaborations. Third, we provide managers and knowledge brokers with mechanisms for facilitating knowledge sharing and fostering supportive spaces for collaborative innovation.

B. Limitations and Avenues for Future Research

Our study has some limitations. First, while the focus on producer cooperatives enabled us to draw implications about how these organizational types act as metaorganizations, this might also limit our findings' generalizability to other cooperatives with different governance structures. Future studies can investigate the dynamics of knowledge coordination and collaborative innovation for GCs that other types of cooperatives and hybrid organizations address, thereby enhancing our understanding of how organizations with alternative governance structures contribute to solving GCs. Similarly, future studies utilizing large-N quantitative analyses can help identify the impact of these differences on the cooperatives' ability to transform members' practices through knowledge sharing.

Second, our cases concentrate on a field-level proenvironmental logic that primarily operates within national boundaries. While all three producer cooperatives serve international markets and are affected by macro consumer trends and institutional shifts, examining their ability to influence their offshore partners (e.g., distributors, freight providers, in-market intermediaries) toward a proenvironmental logic was beyond the scope of this study. Thus, it limits us from understanding if and how producer cooperatives can enable collective action on a transnational level. Recent studies suggest that while such action appears possible [48], the attempts by producer cooperatives to coordinate international collective action face significant challenges from powerful global supply-chain actors [29], [49]. This predicament suggests a fruitful context for examining the boundary conditions of collaborative innovation for collective action in the context of metaorganizations.

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