

Article

Rural Research and Development Corporations' Connection to Agricultural Industry School Partnerships

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Abstract: The Australian Government has prioritized science, technology, engineering, and mathematics (STEM) education in recent years to ensure that the country has an adequate future workforce. The agriculture industry is a major employer with a diverse range of occupations heavily focused on STEM. Many students do not realize the career opportunities in the sector, which is currently facing severe workforce shortages. Industry school partnerships (ISPs) have been identified as one creative model to improve students' knowledge of an industry and aspirations for associated careers. Whilst ISPs have been implemented in the STEM context, limited research understands how industry organizations are involved in, influence, and interconnect with ISPs. Australia's Rural Research and Development Corporations (RRDCs) are legislated agricultural industry bodies and were selected to investigate due to the value ISPs could provide to this STEM-focused industry with workforce shortages. This qualitative case study analyzed data from the most current RRDC strategic and annual operating plans as of 27 July 2023 and semi-structured interviews with an employee(s) in a position relevant to student education of all 15 RRDCs in 2022. The key findings were that ISPs were considered part of the solution to address industry sustainability, though RRDCs were commonly only informally involved. Collaboration between industry partners, facilitators, and teachers at strategic and management levels and across commodities was essential. RRDCs were found to be strongly connected to ISP ecosystems through their role in research and development. We argue that RRDCs are positioned as essential stakeholders with the scope to improve agricultural ISP ecosystems as part of their role in driving agricultural innovation. These findings support the application of ecological systems theory to agricultural ISPs and help us to understand these structures. This paper aims to help those creating ISPs to consider and understand all stakeholders, including industry bodies, to deliver quality future partnerships that benefit both STEM sectors and primary and secondary student education.

Keywords: primary and secondary agricultural education; rural research and development corporations; ecological systems theory; industry school partnership



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1. Introduction

The Australian Government has prioritized science, technology, engineering, and mathematics (STEM) education in recent years to ensure the country has an adequate future workforce [1,2]. Industry school partnerships (ISPs) offer one creative model to provide authentic experiences to connect learners with careers [3,4] and have been identified in previous literature [5–8], and by the Australian Government [1,9], as valuable and important. These partnerships comprise activities where school students interact with industry professionals, such as career talks in class and excursions to industry partners' workplaces [4]. Activities can be informal, one-off events through to more complex long-term

partnerships involving greater coordination between various stakeholders. Stakeholders can include students, facilitators, school staff, industry professionals, businesses and industry bodies [4,10]. Facilitators can help to connect school staff and industry partners and organize activities. Often, school staff or industry professionals will facilitate partnerships themselves, while other times, a dedicated facilitator is involved. These facilitators may be employed through organizations that deliver ISP programs, such as universities, and education or industry organizations. Facilitation of partnerships is important to ensure that both the educational and industry partners find value through their involvement. However, limited research explores the industry side of ISPs. Understanding how and why industry professionals, businesses and industry bodies want to participate would enable more successful partnerships to be formed and policies to be developed.

The agriculture industry offers an interesting case site to explore the value of STEM ISPs. The agriculture industry is a major employer with a diverse range of STEM-focused occupations. However, the industry is facing severe workforce shortages. Intensified by COVID-19 and influenced by factors such as urbanization, insufficient number of graduates, and an ageing population, workforce shortages are evident on a global scale [11–13]. This complexity highlights the wickedness of the workforce challenge. Wicked problems are “those that are complex, unpredictable, open ended, or intractable” [14] (p. 711). They have no simple solution, if one at all [14,15]. However, changing negative perceptions and increasing students’ career knowledge is one part of solving this challenge to increase the number of students aspiring to become the next generation of agriculture’s STEM workforce [11,16]. There are many influences on students’ career aspirations. However, ISPs are one way to increase awareness of agricultural careers [17–19].

ISPs can be better understood by being theorized as an ecosystem comprising different but related social systems, which contain a range of stakeholders and environmental influences connected to these partnerships [20–23]. While research, albeit limited, has explored the nature of industry participants [24,25], a clear gap exists in the literature regarding industry bodies. Industry organizations reside in the outer layers of ISP systems and while they may not be directly involved on the ground in delivering partnership activities, they are often connected through policy or resource allocation [22,26].

Through the case of one distinct type of agricultural industry body, Rural Research and Development Corporations (RRDCs), this study seeks to help fill this research gap by better understanding the roles these organizations have in ISPs. Funded through compulsory producer levies and Australian government funding, RRDCs are either statutory or industry-owned corporations [27]. These corporations have been chosen to be explored in further depth as they are well established, ingrained in legislation, and have clear and consistent roles to drive agricultural innovation, which require a skilled and engaged workforce and agricultural education programs [27,28]. The role of all RRDCs is to deliver practical improvements for their sectors through research, development and adoption [29]. A sustainable, progressive industry needs a strong workforce. We argue that RRDCs’ role in driving agricultural innovation aligns with primary and secondary student education aimed at attracting the next generation of agricultural professionals [11]. With workforce shortages being a significant and widespread challenge for the agricultural industry, we seek to expand our knowledge of one component of agricultural ISP ecosystems, RRDCs, identifying if and how ISPs fit within their broader function. This paper aims to answer the following research questions:

1. How do RRDCs describe their role in the implementation of ISPs?
2. How do RRDCs connect and influence other parts of the ecological system regarding ISPs?

Ecological Systems Theory (EST)

Industry school partnerships often resemble a natural ecosystem, a community where biotic and abiotic factors interact and interconnect [30]. Bronfenbrenner, a key psychologist in the development of socioecological theories, originally applied this ecological thinking to the developing learner in 1976, which has subsequently become a popular model in a

range of education contexts [20,31–33]. Researchers have also applied ecological systems theory (EST) beyond the developing learner to contexts including ISPs [21,22,26].

Bronfenbrenner's (1976) five systems, when applied to ISPs, are depicted in Figure 1, with the microsystem at the core of the diagram and each following system one layer further away. The microsystem contains those directly involved in ISPs, including students, teachers, and industry partners. Moving further from the immediate setting, the mesosystem contains vital influences, including industry participants' managers, principals, and students' families. The exosystem contains stakeholders such as RRDCs, other industry bodies, and education departments, which can often influence the micro and mesosystems through policy or resource allocation. The macrosystem includes "overarching institutions of the culture or subculture, such as the economic, social, educational, legal, and political systems" [20] (p. 14). Lastly, a later addition, the chronosystem, explores influences on the ecosystem over time [21].

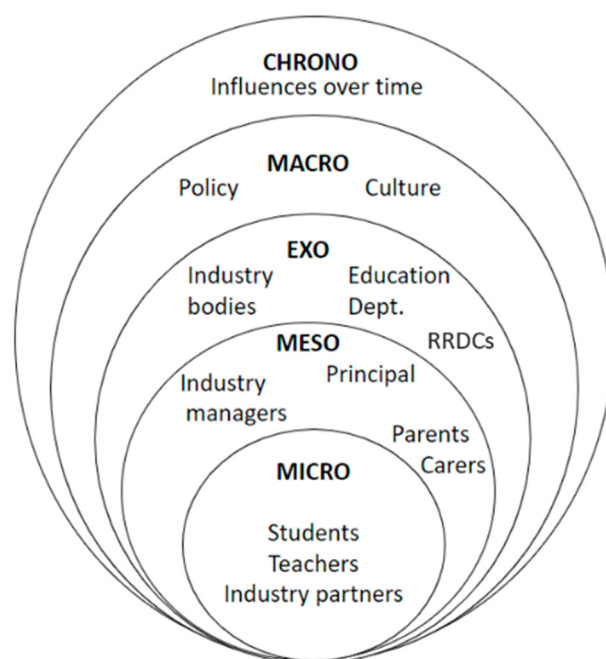


Figure 1. ISP ecological system as depicted by the researchers, including key stakeholders/components.

This theory provides a highly applicable framework to explore the interconnections and influences between ISP stakeholders to gain a more complete understanding of the nature of these partnerships [21,22]. An understanding of ISPs as a whole system and the interconnections and influences between stakeholders across all systems aims to help those delivering and designing ISPs to best meet each stakeholder's needs. This includes capitalizing on the influences and interconnections between stakeholders to create more streamlined, sustainable partnerships that benefit the agricultural industry and student education. By applying Bronfenbrenner's [20] EST to ISPs, building on the works of Flynn [22] and Leonard [26], RRDCs have been identified as key exosystem stakeholders. Flynn [22] found that interconnections with the exosystem are key to partnership effectiveness. The industry organizations in this study's exosystem were the Queensland Resources Council and the Queensland Mining and Energy Academy [22]. However, within agricultural ISP ecosystems, many industry organizations cover different commodities spread across varying geographical locations [34]. These organizations often have different levels of prioritization for ISPs, which may lead to unequal access for students due to their location. This increased complexity warrants further exploration if we are to understand the influences within this system.

2. Materials and Methods

This materials and methods section details the criteria for case selection and articulates the rationale behind the choice of the case and the sampling procedures. It will then describe the data collection methods employed, including the development of the interview guide, the selection process for strategic and annual operational documents, and protocols adhered to during the interview process.

The criteria for case selection were first, STEM-related industry bodies, and second, an industry where workforce shortages are prevalent, as ISPs could be valuable. A third criterion was the type of industry body needed to form a bounded case. Based on this criterion, RRDCs were selected. RRDCs are one distinct type of industry body and are well established and ingrained in legislation, forming a bounded case. The agriculture industry requires a strong STEM-related workforce and is currently facing shortages. Hence, the agriculture industry's RRDCs provided a suitable case to help fill the research gap relating to industry bodies' role in STEM ISPs. To obtain a comprehensive understanding of RRDCs, each ($n = 15$) of these organizations was invited to participate and all agreed.

A case study design drawing on Yin's [35] and Merriam's [36] approaches was selected to gain an in-depth understanding of RRDCs' role in implementing ISPs and how they connect and influence other parts of the ISP ecological system [36] (p. 19). This descriptive qualitative case study utilized documents and semi-structured interviews as data collection methods. Initially, each of the 15 RRDCs' strategic plans was read to better understand the purpose and priorities of these corporations. These documents were high-level summaries with limited primary and secondary student education information. This finding led to semi-structured interviews with appropriate employees at each RRDC to better understand their involvement in ISPs. Following this, a content analysis of each RRDC's strategic plan and annual operating/investment plan (AOP) was undertaken to understand how primary and secondary student education was included at the strategic level. This research was approved by the CQUniversity Australia Human Research Ethics Committee, approval number 23670.

2.1. Documents—Strategic and Annual Operating Plans

Content analysis of each RRDC's strategic plan and AOP as of 27 July 2023 was undertaken to understand the level of priority agricultural education has and any current or intended future involvement in such activities [37,38]. These documents were selected for analysis as they were the publicly available strategic planning documents for each RRDC. All RRDCs except Horticulture Innovation Australia had one strategic plan and one AOP. Horticulture Innovation Australia had a strategic plan and an AOP for each of its 34 industry funds, which consisted of different horticultural commodities. This adjustment resulted in a total of 96 documents analysed. The following search terms were applied systematically to each document to identify involvement in agricultural education (including stemmed words): educat(e/ion), student, school, train, and learn. The context of each keyword found was analysed, and only instances where the words were explicitly used about primary and secondary student education were counted and included in Table 1.

2.2. Semi-Structured Interviews

Semi-structured interviews were undertaken with employees from every RRDC ($n = 15$). This phase consisted of interviews with 14 employees, each from a different RRDC, and one recording with four employees from the fifteenth RRDC. These interviews provided a greater understanding of RRDC involvement in education, specifically ISPs. By analyzing the descriptions and perspectives of those inside the ISP exosystem, we take a constructivist approach to build knowledge from the employees' experiences [133].

Table 1. RRDC strategic and AOP content analysis for primary and secondary student education keywords, including notes.

RRDC	Number of Mentions						Notes
	Educa (tion/te)	Student	School	Train	Learn	Teach	
1. Australian Meat Processors Corporation (AMPC) [39,40]	1	0	2	0	0	0	The strategic plan stated that they aimed to “develop a schools program starting with secondary school students to introduce them to all the opportunities that the processing industry has to offer” [39] (p. 6).
2. Australian Wool Innovation (AWI) [41,42]	16	14	4	2	10	0	References to several programs including the following: -Learn about Wool lesson plans -Wool4School design competition -Woolmark Learning Centre The strategic plan also noted that the field station could be used for school activities.
3. Dairy Australia [43,44]	11	0	12	0	0	1	The 2023/24 AOP included a school engagement project with the following activities listed: -“Educate school children on the value of dairy including the health benefits of dairy and building an understanding of the way food is produced. Promoting careers in dairy will also be a focus. -Continue to leverage the Discover Dairy education platform providing curriculum linked resources to school teachers and children. -Engage primary school children through the eight-week program, Picasso Cows. Seek further income opportunities to leverage this program. -Continue to leverage the Discover Dairy education platform and resources linked to the curriculum. -Leverage messages through existing initiatives such as virtual classrooms, virtual reality and the Life Education and Primary Industry Education Foundation Australia partnership. -Engage with regions to further amplify this message to school children in their regions and work with ambassadors to promote dairy to a younger audience” [44] (p. 30).
4. Eggs Australia [45,46]	0	0	0	0	0	0	
5. Forest and Wood Products Australia (FWPA) [47,48]	3	0	5	0	14	12	Numerous references to ForestLearning teacher education program.
6. Livecorp [49,50]	0	0	0	0	0	0	
7. Cotton RDC (CRDC) [51,52]	0	0	0	0	0	0	
8. Fisheries RDC (FRDC) [53,54]	0	0	0	0	0	0	
9. Grains RDC (GRDC) [55,56]	1	0	0	0	0	0	PIEFA membership investment is noted in the AOP.
10. Wine Australia [57,58]	4	0	3	0	0	0	The AOP stated “we will continue to work with the school, vocational and higher education sectors as well as Australian Government-funded initiatives addressing workforce and labour issues across agriculture to promote pathways to the grape and wine sector as a career of choice” [58] (p. 15).
11. Meat & Livestock Australia (MLA) [59,60]	10	2	4	0	0	7	The strategic plan stated “The ‘school education’ product group engages schools and teachers through education partnerships and the promotion of the newly developed national curriculum aligned teaching resources, focusing on animal welfare, environmental management and the role of red meat in a healthy balanced diet. Initiatives include: -membership of Primary Industries Education Foundation Australia (PIEFA) and subscriptions to education service providers such as Kids Media and Education Australia to promote the Australian Good Meat educational resources—membership investments also support the opportunity for access to teacher and student insights into preferred teaching methods, resource needs and sentiment towards teaching Australian agriculture in the classroom -promotion of school education resources through participating at events and social media channels that target teachers and/or students -host online educational programs featuring Red Meat Ambassadors”. [59] (p. 63)

Table 1. Cont.

RRDC	Number of Mentions						Notes
	Educa (tion/te)	Student	School	Train	Learn	Teach	
12. Australian Pork Limited (APL) [61,62]	0	0	0	0	0	0	
13. Sugar Research Australia (SRA) [63,64]	0	0	0	0	0	0	
14. Horticulture Innovation Australia (HIA) * [65–130]	1	0	2	0	0	0	Banana fund investment plan identified an Australian Bananas school partnership—nutrition program in partnership with Life Education Australia. The berry fund investment plan identified a berry industry careers program which states that it could include a school leaver mentoring program.
15. Agrifutures Australia [131,132]	3	2	5	0	1	1	The AOP identified the following projects: -PIEFA Educational Materials for the Australian Chicken Meat Industry -Cultivating the next generation: the role of school-based educators in promoting agricultural careers -Precision Agriculture using “Real Data” in Education -Developing students and staff while improving farm efficiencies -The aim of this project is to build the capacity of students to utilise and interpret a range of data sets using GPS technology on livestock monitoring. -All About Alpacas: Teaching Resources for Australian Schools -Cultivating the next generation: the role of school-based educators in promoting agricultural careers -Hagley Farm School Agricultural Learning Centre The following were identified as planned activities in the AOP: -Conduct a cross-sector project in determining the future workforce requirements for agriculture, forestry and fisheries industries. Agriculture Career Advisory Services: Phase 1: identify and report on the current perceptions and knowledge within secondary schools of career opportunities in the Australian Agriculture (including fisheries, forestry and horticulture) sector. -Identify current perceptions and knowledge within NSW Government, Catholic and Independent secondary schools of career opportunities in the Australian agriculture sector. [131]

* Strategic Investment Plan and Annual Investment Plan for all 34 industry funds. All industry funds were counted together under the banner of Horticulture Innovation Australia when referencing the number of plans.

Purposive sampling was utilized to select appropriate employees within each RRDC, targeting those in positions related to education, where applicable, or workforce attraction/retention/capability development. The occupations held by participants included positions related to communications, capacity building, capability development, people and culture, extension, adoption, research and development, managing specific programs related to education, training, careers and development, marketing strategy, relations, and engagement. Participants ranged in age from 25 to into their 50s. Sixteen participants identified as female, and two, from the same RRDC identified as male. The number of years participants had been in their current or similar position ranged from less than one year to eleven years. Participants had worked in agriculture from less than one year to over 20 years with one having worked in agriculture and then pursued other work, before returning to the industry. Participants were recruited through known contacts and identifying appropriate employees from RRDC websites and documentation. Participation in the program was voluntary, and any RRDC employee approached had no obligation to be involved. Data collection ceased once an employee at each RRDC had been interviewed.

A semi-structured interview schedule was designed to explore this study’s research questions. There were 17 questions in the interview guide. This included four demographic questions, with the remaining 13 questions asking if and why ISPs are important, the level of current and potential future involvement, barriers to involvement, and key principles for success. These questions were selected to build, and further expand, upon the information contained in the strategic and AOPs. This was important as limited detail regarding ISPs

was provided in the planning documents. The audio-recorded interviews were transcribed using Otter.Ai [134]. Each interview was approximately 45 min long and was conducted via a phone call or Zoom meeting by one or two researchers. Braun and Clarke's [135] six-step thematic analysis method was utilized to analyze and interpret the interview data to develop themes. First, data familiarization was undertaken, including transcribing interview transcripts with Otter.ai and re-reading them [40]. Next, the transcripts were printed, coded, and entered into NVIVO [136]. The research questions were then considered, and initial themes were generated, and developed, and reviewed several times to produce a convincing and relevant story. The final themes were refined and named before writing this article. To ensure trustworthiness and rigour in the analysis process, after initial coding and theme generation by one researcher, the researchers discussed the data as a team to reach a consensus on all codes and themes [137].

3. Results

3.1. Strategic Plans and Annual Operating Plans

The most recent RRDC strategic and AOP analysis identified nine RRDCs with content specifically related to primary and/or secondary education. Of these, nine were references to various programs and activities, including teacher education, lesson plans/learning resources, and student nutrition programs, as noted in Table 1. The high-level nature of these plans meant that it was difficult to determine the programs' extent, and whether they included an ISP component. Dairy Australia's AOP included virtual classrooms and working with ambassadors to promote dairy (Table 1). These activities may have been ISPs, where farmers or other industry professionals interact with students, though limited detail was provided. Meat & Livestock Australia included an initiative to "host online educational programs featuring Red Meat Ambassadors" [59] (p. 63), however, again, it was unclear if these programs offered the opportunity for students to interact with the ambassadors or whether they comprised pre-recorded materials. Some documents included mentions of programs or facilities that could be classified as ISPs. For example, Australian Wool Innovation notes that the field station could be used for school activities [41], and Horticulture Innovation Australia's berry funds' strategic plan included a careers program that could incorporate a school leaver mentoring program [45]. Australian Meat Processors Corporation aimed to "develop a schools program starting with secondary school students to introduce them to all the opportunities that the processing industry has to offer" [39] (p. 6). Table 1 includes a quotation from Wine Australia's strategic plan, stating that they will work with schools to address workforce issues [54]. Six RRDCs, as listed in Table 1, made no mention of programs, intentions, or stances specific to primary and secondary student education.

This content analysis highlighted RRDCs' limited involvement with primary and secondary students and their teachers past the creation of learning resources. However, as strategic plans and AOPs only delivered a high-level summary, the interviews sought to better understand RRDCs' involvement in education, and specifically ISPs.

3.2. Semi-Structured Interviews

3.2.1. ISPs Are Important for Industry Sustainability

Interviews identified that most RRDC employees saw ISPs as crucial for the agricultural industry and worth some investment. Many highlighted increasing student and teacher knowledge, awareness, or understanding as important, which can be linked to improved social licence and career consideration. Martin and Shepherd [138] (p. 4) explained that "the term social licence to operate is a shorthand way to describe the latitude that society allows to its citizens to exploit resources for their private purposes". The industry risks losing its social licence to operate from poor public perceptions, and hence educational opportunities to ensure the community bases their decisions on reality, are important.

All interviews broached the topic of careers. Some participants explicitly discussed workforce shortages. For example, RRDCE7 saw ISPs as "certainly not a silver bullet, but a

pretty crucial piece of the puzzle when it comes to trying to address some of these workforce issues that we're having". RRDCE11 extended on the workforce shortage topic: "With the global pandemic, we have to be more sustainable, we have to find a local sustainable workforce here within Australia. And that is what I am aiming to do". Others touched on career awareness and perceptions: "to change the perceptions of the role, the job roles in agriculture and the diversity of roles" (RRDCE3), and "they'd know more about the potential jobs that are available in agriculture" (RRDCE10).

In addition to a sustainable workforce, participants discussed greater community support and trust, which leads to improved social licence. This relationship was something that they thought could be improved through ISPs. RRDCE9 described potential benefits from greater community appreciation of the agricultural process:

It then may help us when we come around to needing community support for things like continued access to water, nutrients, or increasing the price of [product] because we've had a hailstorm, the community there might say, you know what I am willing to, you know, [buy] the ugly [produce]. (RRDCE9)

RRDCE11 explained that through ISPs:

You're actually building community trust, as well. I think, you know, if you're hitting on the right key messages around sustainable production, and all of those bits and pieces, I think it goes a long way to build community trust.

(RRDCE11)

3.2.2. RRDCs Are Informally Involved in ISPs

Whilst ISPs were identified by participants as important for the agricultural industry, RRDCs were involved in varying capacities. The interviews indicated that most RRDCs participated in ISPs in some form, often informal, without a formalized program. RRDCE13 explained that "it's been ad hoc". RRDCE11 summarized the views of many participants:

And [an] ISP is not in our plan. I guess, as we go down to look at our everyday operational activities, yeah, I guess we do it in an informal way, indirect way. We're not involved in a formal way at this point.

Interestingly, two RRDCs were in the process of establishing ISPs, and were trialling different models including RRDCE12, who said, "It's just trying to build that right model. So, we have... been looking at some different models and then we are going to pilot a few and see what works".

Interviews described RRDC employees directly participating in ISPs, such as classroom talks or site visits. For example, RRDCE11 stated that "occasionally we do have teachers contact us that could someone come to our school, and we are talking about... markets, and pricing and/or talk about a specific thing". Sometimes RRDC employees attended events with levy payers. However, for RRDCE15.1, this was only to "assist in facilitating conversation". For example, "when we get a really tricky question is when we step back in and assist with some more industry level messaging". More often RRDCs were facilitating ISPs by making connections for other organizations hosting ISPs; for example, RRDCE9 had "been trying to connect the program manager... within PIEFA with grower contacts", and RRDCE6 explained that "if they're existing, being created elsewhere, we will definitely facilitate, coordinate, promote". Some RRDCs were organizing their own ISPs, including as part of a conference or other industry events. RRDCE12 mentioned that as part of a program included in the content analysis in Table 1, "they might organize a trip onto farm".

Whilst not all RRDCs participated in ISPs, and many only played a minor role, the consensus was that RRDCs could play a more prominent role in ISPs. However, further involvement was subject to the range of barriers or influences against ISP involvement, most commonly resourcing because "there's only so much time and money" (RRDCE12) and competing priorities. RRDCE2 summed up the relationship between the two, a common sentiment amongst other interviewees:

We are a very small team with a very small budget, and we have a lot of other priorities, and things that are important and urgent, and then there's important and not urgent and I think schools' programs fit in the important but not urgent, and so they probably don't have as much focus when you've got a small, small budget.

3.2.3. Who Can Address the ISP Solution to This Wicked Workforce Problem?

Whilst ISPs were perceived to be important and most RRDCs were or wanted to be involved in some capacity, who is best placed to deliver and participate in ISPs was up for discussion. RRDCE5 asked, "where would it [ISPs] sit?" In terms of ensuring the delivery of ISPs, RRDCE10 stated, "it's everyone's responsibility", and RRDCE9 stated, "and they [producers] could all step up"; however, "nothing beats the actual person who does the actual job day to day talking to the kids or talking to anybody" (RRDCE15.1). Primary producer involvement was seen as essential for a successful ISP program: "I'm going to say it comes back to each of the producers, unfortunately, stepping up, but as I say, they've just got a lot on their plate at the moment" (RRDCE9). RRDCE12 highlighted research that supported those on the ground as the best participants in ISPs: "Our research shows that farmers are a really trusted voice. So, they're really highly trusted and they're, I guess, the most authentic and credible spokespeople in this space". The agreement that "those on the ground" (RRDCE2) are best placed to be directly participating, meaning they are involved in the activities with students, was shown by being explicitly stated by several interviewees. It was also highlighted when discussing how RRDCs participate, which was more likely to be facilitating and connecting to those "on the ground". rather than participating in the activities with students themselves. RRDCE13 suggested, for her sector, which included many agribusinesses that were large organizations, that it "would help... for [primary production] organizations more broadly, to acknowledge the need for that [ISPs], and therefore, give someone a role within that organization, X number of days to be able to participate in different activities like this".

RRDCE9 introduced schools to the mix of stakeholders with a potential role to play, along with a suggestion for how RRDCs and other industry bodies may be involved in ISPs:

Maybe the schools need to be encouraged to think about what's growing out and in area and reach out to growers as well. And for them, it's about maybe saying, well, here's who to contact to even find out who's paddock that is that you keep driving past. So maybe that's where we say, oh come to [RRDC], and ... I'll direct you on to [the relevant industry body], and they can tell you what the grower is and, you know, connect people.

The issue of competing priorities for RRDCs, or the level of priority given to ISPs, was repeatedly raised; for example, RRDCE1 stated, "the challenge I see across a lot of industries is the priority... that's always your biggest challenge". Whilst ISPs were, for the most part, seen as important, how much investment and input could be provided by RRDCs was debated. Measuring the return on investment was also perceived to be a large challenge: "... the return on investment is a challenging one to be able to capture". (RRDCE1). RRDCE6 was not alone in thinking that ISPs would "probably be enhanced with some really strong data, I don't know how you would get it, but if there's strong data coming through those programs what you know demonstrate outcomes that would really help RDCs. Yeah, and make it a bit more of a priority".

Following discussions concurring that most RRDCs cannot deliver ISPs alone, RRDCE4 noted the importance of other industry bodies and highlighted different organizations that could be leveraged:

Our industry associations are really important. So, we have multiple tiers of that here. So, we've got [industry body], who are the industry body, national industry body, and then there's state-based under that, and then there's local based under

that, and then there's, you know, regional based under that. So, there's this huge kind of structure that we can leverage.

RRDCE2 also agreed that “the peak industry councils and all of those sorts of organizations have a role to play,” and coordination will “make the dollars go further . . . and make sure that it all fits in with the curriculum, so teachers actually use it”.

In addition to discussing industry bodies and those working in the industry, there was a suggestion that this work be led by the government, and there was a need for a national body with curriculum linkage. Whilst there was no cohesive message describing who should be involved in ISPs, it was clear that many RRDCs did not want to “go it alone” (RRDCE13) and would rather collaborate with, or support, other organizations. The discussions in terms of who “owns” or is involved in the ISP solution touched on many stakeholders, including industry professionals, RRDCs, other industry bodies, schools, and the government, linking to the next theme: collaboration is key.

3.2.4. Collaboration Is Key

Collaboration, or “linking in with. . . other associations and groups” (RRDCE15.4), was highlighted throughout most interviews and was seen as important to help overcome resource barriers and improve the return on investment. Collaborating with suitable people and organizations was seen as a key principle for successful ISPs at various levels.

Resource barriers were noted in most interviews: “it's people and time and, and budget” (RRDCE3), along with ISPs often being “quite resource intensive activities to plan and coordinate and implement” (RRDCE6). However, collaboration between RRDCs, other industry bodies, and education service providers was identified as one way to reduce these barriers. RRDCE15.4 explained that they would continue supporting other organizations delivering ISPs “because they're collaborative, we can't get someone out into every school across Australia, we don't have the capacity to do that. So, linking in with these other associations and groups is really important to us so that we can support their overall initiatives”.

RRDCE15.4 also discussed leveraging investments and collaborating as a whole agriculture industry, rather than individual commodities:

That's why we partner with other places to leverage that, I think it's all about collaboration, I don't think that we can see ourselves as just the [commodity] industry. I think we have to collaborate and make sure that we're all working together with that common goal. Because we, you know, it's just too difficult to do it otherwise. (RRDCE15.4)

After bringing the right people together to collaborate on an ISP, many highlighted the importance of working together to plan a successful partnership that is relevant and valuable for both education and agriculture parties. RRDC15.1 thought it was important to find “the value proposition for all sides and being really clear about that, and really clear about what you want to get out of the day and the expectations from both sides”. RRDCE11 added, “you obviously need to have a well-planned, sort of a well thought out plan as to how the partnership is going to work and who does what”.

Collaboration was seen as a way to not only reduce time and monetary resource barriers but also a lack of knowledge and connections. Education service providers were valued by many and were often engaged because “they have skill sets and networks and experience that, you know, as a program manager, I just don't have that” (RRDCE7), or to “piggyback on their reach and credibility” (RRDCE12).

Collaborating with other organizations was seen to improve return on investment:

I think if we had a coordinated approach, would be very beneficial as well. So, I think you could spend a lot of money. . . investing in promoting agriculture, though I think the more streamlined we can do it the more. . . bang for buck we would get as well. (RRDCE14).

This sentiment was also captured by RRDCE3, who said “this is something that needs strategic coordination amongst all commodity groups”. Several reasons why we need to collaborate across commodity groups were given, including that “it is super competitive, and I think it’s really difficult for us, and that’s why we’re in a structure like PIEFA (Primary Industries Education Foundation of Australia) is that we can come together and kind of work across agriculture” (RRDCE4). RRDCE10 believed that agricultural education needed significant investment and a collaborative effort to compete with other industries:

So, I believe that for this to be truly remarkable, which it needs to be, you know, because we’re competing against those Navy ads (Royal Australian Navy advertising campaigns), and they’re bloody attractive to people, right. So, if we really want to do a good job of this, it needs a significant investment. And I think that it is, it needs a collective for, and I don’t know whether it’s like an organization that is placed to like, bring a room together, but actually think it’s everyone’s responsibility.

Collaboration was also highlighted as important for the day-to-day running of ISPs. It was found to be important to collaborate with the right people and communicate effectively to plan relevant and valuable partnerships. Participants spoke about having the right facilitator, industry partner and school. For example, RRDCE8 said “I think it’s actually having, someone who is like a bit of an advocate, let’s say in the education sector, who sort of makes it easy for businesses to sort of reach out or goes finding those different businesses that would be target businesses where there’s gaps at the moment”. RRDCE3 added “I think the value is having someone that knows the education system. So, you’re looking at a particular group of people with ag, with some sort of agricultural knowledge”. RRDCE14 discussed matching up the right schools with the right industry partner: “I think having the schools and the right people in the school to be the mentors, as well as the right [business] and the right people within the [business] that are passionate, will make it successful”. The importance of a facilitator was evident when RRDC4 said “there are some people that don’t know how to, probably access those opportunities too, particularly locally, that aren’t necessarily connected to the groups that are running them”. A facilitator was identified as someone who may be able to bring together potential industry partners and schools who do not have the knowledge of how to connect themselves.

4. Discussion

This research sought to answer two research questions. Firstly, how do RRDCs describe their role in the implementation of ISPs and secondly, how do RRDCs connect and influence other parts of the ecological system with regard to ISPs? The analysis of strategic and annual operating plans and interview transcripts demonstrated that whilst ISPs are seen as important for industry sustainability, including workforce and social licence, their role in the implementation of ISPs was commonly informal. Interviews articulated the importance of ISPs in attracting students to careers in the industry and improving community perceptions; however, whilst workforce challenges and social licence concerns are repeatedly raised in RRDC strategic plans, there were limited mentions of ISPs in the documents [52,56,57,134]. The importance of ISPs for the agricultural industry has also been raised by industry professionals willing to participate in these activities, including the same workforce concerns [24]. These types of partnerships have been on the policy agenda for many years, with recommendations made to include more input from the industry [4,137]. Specifically for agriculture, strengthening industry–school links is recommended in the National Agricultural Workforce Strategy [11].

Interviews indicate that RRDCs’ role in ISPs was often informal, aligning with the limited information available in the documents analysed. They were involved informally by connecting their levy payers with other ISP stakeholders, and sometimes participating in activities with students themselves, more often than having their own dedicated ISP programs. This research showed that most RRDCs participate in ISPs in some capacity, but

their involvement could be increased. However, resourcing, including time, money, and the right people, were major barriers that influenced the level of involvement.

The other major influence was the level of priority given to ISPs, considering other competing priorities. This aligns with previous research into understanding the perceptions of industry professionals participating in ISPs [22,24,139]. Teachers have also been found to face similar barriers, including time and resources, when implementing agriculture education programs [140].

RRDCs wanted their role to be collaborative, noting the importance of collaboration between ISP stakeholders and across sectors. They saw the role of a facilitator as important to ensure successful collaboration between stakeholders. In previous research, facilitators were found to be valuable, from both school and industry perspectives, often by reducing time and knowledge barriers [24,25,141–143]. This desire for collaboration aligns with the performance principles set out in RRDC funding agreements, of which one relates to “strategic and sustained cross-industry and cross-sectoral collaboration that addresses shared challenges” [28].

The analysis of interview transcripts identified a complex system of connections and influences between RRDCs and numerous other stakeholders. This consolidates RRDCs as important ISP stakeholders. In some cases, RRDC employees participated in ISP activities as microsystem stakeholders. Whether actively participating in ISPs or not, all RRDCs were found to be connected to ISP ecosystems through their role in the exosystem, with interconnections to many stakeholders including levy payers, other industry organizations, and government. RRDCs could, and did, influence other ISP ecosystem stakeholders, most commonly levy payers in the microsystem, facilitators in the micro or mesosystems depending on the extent of their role, and other industry bodies in the exosystem. Participants strongly reflected an interconnection with the macrosystem by highlighting a desire to improve the agriculture industry as a whole system, rather than any individual entity. They were also interconnected with the macrosystem through their position in the industry. Due to the nature of RRDCs, they have the ability to change culture in the agricultural education space through their research and development, direct involvement in ISPs, and messaging to industry participants. They have channels to push ISP messaging and undertake research to then share and drive change. They were also found to be interconnected with the chronosystem through their involvement, or potential to be involved, over time. RRDCs are ingrained in Australia’s agriculture industry and are at low risk of being abolished. This enables RRDCs to have the ability to participate at any level, including contributing to culture change over time. These kinds of indirect links, as explored by Flynn and Pillay [23], can be critical for ISP sustainability and the removal of barriers.

We argue that strengthening the workforce and social licence are important parts of the agriculture innovation system, also raised by levy payers [52,56,57,63]. Agricultural workforce shortages are of concern across the supply chain, including on- and off-farm roles, with the Australian Government including human capital as a key theme in the Delivering Ag2030 plan to build the industry [11,144–146]. Likewise, research and government reports deem establishing and maintaining a social licence to operate as important for future success [147,148]. As one means to help improve student career aspirations and increase student knowledge of agriculture, we argue that ISPs are an important part of the workforce and social licence solution that requires further implementation and innovation [4,9,149]. Due to RRDCs’ role in driving agricultural innovation, we find these organizations are positioned as stakeholders with scope to innovate agricultural ISP ecosystems.

4.1. Theoretical Implications

This research builds on the work of Leonard [26] and Flynn [22]. Leonard [26] applied ecological systems theory to partnerships with various community organizations over 60 years at one school in the United States of America, and with a student focus, found that successful students’ needs are met through a variety of relationships at different

system levels and suggested that a cultural reform strategy has advantages for student development. Flynn [22] studied mining and energy ISPs in Queensland, Australia, similar to the agricultural ISPs in this study. Both researchers explored the exosystem of the ISPs they investigated. Stakeholders in the exosystem of Flynn's [22] study included the state government and a mining and energy association, while Leonard's [26] included a statewide business consortium and many other companies. These studies highlighted exosystem stakeholders as important and influential. Leonard [26] found "that some exosystem relationships could positively affect student development at three levels, by strengthening the small "pockets of excellence," by promoting whole-school change, and by challenging macrosystem-level politics and pushing the district in the right direction" (p. 1001). Likewise, Flynn [22] found that "the interdependency between the exosystem and lower-system levels emerged from the data as a key to the overall effectiveness" (p. 117) of the partnership. Many studies apply EST to other contexts, where exosystem stakeholders are also found to be influential to the systems studied [150,151]. These studies confirmed the importance of exosystem stakeholders, supporting Bronfenbrenner's [20,21] hypotheses and propositions and maintaining the importance of examining ecological systems as a whole. Likewise, this research demonstrates strong interconnections between RRDCs, as exosystem stakeholders, and all levels of ISP ecological systems, supporting the application of EST to agricultural ISPs. This highlights the importance of considering the whole ecosystem, including the exosystem, when exploring agricultural ISPs.

4.2. Practical Implications

Through this research, we constructed knowledge with practical implications for RRDCs, industry professionals, teachers, and those designing and implementing ISPs.

For RRDCs, this research increases awareness of how, as exosystem stakeholders, they are connected to ISPs, and how their strategies, programs, and decision making can impact on ISPs. To the authors' knowledge, the role of RRDCs in ISPs has not been explored previously. This knowledge can be used by RRDCs if innovations to ISPs are sought in the future. This research identified a number of ways in which RRDCs could contribute to more effective agricultural ISP implementation. This includes providing a facilitation role. This could involve maintaining a register of industry professionals and school staff who are interested in participating in ISPs. This register would simplify the process of connecting willing stakeholders. RRDCs could also facilitate connections between school staff and other industry groups and organizations who may be willing to participate in or further facilitate ISPs. In addition, RRDC staff could directly participate in ISPs as industry partners. Examples of activities RRDC staff could participate in, or facilitate, would include school incursions to share information about their career and bringing hands-on career-related activities for students to participate in.

For industry professionals, this research demonstrates that the priority level by levy payers needs to increase for ISPs to be included further in RRDC strategy and AOPs. RRDCs often informally participate in ISPs by connecting industry professionals with facilitators who coordinate partnership activities or schools. Hence, for industry professionals wanting to be involved in ISPs, making RRDCs aware of this will enable RRDCs to make contact if an appropriate opportunity arises. A formal process to register involvement may prove useful for RRDCs and industry professionals.

Practical implications for those designing ISP programs, frameworks, and policies include the consideration of on-ground facilitators, who coordinate, support, and attend partnership activities. On-ground facilitation aligns with previous studies as a key principle for ISP success [25,141–143]. Facilitators can aid the implementation of ISPs by helping teachers and industry professionals overcome barriers such as time, resources, and funding [4,24,25,143]. RRDCs are one potential source of funding for ISP programs which include dedicated facilitators who connect stakeholders and arrange partnership activities. Furthermore, this research also increases our knowledge of the influences and connections within ISP ecosystems, aiding those designing programs to consider all stakeholders.

At a school level, this research highlights that RRDCs are open to connecting further and providing appropriate agricultural professionals to partner with. Many participants discussed that they could connect schools with levy payers or other industry bodies who have the appropriate connections. Whilst education was not a main priority of RRDCs, examples of successful initiatives that schools could be involved in were highlighted.

4.3. Limitations and Directions for Future Research

While this study broadens our knowledge of one stakeholder in agricultural ISP ecological systems, limited research explores other stakeholders. Our knowledge of how these systems work is limited by a lack of research relating to the stakeholders in other parts of the system, including other agricultural industry bodies, the government, and those involved in the education system. In addition, limited research has explored other STEM-related industry bodies regarding ISPs. We recommend that future research focuses on other ISP stakeholders and ultimately brings this knowledge together to provide a greater understanding of the ecologically systemic nature of STEM ISPs.

5. Conclusions

This research makes a significant contribution to STEM, and specifically agricultural, education, by better understanding the nature of one component of agricultural ISPs: RRDCs. ISPs were identified by participants as a valuable part of the solution to address wicked industry sustainability problems through workforce attraction and social licence to operate. Furthermore, RRDCs were found to be interconnected with ISP ecosystems. Due to this, we argue that RRDCs are positioned as important stakeholders with scope to improve agricultural ISP ecosystems as part of their role in driving agricultural research and development. It is hypothesized that industry organizations from other STEM-related sectors are also interconnected with, and have scope to improve, ISP ecosystems.

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