Journal of Agricultural Education, 65(2), 226-240
https://doi.org/10.5032/jae.v65i1.2495

Primary and Secondary School Students' Knowledge and Perceptions of Agriculture

Jaime Manning[1]
Amy Cosby[2]
Nicole McDonald[3]
Eloise Fogarty[4]

Abstract

Agriculture is a significant contributor to the global economy and critical for future food and fibre production. To maximise the industry efficiencies and improve sustainability, a knowledgeable workforce is essential. Today's school-aged youth will be the next generation agriculture workforce. However, there is concern that today's youth are more detached from agriculture than ever before, viewing the industry as an unattractive career prospect and possessing low levels of agricultural literacy. Using a qualitative approach, this research presents the results from an open-response survey item asking Australian primary and secondary students to 'list three words you think of when you hear the word 'agriculture''. Focus groups with Australian primary and secondary teachers were also conducted to explore these findings. Overall, students appear to have what can be described as a conventional understanding of agriculture as it relates to traditional farming, particularly animal production. However, students appeared to have a lower level of understanding and perception of the industry in less-traditional settings, including modern careers and the technologies involved. Improved agricultural education in Australia, including both formal and informal programs on possible career paths and technology adoption in the industry is recommended to support knowledge development of the modern sector to attract the next generation workforce.

Introduction

The knowledge and perceptions of agriculture for the next generation workforce is a significant concern. Knowledge in particular is vital for efficient food and fibre production; a crucial feat amid the growing global population that is expected to reach 9 billion people by 2050 (Doerfert, 2003). Knowledgeable labour is also crucial for economic growth. According to the Food and Agriculture Organization of the United Nations (FAO; 2021), agriculture contributed USD 3.5 trillion to the global economy over the past 20 years. However, while the industry offers an opportune context to boost the economy, the global agricultural workforce on the decline, losing 176 million people over the last two decades (FAO, 2021). Labour inefficiencies can also impact environmental sustainability; for example greenhouse gas intensity which varies, at least in part, due to differences in the implementation of agricultural knowledge and innovation around the world (FAO, 2021).

[1]Jaime Manning is a Senior Lecturer in the School of Health, Medical and Applied Sciences at CQUniversity Australia, Rockhampton, QLD, 4701, j.k.manning.edu.au. https://orcid.org/0000-0003-4785-4313
[2]Amy Cosby is an Associate Professor of Agricultural Education and Extension in the Institute for Future Farming Systems at CQUniversity Australia, Rockhampton, QLD, 4701, a.cosby@cqu.edu.au. https://orcid.org/0000-0003-2199-7607
[3]Nicole McDonald is a Senior Research Officer – Agricultural Education and Extension in the Institute for Future Farming Systems at CQUniversity Australia, Rockhampton, QLD, 4701, n.mcdonald3@cqu.edu.au. https://orcid.org/0000-0001-7751-3574
[4]Eloise Fogarty is a Senior Research Officer – Agricultural Education and Extension in the Institute for Future Farming Systems at CQUniversity Australia, Rockhampton, QLD, 4701, e.fogarty@cqu.edu.au. https://orcid.org/0000-0003-0212-0156

The next generation workforce consists of today's school-aged youth. If today's youth do not possess adequate levels of agricultural knowledge, their ability to address these issues and transform agriculture into a thriving industry of even greater social, economic, and environmental value will be severely impeded (Cosby et al., 2022d). Moreover, without adequate knowledge, it is unlikely that students will perceive the industry as a viable and attractive career option, and thus will be less likely to pursue a career in this area (Cosby, 2019; Lent et al., 1994; McIlveen & McDonald, 2019). For this reason, understanding the knowledge and perceptions of school students of all ages is essential to identify any potential shortcomings of current agriculture teaching, and to develop strategies for improvement.

Systematic reviews on agricultural literacy research conducted between 1988 and 2020 show that many school-aged youth lack the level of agricultural knowledge development expected of their grade level (Cosby et al., 2022d; Kovar & Ball, 2013). For primary school students, research has found that younger students possess limited agricultural knowledge, particularly about food processing, non-food products and modern agriculture (Hess & Trexler, 2011a; 2011b; Meischen & Trexler, 2003). Primary students also demonstrate little understanding about food origins or why certain plant and animal species may be selected for farming (Trexler et al., 2013). Moreover, though agriculture is intrinsically linked with science, technology, engineering and mathematics (STEM) subjects, Brandt et al. (2017) found that many primary students with adequate STEM knowledge still exhibited deficits in their knowledge of modern agriculture.

For secondary students, the research presents much of the same story. That is, while understanding appears to increase with grade level (Cosby et al., 2022c; Gartaula et al., 2020), secondary students still exhibit an overall lack of agricultural knowledge (Pense et al., 2006). The difference in rural and urban students' knowledge has also been reported, with urban secondary students considered disadvantaged in terms of their connection to and knowledge of agriculture (Gartaula et al., 2020). Though this trend has been broadly acknowledged (Fathima et al., 2016; Whitehead & Estepp, 2016), recent research (Cosby et al., 2022c) found that inner regional students actually had the highest level of knowledge compared to urban and remote students, though the author's concede this may have been impacted by the method of participant location classification.

Incorporation of agriculture-specific outcomes in school curriculums can improve student agricultural knowledge, both in terms of how the industry functions and the breadth of available careers. Furthermore, these teachings can help to correct misconceptions about the industry, particularly those that may impact societal acceptance of agriculture. For example, in Australia, the use of hormones to encourage muscle growth in poultry has been banned for over 60 years (Australian Chicken Meat Federation, 2021). However, in a survey of over 5000 Australian students, only 38.1% of primary and 52.9% of secondary students were able to identify this (Cosby et al., 2022b). In that same research, students were asked to identify the ways in which commercial milking occurs on farm. While most students were able to identify that milking machines are used (78.3% primary and 87.4% secondary students), many also thought that milking occurred by hand (77.9% primary and 58.6% secondary students), and this proportion was considerably higher than those who recognised that robotic milking is used (26.7% primary and 52.6% secondary students) (Cosby et al., 2022b). This highlights the prevalence of stereotypical misconceptions about the industry and emphasises potential areas where future societal acceptance of agriculture may breakdown.

True agricultural literacy requires a deep understanding of agriculturally relevant scientific concepts and processes that allows individuals to make personal decisions related to food and fibre industries and participate in socio-cultural affairs and economic productivity (Meischen & Trexler, 2003). This reflects a shift in the definition of agricultural literacy over the past two decades; from requiring a general understanding of the mostly technical aspects of production and distribution of agricultural products, to understanding the broader environmental and global social significance of the industry

(Brandt et al., 2017). In this research, we have used the theoretical framework of agricultural literacy described in Brandt et al. (2017), which recognises that the "knowledge underlying agricultural literacy spans a variety of disciplines, including science, mathematics, engineering, geography and history". Using this framework, this research presents the results from an open-response survey item asking Australian primary and secondary students to 'list three words you think of when you hear the word 'agriculture''. Focus groups with Australian primary and secondary teachers were also conducted to explore these findings.

Research Questions

The research questions to be addressed were:

(i) What do primary and secondary students associate with the word 'agriculture'?
(ii) Do these associations or perceptions change with age?

Using a qualitative approach, the aim of this research was to identify Australian students' associations, understanding and perceptions of the industry, including any potential misconceptions or lack of industry acceptance.

Materials and Methods

Survey

Australian primary (Grade 4 – 6) and secondary (Grade 7 – 10) school students were surveyed as part of a larger body of work examining student agricultural knowledge (Cosby et al., 2023; Cosby et al., 2022c). The data presented in this paper is from the single open-response survey item asking students to 'list three words you think of when you hear the word 'agriculture''. Demographic data (i.e., gender, grade/year level, previous farm exposure, location) is also presented. Location was based on school location and defined by the Australian Statistical Geography Standard Remoteness Structure (Australian Bureau of Statistics, 2016). The structure defines five areas of relative remoteness across Australia: major city, inner regional, outer regional, remote, very remote. For the purposes of this research outer regional, remote, very remote were amalgamated into a single group.

Schools in Australia were invited to participate in the study by email. Additionally, a social media advertisement was used to encourage nomination of a school by parents, teachers, and community members. Students were selected by their principal and/or teacher to participate. The survey was completed in either electronic or written format and students could withdraw at any time up until the survey was completed, after which withdrawal was not possible as the data was anonymised. Following survey completion, electronic responses were exported into a spreadsheet program. Written survey responses were then transcribed into a spreadsheet and merged with the electronic responses.

This research was approved by the CQUniversity Australia Human Research Ethics Committee (approval number 21738). Approval was also granted by each state education department (except Western Australia), respective catholic dioceses, or independent school, relevant to each school type (Government, Catholic or Independent).

Survey participants

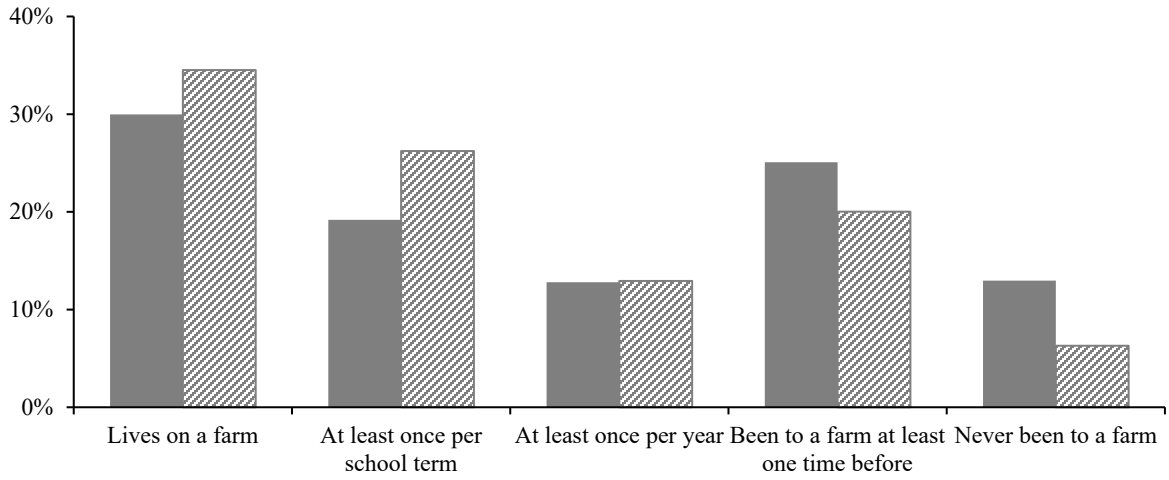
A total of 2477 primary school students (Grades 4 – 6) and 2763 secondary school students (Grades 7 – 10) completed the survey. Initial screening of illegible (students scribbled over the survey) or ineligible (students were in a grade lower than Grade 4) resulted in the removal of 31 primary and 22 secondary surveys. As such, the results in this study are from 2446 primary students and 2741 secondary students.

For primary students, there was an even distribution of female (49.4%, n = 1209) and male (48.9%, n = 1195) participants. Forty-two students (1.7%) selected 'other' or did not respond to this question. Students represented Grades 4 (30.0%, n = 718), 5 (33.2%, n = 794) and 6 (36.8%, n = 880). Most students were in remote areas (45.1%, n = 1104) or inner regional areas (36.0%, n = 880). The remaining 18.9% (n = 462) of students were from major cities.

For secondary students, there was slightly more male participants (53.6%, n = 1396) compared to female (42.1%, n = 1096). A small proportion (4.3%, n = 111) selected 'other' or did not respond to this question. Students represented Grades 7 (28.1%, n = 732), 8 (24.2%, n = 630), 9 (25.9%, n = 674) and 10 (21.8%, n = 567). Like the primary cohort, most students were in remote areas (51.1%, n = 1331) or inner regional areas (30.0%, n = 781). Again, the remaining 18.9% (n = 491) of students were from major cities. Figure 1 presents the level of farm exposure characteristics of the surveyed students.

Figure 1

Level of farm exposure of the surveyed primary (dark grey) and secondary (striped) students, expressed as a percentage (excluding blank responses).



Content Analysis

A content analysis of student responses was conducted (Lincoln & Guba, 1985). Initial categories were developed to code the data into meaningful groups. Preliminary analysis was then undertaken with the most cited words. These initial categories and preliminary analysis were then reviewed and refined by the broader research team, resulting in an agreed set of 11 defined categories (Table 1). These 11 categories were considered 'valid' as they represented data that were clear, unique, comprehendible responses. An additional four categories were also developed to represent responses that were unclear, contained repeated responses, or otherwise suggested the student had misunderstood the task. Any responses within these latter four categories were considered 'invalid'. For clarity, given the question asked students to provide three words associated with agriculture, each word is considered a 'response'. If students provided all three words, this was considered a 'complete response'.

Table 1

Valid Categories, Definitions and Examples Demonstrating Primary and Secondary Student Responses to "List Three Words You Think of When You Hear the Word Agriculture"

Categories	Definition	Example
Animals	Living organisms their features or characteristics	Animal(s), cattle, cow(s), horse(s)
Attitudes	Thoughts or feelings	Different, angry, fun, old/age
Context	Environmental settings or situational characteristics	Farm(s), environment, forest(s), outback
Culture	Art, collective behaviour, beliefs, characteristics, customs, experiences, qualities, settlements, and ethnic groups	Aboriginal, multicultural country, Torres Strait Islander
Equipment	Infrastructure, machinery, tools or their parts	Tractor(s), machines, technology, (farming) equipment
Inputs	Production resources or supplies	Soil, dirt, water, seed(s)
Knowledge and disciplines	Educational practices, settings or subject areas	Scientific, learn(ing), teacher(s), horticulture
Occupations	Jobs	Farmer(s), work, job(s), labour
Products	Goods or commodities	Wheat, fibre(s), sugarcane, milk
Values	Something of worth or importance	Life, community, earth/world, family
Work	Activities or tasks performed	Farming, planting, gardening, irrigation, building/construction,

Using the defined categories in Table 1, a content analysis of all the primary student data was undertaken. All words, including responses containing more than one word (e.g., "large scale farming") were included in the analysis. In this case, the response was coded to all applicable categories. If the intended meaning of a single word was unclear (e.g., "art"), the complete response was examined to clarify the likely intended meaning. For example, a complete response of "art", "Aboriginal" and "history" would have seen "art" categorised to both *Context* and *Culture* as it is unclear if the student was referring to art depicting a farm, or aboriginal art.

A content analysis of all the secondary student data was also completed. While most words were coded to the same category as the primary student analysis, some responses appeared to have a different intended meaning. For example, "water" would generally be categorised to the *Inputs* category. However, one secondary student had a response of "water sport" which was coded to both the *Inputs* and *Context* categories in that case.

For the *Attitudes* category, an additional analysis was conducted on both primary and secondary responses to determine if the response referred to a positive, negative, or neutral category. This was done by examining the individual word and interpreting the implied meaning or connotation. For example, "beautiful", "benefits" and "smart" were categorised as positive. Comparatively, "angry", "hard" and "loud" were considered negative and "confused" and "different" were considered neutral. Again, following categorisation, the broader research team met to discuss the process, and agree on the classifications.

Data analysis

Frequency statistics were calculated for primary and secondary student responses coded to each category. These frequency statistics were based on the total number of responses (i.e., not total number of words) coded to each category. This choice was made as some responses contained more than one word and not all words necessarily pertained to each category. For example, a response of "crops/animals" was coded to both the *Products* and *Animals* categories, even though the latter category was not relevant to the "crop" portion of the answer. Both response counts and percentages were calculated. The frequency of common answers as a proportion of the total responses for each cohort (primary and secondary) was also calculated.

Focus Groups

To help provide more insight into the results of the study, five focus groups, two for primary teachers and three for secondary teachers, were conducted in February to April 2023. Each focus group had between four to six participants and were asked to provide their feedback and opinions on the results gathered. The content of the focus group was not formally analysed, but instead used to provide further context to the survey results.

Results

Responses per category

The frequency of responses per category for primary and secondary students are presented in Table 2. There were 5879 and 8109 valid responses from primary and secondary students, respectively. Primary students also had many invalid responses (n = 1543), the most common of which being a blank response, "I don't know" or similar response, indicating the student was unsure (n = 1460).

When comparing primary and secondary students, the distribution of responses between categories was similar. That is, *Animals*, *Products* and *Work* were the top three categories for both cohorts. Conversely, *Knowledge and Disciplines* and *Values* were amongst the least common categories for both cohorts. Notable differences between the primary and secondary responses related to the *Context*, *Culture* and *Work* categories, with primary students citing 6.8% more Context responses, 2.8% more *Culture* responses and 3.9% less *Work* responses than secondary students. A summary of common responses per category for primary and secondary students are presented in Table 3 and Table 4.

Table 1

Frequency of Responses per Category for Primary and Secondary Students.

Category	Primary		Secondary	
	Total responses	**Unique responses**	**Total responses**	**Unique responses**
Animals	1057	106	2165	114
Attitudes	207	104	209	109
Context	1072	252	1254	258
Culture	494	192	126	74
Equipment	179	55	286	60
Inputs	132	24	210	39
Knowledge and disciplines	123	45	137	67
Occupations	141	50	116	27
Products	1198	160	1626	166
Values	134	56	85	35
Work	1142	187	1895	242
Total valid responses	**5879**	**1231**	**8109**	**1191**
Unsure	1460	-	467	-
Illegible	30	-	7	-
Invalid	12	-	20	-
Repeated word	41	-	21	-
Total invalid responses	**1543**		**515**	

Note. Both the total number of responses per category and the number of unique responses is shown. Responses from the Unsure, Illegible, Invalid or Repeated word categories were considered invalid.

Table 2

The Three Most Common Responses per Category for Primary Students.

Category	Top 3 responses	Count	% of category	% of cohort total
Animals	Animal(s)	571	54.5	9.8*
	Cow(s)/Cattle	255	24.1	4.3
	Sheep	44	4.2	0.7
Attitudes	Angry	24	11.6	0.4
	Fun	19	9.2	0.3
	Different	14	6.8	0.2
Context	Farm(s)	483	45.1	8.2*
	Land	124	11.6	2.1
	Nature	72	6.7	1.2
Culture	Aboriginal/Indigenous/Torres Strait Islander	124	25.1	2.1
	Culture(s/al)	97	19.6	1.6
	Country	50	10.1	0.9
Equipment	Tractor(s)	87	48.6	1.5
	Machine(s/ry)	33	18.4	0.6
	Tech(nology)	12	6.7	0.2
Inputs	Dirt/soil	55	41.7	0.9
	Water	39	29.5	0.7
	Seed(s)	21	15.9	0.4
Knowledge and disciplines	Science(s/tific)	31	25.2	0.5
	Teach(ers/ing)	21	17.1	0.4
	School(s)	16	13.0	0.3
Occupations	Farmer(s)	74	52.5	1.3
	Work	22	15.6	0.4
	Job(s)	17	12.1	0.3
Products	Crop(s)	357	29.8	6.1*
	Plant(s)	276	23.0	4.7
	Food	222	18.5	3.8
Values	Life	34	25.4	0.6
	Community	21	15.7	0.4
Work	Help(er/ful/ing)	17	12.7	0.2
	Farming/Farm work	811	71.0	13.8*
	Grow(ing/th)	77	6.7	1.3
	Plant(ing)	42	3.7	0.7

Note. The frequency of each response is shown. The proportion of each response based on the number of responses per category and for the entire cohort (n = 5879) is also shown. An asterisk (*) is used to highlight answers that accounted for at least 5% of all responses.

Table 3

The Three Most Common Responses per Category for Secondary Students.

Category	Top 3 responses	Count	% of category	% of cohort total
Animals	Animal(s)	1010	46.7	12.5*
	Cow(s)/Cattle	489	22.6	6.0*
	Livestock/Stock	229	10.6	2.8
Attitudes	Fun	49	23.4	0.6
	Boring/Boredom	20	9.6	0.2
	Hard [work]	15	7.2	0.2
Context	Farm(s)	565	45.1	7.0*
	Land	85	6.8	1.0
	Nature	69	5.5	0.9
Culture	Aboriginal/Indigenous/Torres Strait Islander	31	24.6	0.4
	Culture(s/al)	23	18.3	0.3
	Country	16	12.7	0.2
Equipment	Tractor(s)	125	43.7	1.5
	Machine(s/ry)	100	35.0	1.2
	Tech(nology)	15	5.2	0.2
Inputs	Dirt/soil	98	46.7	1.2
	Water	65	31.0	0.8
	Seed(s)	13	6.2	0.2
Knowledge and disciplines	Science(s/tific)	34	24.8	0.4
	Horticulture	17	12.4	0.2
	Learning	17	12.4	0.2
Occupations	Work	53	45.7	0.7
	Farmer(s)	32	27.6	0.4
	Labour	5	5.2	0.1
Products	Plant(s)	591	36.3	7.3*
	Crop(s)	485	29.8	6.0*
	Food	276	17.0	3.4
Values	Sustainab(le/ility)	16	18.8	0.2
	Earth	15	17.6	0.2
	Green	12	14.1	0.1
Work	Farming/Farm work	996	52.6	12.3*
	Work(ing)	180	9.5	2.2
	Grow(ing)	103	5.4	1.3

Note. The frequency of each response is shown. The proportion of each response based on the number of responses per category and for the entire cohort (n = 8109) is also shown. An asterisk (*) is used to highlight answers that accounted for at least 5% of all responses.

Attitude analysis

Further examination of the *Attitudes* category showed that almost half of primary school responses (47.1%, n = 1127) and a significant proportion of secondary school responses (40.7%, n = 1060) were positive (e.g., "awesome", "a good subject" "essential"). Conversely, 33.7% (n = 806) of primary responses, and 38.0% (n = 989) of secondary responses were negative. Examples of negative responses included "hard work", "dry and boring", "pollution". The remaining 19.2% (n = 459) of

primary responses and 21.3% (n = 544) of secondary responses were considered neutral (e.g., "alternative", "common", "different").

Discussion

Using a qualitative approach, this research has examined the associations, understanding and perceptions of agriculture that Australian school students possess. Framed within the theoretical framework of agricultural literacy described in Brandt et al. (2017), this research sought to understand the variety of associations students have with agriculture, as well as any common themes that could be identified. Across both cohorts, the most often referenced aspects of agriculture related to *Animals*, *Context*, *Work* and *Products*. Conversely, responses related to *Knowledge* and *Disciplines*, *Values* and *Attitudes* were less common.

The most common response across both cohorts related to "farming" or "farm work", accounting for 13.8% of primary responses and 12.3% of secondary responses. Similarly, the farm context was most identified under the *Context* category and being a farmer was the most common identified occupation. This highlights the common association of agriculture and a typical farming system but suggests a lack of knowledge or awareness of the breadth of modern agriculture and other related aspects (Cosby et al.. 2022c, PIEFA, 2020). This was identified by the focus group participants, with one secondary teacher stating that the students had "clearly [focused on] work on the farm, rather than careers", with another clarifying this as "the actual physical work, the hard jobs". Student responses relevant to the *Occupations* category support this, with only small numbers of students identifying roles other than farming, and some even asserting roles that were not directly relevant to agriculture (e.g., "doctor").

A stereotypical view of agriculture as involving "farming, tractors and paddocks" and "hard manual labour" has previously been reported in research of late secondary and first-year university students (YouthInsight Australia, 2017). YouthInsight Australia (2017) noted that popular culture (i.e., movies, television, cartoons) and the media significantly impacted opinions of the sector, leading to a narrow view of conventional agriculture and resulting in a low level of interest in an agricultural career. Similarly, in research of Australian Year 7 and 10 students, typical careers were found to be entrenched in student's minds (e.g., farmer, machinery operator), while knowledge and perceptions of other occupations (e.g., agronomist, fisheries scientist) were much lower (PIEFA, 2020). As the industry continues to face seemingly conflicting needs of increased productivity and increased sustainability, attraction of a skilled future workforce is essential (Department of Agriculture Water and the Environment, 2020; Wu et al., 2019). However, these results, and those of the current research highlight potential issues associated with attraction of future workers into the field, particularly if they are not aware of the range of jobs available.

Similarly to the associations of conventional farm work, common references to "tractors" and "machines" rather than "technology" support the idea that students still picture traditional farming systems, rather than the modern and innovative industry that agriculture is today (Wu et al., 2019). One secondary teacher stated, "I thought they'd at least recognise some technology in there… but [the result] … it's pretty low". Supporting this, another secondary teacher stated, "I'm surprised they didn't pick up technologies [and] the different types of emerging technologies. Because… it's in the curriculum to teach it… so I'm surprised they didn't pick it up". Again, this highlights the need for improved education and communication of the current state of the industry, including the technology used in agriculture to assist in future workforce attraction.

Like the generic responses for the *Work* category, students, particularly at secondary level, readily responded with generic references to "animals" or "livestock" as opposed to specific animal types. Overall, the high frequency of *Animal* responses is unsurprising given the typical association between animals and farms. This is particularly true for Australia, where livestock and dairy establishments

account for 74% of all agricultural businesses (ABARES, 2022). It may also reflect the common exposure of students to animals through agricultural shows, farm visits or animal discovery centres (Hillman & Buckley, 2011) as well as the common representation of animal-based farm work in popular culture (e.g. Heartland (CBC, Canada), Yellowstone (Paramount, USA) and McLeod's Daughters (Nine Network, Australia) are all multi-series television shows based on livestock-producing farms). Though "cows" and "cattle" were also commonly identified by both cohorts, the dominance of more general references to "animals" and "livestock" may indicate a lack in depth of understanding of the types of animals farmed. This supports previous reports by PIEFA (2020), where between 39% and 56% of surveyed Year 7 to Year 12 students (n = 1108) stated that they "did not know anything" or "did not really know much" about specific animal farming systems such as poultry, pig and aquaculture production. Lack of specific knowledge was also evident for crop-based systems, with common *Products* responses mostly referring to "plants", "crops" or "food" more broadly, rather than specific crop types. Today's students are tomorrow's consumers. Thus, knowledge of farm product origins, including the source of each product, is vital to ensure continued industry support through consumer purchasing behaviour. These concepts can be taught across several curriculum areas, including Health, Geography or Economics, allowing for cross-curricula development of agriculture knowledge and perceptions (Nanayakkara et al., 2017). For secondary students, broader aspects of food production should also be taught, including political, social and environmental features (Fordyce-Voorham, 2015), particularly as students begin to consider their employment prospects or further education plans following school.

Examining the *Attitudes* and *Values* categories, students in general appear to perceive the industry as positive, with 40 – 50% of those in the former category considered to have a positive connotation. This was similarly reflected in PIEFA (2020), where 41 – 79% of students had a "somewhat positive" or "very positive" sentiment toward all listed production systems, including animal and plant systems. In that report, students were most heavily influenced in their perceptions by schoolteachers (59%), followed by traditional media (51%) and family and friends (44%). This is important to consider, particularly given the known influence of teacher's perceptions of agriculture on the likelihood that they will incorporate agriculture contexts in their teaching (Knobloch et al., 2007) and the impact of parent perceptions on encouraging a career in the field (Dodd, 2011). In the context of encouraging movement into the agriculture workforce, concurrent increase in teacher knowledge and perception of the industry, for example, through professional development, is likely to assist in attraction of future workers.

The *Values* category also gives insight into the how these perceptions may be improved, with common responses of "life" and "[the] earth" showing an understanding of the reliance of the industry natural resources. Sustainability was also commonly identified by secondary students, highlighting a progression in knowledge from primary to secondary students. As the industry moves towards more sustainable production, the importance of bridging the gap between what consumers perceive and what is accurate about the industry will be essential. This could involve education related to industry-specific sustainability frameworks (Cotton Australia & CRDC, 2019; Dairy Sustainability Framework, 2021; Sustainable Australian Beef, 2017), including enabling of students to make sustainable consumer choices and identify potential greenwashing (Cosby et al., 2022a).

One interesting result from this research was the number of references to *Culture*, including First Nations People. This was evident for both primary and secondary students and accounted for around 25% of responses under this category. Though agriculture is an important aspect of society, the initial frequency of responses was surprising. However, on further examination it was hypothesised that the frequency of responses reflects that the world 'agriculture' contains the work 'culture' and may have triggered students to relate it in this way. This was affirmed throughout the focus groups, where primary teachers stated, "they've focused on the culture word" and "if you didn't use the word agriculture, you'd have a lot less linking culture to that… if you used the word farming, you'd probably get zero". References to "cultures" and First Nations Peoples may also reflect concurrent learning in other school

subjects, which again was reflected in the focus groups, with one primary teacher stating that "the history and geography… that we've been doing the last few years is very Aboriginal and Torres Strait Islander based… [so] that doesn't surprise me that, you know, they might have just seen the word culture in agriculture", and another agreeing stating that "it's a big part of their vocab and learning these days". This potential misunderstanding of the word should be considered in future research, with an initial question that confirms their understanding of the definition of 'agriculture' likely to assist in analysis.

Limitations of this research include the potential impact of student selection by school principals and/or teachers, the assumption that students had adequate comprehension of the task and limitations associated with qualitative analysis. In the first instance, principal and/or teacher selection of students may have led to bias in the data, in that it is likely that students with higher reading and writing comprehension would have been selected over those with lower academic capability. This may have potentially skewed the data, resulting in a surveyed population of students that were not representative of the true population. Relatedly, this research assumes that all surveyed students were able to understand what was required of this task. In the case of the secondary students, the low number of invalid responses suggests most students were able to at least understand what was required. Comparatively, the large number of invalid responses from primary students, particularly those in the Unsure category, indicate that this was not the case for the younger cohort. Based on the structure of the question, it is unknown whether this reflects a true lack of knowledge of agriculture or a lack of comprehension of the task. Further research should attempt to explore this, potentially through semi-structured interviews which would allow for more insight into why particular responses were given. Finally, based on the nature of qualitative analysis, this research was also limited by the research team's ability to interpret student responses that were less clear (e.g., incorrectly spelled or an unclear meaning). Incorporation of semi-structured interviews, as previously recommended, would benefit this, allowing for nuanced understanding of student answers. Future research of this manner should also attempt to understand why students chose specific words, particularly as it relates to development of programs that are able to adequately communicate learnings.

Conclusion

In summary, there is a need for agriculturally literate school-aged youth to help address global food shortages amid a growing population. In Australia, there are plans to grow our agricultural leadership, improve environmental sustainability and increase the economic value of the industry to 100 billion AUD by the year 2030 (National Farmers Federation, 2019). To support this endeavour, a 25% increase in the size of the local agricultural workforce is required (National Farmers Federation, 2019). While school-based education programs can support agricultural knowledge development, there is a gap in knowledge regarding student associations, understanding and perceptions of the agricultural industry. This study sought to identify these associations and perceptions using an open-response survey question asking students to "list three words you think of when you hear the word 'agriculture'". Overall, students appear to have a conventional understanding of agriculture as it relates to farming, particularly animal production. However, it appears they have a lower perception of the industry in modern settings, including less traditional careers and the technological innovation of the industry. Improved agricultural education and career information at key points throughout the schooling career should be developed to support this knowledge development throughout a student's schooling career. Collaboration between the agriculture and education sectors is needed to ensure that resources developed by teachers reflect the modern industry, and students can speak with those employed in a wider variety of careers to learn more about pathways to employment.

References

ABARES. (2022). *Snapshot of Australian Agriculture 2022* (ABARES Insights, Issue 1, 2022). Australian Bureau of Agricultural and Resource Economics and Sciences - Department of Agriculture Water and the Environment. https://daff.ent.sirsidynix.net.au/client/en_AU/search/asset/1033241/0

Australian Bureau of Statistics. (2016). *1270.0.55.005 - Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure, July 2016* Australia Bureau of Statistics. Retrieved 19 Jul 2022 from https://www.abs.gov.au/websitedbs/d3310114.nsf/home/remoteness+structure

Australian Chicken Meat Federation. (2021). *Time to seperate fact from fiction*. Retrieved 29 April 2022 from https://www.chicken.org.au/time-to-separate-fact-from-fiction/

Brandt, M., Forbes, C., & Keshwani, J. (2017). Exploring elementary students' scientific knowledge of agriculture using evidence-centered design. *Journal of Agricultural Education*, *58*(3), 134-149. https://doi.org/10.5032/jae.2017.03134

Cosby, A., Fogarty, E. S., & Manning, J. (2023). Australian primary school students's knowledge of the agricultural industry. *Education Sciences*, *13*(2).

Cosby, A., Lawson, A., Gudde, J., & Fogarty, E. S. (2022a). Connecting nature: The potential of Australian dairy initiatives in collaborative biodiversity governance. *Agronomy*, *12*(2). https://doi.org/10.3390/agronomy12020366

Cosby, A., Manning, J., Fogarty, E., Snowden, A., McCosker, A., McDonald, N., Lancaster, L., & O'Dea, M. (2022b). *Ag knowledge in schools. What do Australian primary and secondary students know about Agriculture?* https://static1.squarespace.com/static/631b1176bb0573377cd87416/t/631b2df08f71a31aacdd1297/1662725695202/Ag+Knowledge+in+school+report+FINAL.pdf

Cosby, A., Manning, J., Lovric, K., & Fogarty, E. S. (2022c). The future agricultural workforce – is the next generation aware of the abundance of opportunities? *Farm Policy Journal*, 18-30. https://www.farminstitute.org.au/product/fpj1902-cosby-a-et-al-2022-the-future-agricultural-workforce-is-the-next-generation-aware-of-the-abundance-of-opportunities/

Cosby, A., Manning, J., Power, D., & Harreveld, B. (2022d). New decade, same concerns: A systematic review of agricultural literacy of school students. *Education Sciences*, *12*(4). https://doi.org/10.3390/educsci12040235

Cosby, A., Manning, J., & Trotter, M. (2019). TeachersFX - building the capacity of STEM, agriculture and digital technologies teachers in Western Australia. *International Journal of Innovation in Science and Mathematics Education*, *27*(4), 76-87. https://doi.org/https://doi.org/10.30722/IJISME.27.04.006

Cotton Australia, & CRDC. (2019). *Australian Cotton Sustainability Report 2019*. https://www.crdc.com.au/sites/default/files/pdf/Australian%20Cotton%20Sustainability%20Report%202019%20-%20single%20pages.pdf

Dairy Sustainability Framework. (2021). *2020 Reporting*. https://dairysustainabilityframework.org/wp-content/uploads/2021/11/DSF-2020-Reporting.pdf

Department of Agriculture Water and the Environment, N. A. L. A. C. (2020). *National Agricultural Workforce Strategy discussion paper*.

Dodd, J. (2011). *Sustaining Agriculture in NSW High Schools - An Assessment of the Use of Examples from Alternative Agriculture and Investigation into the Role of High School Agriculture in Meeting The Future Needs of the Industry* [Masters Thesis, Charles Stuart University]. https://cdn.permaculturenews.org/files/JDoddDissertation.pdf

Doerfert, D. L. (2003). Agricultural literacy: An assessment of research studies published within the agricultural education profession. Proceedings of the 22nd Annual Western Region Agricultural Education Research Conference, Portland, https://www.agedweb.org/WRAEC/2003/papers/Doerfert.pdf

FAO. (2021). *World Food and Agriculture – Statistical Yearbook 2021.*

Fathima, R., Krishnankutty, J., & Krishnan, S. (2016). Differential awareness about components of agriculture among students in Kerala. *Journal of Tropical Agriculture*, *54*(1), 90. https://jtropag.kau.in/index.php/ojs2/article/view/377

Fordyce-Voorham, S. (2015). Preliminary findings of a food literacy program evaluation using a food literacy model. *Journal of the Home Economics Institute of Australia*, *22*(3), 3-12. https://search.informit.org/doi/abs/10.3316/aeipt.211573

Gartaula, H., Patel, K., Shukla, S., & Devkota, R. (2020). Indigenous knowledge of traditional foods and food literacy among youth: Insights from rural Nepal. *Journal of Rural Studies*, *73*, 77-86. https://doi.org/10.1016/j.jrurstud.2019.12.001

Hess, A. J., & Trexler, C. J. (2011a). A qualitative study of agricultural literacy in urban youth: Understanding for democratic participation in renewing the agri-food system. *Journal of Agricultural Education*, *52*(2), 151-162. https://doi.org/10.5032/jae.2011.02151

Hess, A. J., & Trexler, C. J. (2011b). A qualitative study of agricultural literacy in urban youth: What do elementary students understand about the agri-food system? *Journal of Agricultural Education*, *52*(4), 1-12. https://doi.org/10.5032/jae.2011.04001

Hillman, K., & Buckley, S. (2011). *Report on surveys of students' and teachers' knowledge and understanding of Primary Industries*. https://www.piefa.edu.au/uploads/9/8/9/8/98986708/food_fibre_and_future_pief_report.pdf

Knobloch, N., Ball, A. L., & Allen, C. (2007). The benefits of teaching and learning about agriculture in elementary and junior high schools. *Journal of Agricultural Education*, *48*(3), 25-36. https://doi.org/10.5032/jae.2007.03025

Kovar, K. A., & Ball, A. L. (2013). Two decades of agricultural literacy research: A synthesis of the literature. *Journal of Agricultural Education*, *54*(1), 167-178. https://eric.ed.gov/?id=EJ1122296

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Joural of vocational behavior*, *45*(1), 79-122. https://doi.org/10.1006/jvbe.1994.1027

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

McIlveen, P., & McDonald, N. (2019). The vocational psychology of agriculture: Fiat panis. In J. A. Athanasou & H. N. Perera (Eds.), *International Handbook of Career Guidance* (pp. 459-474). Springer International Publishing. https://doi.org/10.1007/978-3-030-25153-6_21

Meischen, D. L., & Trexler, C. J. (2003). Rural elementary students' understandings of science and agriculutral education benchmarks related to meat and livestoock. *Journal of Agricultural Education*, *44*(1), 43-55. https://doi.org/10.5032/jae.2003.01043

Nanayakkara, J., Margerison, C., & Worsley, A. (2017). Importance of food literacy education for senior secondary school students: food system professionals' opinions. *International Journal of Health Promotion and Education*, *55*(5-6), 284-295. https://doi.org/10.1080/14635240.2017.1372695

National Farmers Federation. (2019). *2030 Roadmap: Australian Agriculture's Plan for a $100 Billion Industry*. https://nff.org.au/wp-content/uploads/2020/02/NFF_Roadmap_2030_FINAL.pdf

Pense, S. L., Beebe, J. D., Leising, J. G., Wakefield, D. B., & Steffen, R. W. (2006). The agricultural literacy of urban/suburban and rural twelfth grade students in five Illinois high schools: An ex post facto study. *Journal of Southern Agricultural Education Research*, *56*(1), 5-17. http://www.jsaer.org/pdf/Vol56/56-01-005.pdf

PIEFA. (2020). *Food, fibre and our future 2020: PIEFA Student Survey Summary Report on Student Knowledge, Understanding and Sentiment About Primary Industries*. Primary Industries Education Foundation Australia. https://www.piefa.edu.au/uploads/9/8/9/8/98986708/piefa_summary_student_survey_report__food_fibre_and_our_future_2020.pdf

Sustainable Australian Beef. (2017). *2017 Framework Report*. Retrieved 26 August 2020 from https://www.sustainableaustralianbeef.com.au/the-framework

Trexler, C. J., Hess, A. J., & Hayes, K. N. (2013). Urban elementary students' conceptions of learning goals for agricultural science and technology. *Natural Sciences Education*, *42*(1), 49-56. https://doi.org/10.4195/nse.2013.0001

Whitehead, I. M., & Estepp, C. M. (2016). Agricultural knowledge and perceptions among students enrolled in agriscience programs in Texas counties bordering Mexico. *Journal of Human Sciences and Extension*, *4*(2), 1-14. https://doi.org/10.54718/GDXG8269

Wu, W., Dawson, D., Fleming-Munoz, D., Schleiger, E., & Horton, J. (2019). *The Future of Australia's Agricultural Workforce*. https://www.qff.org.au/wp-content/uploads/2019/12/19-00351_DATA61_REPORT_AgricultureWorkforce_WEB_191031.pdf

YouthInsight Australia. (2017). *Developing student interest in the agriculture sector*. https://www.manjimup.wa.gov.au/repository/libraries/id:2dsd3ekxd17q9s83uxq6/hierarchy/SITE%20COLLECTION%20DOCUMENTS/our-shire/SEED/media-releases/documents/SEED_YouthInsight_%20DevelopingStudentInterestinAg_Dec2017.pdf