

Technology Use in Agriculture: Awareness and Perceptions of NSW Technology Mandatory Teachers

Abstract

Technology use in agriculture or 'AgTech' (Agricultural Technology), is rapidly changing conventional farming practices and decision-making processes. To ensure the industry can successfully harness the power of AgTech, digital skill development of workers is crucial. This can be achieved by adequate education of the future workforce, today's students. However, a key requirement for student education is to ensure teachers are aware and knowledgeable of AgTech. Teachers' perception of agriculture is also important as they are key influencers of the next generation's awareness of careers in the industry. This study explores the views of Australian 'Technology Mandatory' teachers, a compulsory subject for Years 7 – 8 students containing an agriculture component, with the aim of determining their awareness and perception of AgTech. Teachers were surveyed after participation in a professional development workshop focused on livestock tracking technologies. Results found that teacher perceptions of the agricultural industry had an impact on their knowledge of AgTech on-farm. Conversely, teacher connection to the agricultural industry did not have an impact on awareness. Instead, connection to the agricultural industry was significantly associated with demographic factors including current school location and teaching experience, as well as the use of traditional media, social media and family and friends to gather information on the industry. Overall, most participants understood the importance of technology use for improving animal welfare, productivity and profitability, and environmental sustainability outcomes, and had a positive perception of the industry.

Keywords: Teacher perceptions, AgTech, agricultural technology, professional development, authentic data

Introduction

The Australian agricultural industry plays a vital role in the national economy. Since the beginning of the 21st century, the gross value of agriculture has increased from AUD 70 billion to 75 billion, representing a 7% growth when adjusted for inflation (ABARES, 2022). In 2019-20, the industry contributed 1.9% to the Gross Domestic Product (GDP). Livestock production contributes the greatest value by production (51%), followed by cropping (23%), horticulture (18%), fisheries (4%) and forestry (4%) (ABARES, 2021). Approximately 70% of agricultural output is exported, representing 12% of total goods and services exported in 2020-21 (ABARES, 2022). In addition to significant economic value, the agricultural industry contributes to 2.4% of national employment (Australian Bureau of Statistics, 2022), though a significant proportion of the workforce were found to have left the sector between the 2011 and 2016 census (ABS, 2016). Given the fiscal significance of the industry, futureproofing of Australian agriculture is clearly important. However, Australian producers must often manage significant risk and variability, including commodity prices and a variable climate. This trend is not uniquely Australian. The value of the United States agriculture and related industries is hugely significant, contributing USD 1.055 trillion to the GDP and accounting for 10.3% of all US employment in 2020 (Economic Research Service, 2022). Similar to Australian farmers however, American farmers are expected to maintain this high level of productivity amidst declining farm numbers and stagnating net farm income (Economic Research Service, 2022). Technological advances can assist these challenges, including innovations to improve efficiency of current farm practice.

Agricultural technology, commonly referred to as 'AgTech', is rapidly transforming farming practices. To date, most commercial applications of AgTech have been in the broad-acre cropping sector (Ferguson & Colditz, 2019), including innovations such as auto-steer and guidance

tractors, yield monitoring and remote sensing (Trotter, 2013). In addition, many applications of AgTech are also available in intensive livestock systems, i.e. the management of animals in smaller, more confined areas such as poultry or pig farms and sheep or cattle feedlots (Aquilani et al., 2022). Comparatively, in extensive livestock systems where animals are managed over vast areas of pastoral or rangeland environments with typically low input, uptake of technologies has been slower, though this is changing as development pipelines evolve (Ferguson & Colditz, 2019). In a review of farming technologies in pasture-based systems, Aquilani et al. (2022) identified numerous technologies that can be used. Examples include Global Positioning System (GPS) locators; radio-frequency identification tags (RFID); animal activity monitors (e.g., accelerometers), and remote sensing by satellite images or unmanned aerial vehicles (UAVs).

Digitization of agriculture offers the ability to turn data into actionable information to support decision making processes (Aquilani et al., 2022; Ingram & Maye, 2020). AgTech can also help to improve farm animal welfare through improved monitoring of various aspects of welfare, such as feed and water consumption, access to shelter and rapid detection of disease (Fogarty et al., 2019). However, a key requirement for successful implementation is to ensure that farmers and advisers have the skills required to capture this value. One way to achieve this is to target future agricultural workers and ensure they have high levels of digital literacy (Ingram & Maye, 2020; Manning, Cosby, Power, et al., 2022). This can be achieved as early as school-aged students. In Australia, tertiary educators rely on secondary schools to supply suitable candidates for agricultural degrees (Peltzer, 2019). Therefore, adequate exposure to agriculture in schools, as well as technology and digital skill development, is essential. Though the Australian Curriculum Assessment and Reporting Authority (ACARA) has incorporated agriculture into the national curriculum, implementation is not mandatory (ACARA, 2021). Instead, it is up to the individual school if they choose to incorporate an agricultural course into their curriculum (Peltzer, 2019). The exception to this are high schools in the state of New South Wales (NSW), where agriculture has been introduced as part of the compulsory curriculum (NESA, 2017) within the 'Technology Mandatory' (TechMand) subject for Years 7 – 8.

Subject matter knowledge and awareness is known to impact teaching quality and student achievement (Kola & Sunday, 2015). In the context of agriculture, this is of particular importance for urban school students, where a general lack of awareness and understanding of agricultural issues and available job prospects are magnified (Dodd, 2011). Out of field teaching may also contribute to this knowledge deficit, as teachers are required to teach subjects which they do not have the required pedagogical or technical knowledge (Weldon, 2016). Knowledge is also theorised to impact perception (Rock, 1985) where the former refers to a conscious stored representation and the latter to the representation of objects or events based on stimulus input, usually autonomous with respect to thought. For agriculture, public perception is extremely important, as evidenced by the growing demand for welfare-friendly animal production systems (Alonso et al., 2020) and the potential impact of these perceptions on consumer purchasing behaviour (Napolitano et al., 2010). As AgTech continues to develop at a rapid rate, it is likely that teachers, even those with adequate qualifications, will struggle to remain up-to-date, particularly if they are not given the required time or resources to learn. Professional development (PD) activities can assist in this, by providing teachers with knowledge of novel technologies and the skills to apply them in the classroom. For example, designed in collaboration by the NSW Department of Education and CQUniversity, the GPS Cows Module focuses on emerging AgTech, specifically GPS tracking technology, as a novel method of monitoring livestock behaviour. Provided as a classroom-ready resource, the Module was specifically developed for implementation into the TechMand teaching program. To assist in Module uptake, an accompanying PD workshop was also developed to ensure teachers possessed the skills and confidence to apply the Module in the classroom.

The Purpose of the Study

This paper explores the views of the GPS Cows workshop participants, with the aim of determining the awareness and perception of AgTech by NSW TechMand teachers. The research questions to be addressed are:

- (i) To what extent do NSW TechMand teachers feel connected to or have a positive perception of the agricultural industry?
- (ii) What is the knowledge and perception of technology use in agriculture by NSW TechMand teachers?
- (iii) How do factors such as childhood location, current school location or information source impact teachers' connection to or perception of agriculture?

It is hypothesized that most teachers will be unaware of the role of emerging AgTech and that a teacher's connection to and perception of the agricultural industry will impact their views of these technologies. Additionally, we hypothesize that both connection and perception will be dependent on the teacher's background and their use of different information sources regarding the industry.

Materials and Methods

GPS Cows workshop

The one-day GPS Cows workshops were held at 16 regional and metropolitan locations across NSW in Australia between 2018 and 2019. The purpose of the workshops was to introduce teachers to the GPS Cows Module and to teach the skills required to apply the Module in the classroom. The workshops were available free of charge to NSW government teachers, or for a small nominal fee (AUD 100) for teachers from non-government schools. The workshops were delivered in person by AgTech industry experts. A qualified teacher was also present throughout the workshop to facilitate group discussion.

GPS Cows Module

The Module itself is not the focus of the research (see Manning et al., 2023 for more details). Nevertheless, a brief description of the content is important to contextualise this work. Beginning with an exploration of technology advances in agriculture more broadly, the Module then focuses on GPS tracking technology as a method of monitoring livestock behaviour. Module participants are introduced to a case study farm and sample GPS dataset, which they then learn to analyse and interpret using Microsoft Excel and ESRI ArcGIS Online® (a Geographic Information System software, ESRI (2021)). The Module concludes with a discussion around the use of GPS data to make key productivity decisions, as well as the use of the technology to improve animal welfare. The workshop provided a condensed version of the Module, ensuring teachers were stepped through the activities they would then go on to apply in their classroom.

Data Collection

Following workshop attendance, participants completed a survey containing four open-response and 21 closed-response questions. Open-response questions were used to evaluate the GPS Cows Module itself, including positive aspects of the Module and any improvements that could be made. Closed-response questions were generally answered on a 5-point Likert scale or by selection of a given category (e.g., for demographic data). The survey was co-designed by NSW Department of Education Technological and Applied Studies Advisors and the research team. Internal validity was assessed by testing the content of the questions (Roberts & Priest, 2006) with participants of a pilot workshop comprising of TechMand teachers of various backgrounds and experience levels. Good internal consistency reliability was demonstrated ($\alpha = 0.9$), using IBM SPSS Statistics for Windows (IBM Corp, 2020).

Data from the survey were anonymous, and participation was not compulsory. The mean response rate per question was 94.5% (range 63.2% - 100%). This research was approved by the CQUniversity Australia Human Research Ethics Committee (approval number 21324).

Data Analysis

Closed-ended questions were analysed by descriptive statistics. In addition, Fishers Exact tests were used to analyse the interaction between pairwise combinations of survey questions. The Fishers Exact test was selected due to the low response numbers across some response categories. Similar responses were also merged into a single response category to facilitate analysis (Table 1). The significance value was set at $P \leq 0.05$, and, if found, a contingency table was populated to explore the interactions further. Odds ratios were calculated for all 2x2 tables. Analysis was conducted in R (R Core Team, 2018).

Table 1

Merged Responses for Survey Questions

Survey question	Possible responses	Merged categories
“How many years have you been teaching?”	< 1 year	0 - 3 years
	1 - 3 years	
	4 - 7 years	4 - 10 years
	8 - 10 years	
	10 - 15 years	
16 + years	16+ years	
“Where did you spend the majority of your childhood?”	Capital City – 250,000+ people	Major City
	Major City – 50,000 - 250,000 people	
	Large Town – 19,000 - 49,000 people	Town
	Town – 5,000 - 18,000 people	
“Where is your current school located?”	Rural Town – less than 5,000 people	Rural Town
“Do you have a formal qualification in agriculture?”	Postgraduate	University
	Undergraduate	
	Diploma	TAFE
	TAFE Certificate	
No	No	
“Which of the below best describes your connection to the agricultural industry?”	I’m strongly connected to the industry, keep up-to-date with agricultural issues daily and personally know farmers	Connected
	I’m connected to the industry and regularly keep up-to-date with agricultural issues	
	I have a distant connection with farming and occasionally keep up-to-date	Distant
	I don’t feel connected to the industry and generally don’t keep up-to-date with agricultural issues	
“Where do you get your information about the agricultural industry from? (Select all that apply)”	Print newspaper	Traditional media
	Radio	
	Online newspaper	Online media
	Internet	
	Facebook	Social media
	Twitter	
	Instagram	
	TV	TV
Family	Family and friends	
Friends		
Politicians	Other	
Other		
Various statements (Likert response)	Strongly agree	Agree
	Agree	Neutral
	Neutral	
	Disagree	Disagree
Strongly disagree		

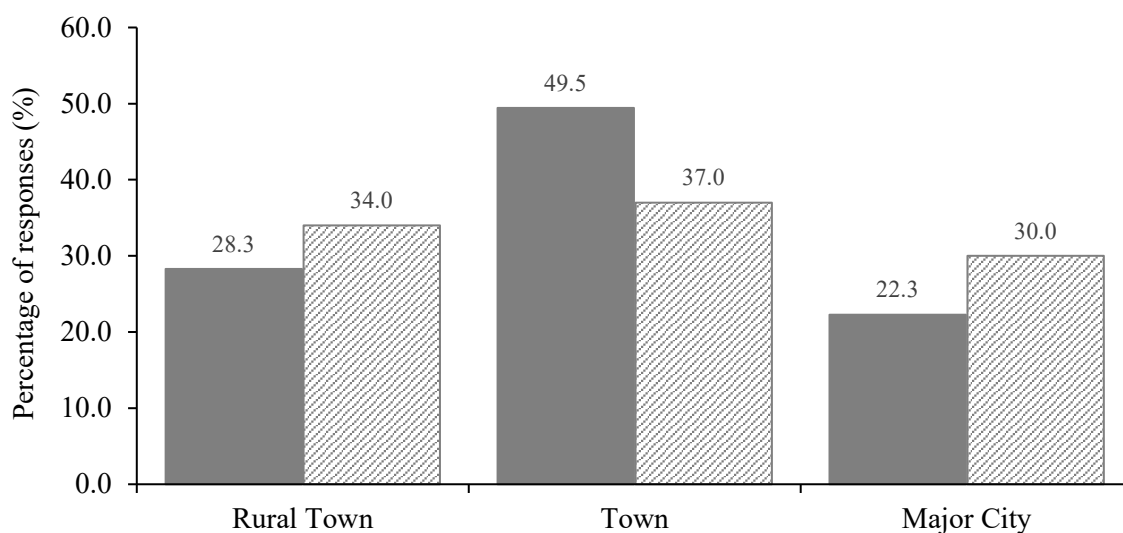
Results

Participant Information

A total of 185 teachers participated in the workshops between 2018 and 2019. Most participants had over 16 years of teaching experience (40.4%; $n = 74$). The remaining participants had between 4 - 10 years (25.1%; $n = 46$), 10 - 15 years (23.0%; $n = 42$) or 3 years or less teaching experience (11.5%; $n = 21$). Sixty-one percentage of participants identified as female ($n = 113$), compared to male (38.6%; $n = 71$). As shown in Figure 1, almost half of participants currently teach in schools in towns of between 5,000 and 49,000 people (49.5%; $n = 91$). Comparatively, the childhood location of participants was evenly distributed between rural towns, towns, and major cities. Over half of participants had a formal qualification in agriculture, either at a university (45.9%; $n = 85$) or TAFE-level (9.2%; $n = 17$). The remaining 44.9% of participants did not have a formal qualification in agriculture ($n = 83$).

Figure 1

Distribution of Current School Location (solid) and Teacher Childhood Location (striped).



Note. Values indicate the percentage of responses. Rural town: < 5,000 people; Town: 5,000 - 49,000 people; Major city: $\geq 50,000$ people.

Connection to and Perception of the Agricultural Industry

When asked about their connection to the agricultural industry, 67.6% of participants indicated that they felt connected to the industry ($n = 125$), compared to 32.4% that indicated only a distant connection or no connection at all ($n = 60$). When asked if their perception of the agricultural industry was positive, 95.1% of participants either agreed or strongly agreed with this statement ($n = 176$). In comparison, 2.7% participants had a neutral response ($n = 5$), and 2.2% of participants disagreed or strongly disagreed with this sentiment ($n = 4$). There was no significant association between participants connection to and their perception of the industry ($p = 0.54$).

Impact of Demographic Factors on Connection to and Perception of the Agricultural Industry

Participant demographics, specifically current school location ($p < 0.001$), childhood location ($p < 0.001$) and teaching experience ($p = 0.001$), were significantly associated with connection to the industry (Table 2). Industry perception was not significantly associated with any demographic response (all $P > 0.05$; Table 2).

Table 2

Association Between Participant Demographics and Connection to or Perception of the Agricultural Industry.

Demographic variable	Connection	Perception
Current school location	<i>p < 0.001</i>	<i>p = 0.06</i>
Childhood location	<i>p < 0.001</i>	<i>p = 0.39</i>
Teaching experience	<i>p = 0.001</i>	<i>p = 0.93</i>
Gender	<i>p = 0.52</i>	<i>p = 0.48</i>

Note. Significance indicated by ***bold italics***.

For both current school (Table 3) and childhood location (data not presented), those from a town or rural town reported higher levels of connection compared to those from major cities. Regarding teaching experience, teachers with 3 years or less experience had a higher conditional distribution of distant connection (data not presented).

Table 3

Association Between Connection to the Agricultural Industry and Current School Location.

Current school location	Connection to agriculture		<i>p</i> -value
	Connected	Distant	
Major City	18 (43.9%)	23 (56.1%)	<i>p < 0.001</i>
Town	63 (69.2%)	28 (30.8%)	
Rural Town	43 (82.7%)	9 (17.3%)	

Note. Whole numbers refer to the number per response pair. Percentages show the conditional distribution of industry connection given current school location (i.e., row total). Significance indicated by ***bold italics***.

Knowledge and Perception of Technology Use in Agriculture

Following workshop completion, participants were asked if they agreed with the statement “technology has the ability improve animal welfare”. Overwhelmingly, participants responded that they agreed with this sentiment (97.3%; *n* = 179). Additionally, 96.7% of participants agreed that “agricultural businesses can improve profitability and productivity by adopting new and emerging technologies” (*n* = 178). A similar proportion (97.3%; *n* = 180) also agreed that “agricultural technologies have the ability to improve environmental sustainability”.

There was a significant association between participants positive perception of the agricultural industry and the belief that technology can improve farm animal welfare ($P < 0.001$; Table 4). Similarly, there was a significant association between positive perception of the industry and the understanding that new technologies can improve profitability and productivity ($P < 0.001$; Table 4) and environmental sustainability ($p < 0.001$; Table 4). Although only four participants disagreed that they had a positive perception of the agricultural industry, most (75%) also disagreed that technology can improve farm animal welfare, productivity and profitability and environmental sustainability (Table 4). There was no significant association between participants connection to the industry and their understanding that new technologies can improve animal welfare ($p = 0.6$), profitability and productivity ($p = 0.3$) or environmental sustainability ($p = 0.5$).

Table 4

Association Between Positive Perception of the Agricultural Industry and Various Statements Regarding AgTech.

Variable		Positive perception of the agricultural industry			P-value
		Agree	Neutral	Disagree	
Technology has the ability to improve farm animal welfare	Agree	174 (99.4%)	4 (80.0%)	1 (25.0%)	<i>p < 0.001</i>
	Neutral	1 (0.6%)	1 (20.0%)	0 (0.0%)	
	Disagree	0 (0.0%)	0 (0.0%)	3 (75.0%)	
Agricultural businesses can improve profitability and productivity by adopting new and emerging technologies	Agree	173 (98.9%)	4 (80.0%)	1 (25.0%)	<i>p < 0.001</i>
	Neutral	2 (1.1%)	1 (20.0%)	0 (0.0%)	
	Disagree	0 (0.0%)	0 (0.0%)	3 (75.0%)	
Agricultural technologies have the ability to improve environmental sustainability	Agree	175 (99.4%)	4 (80.0%)	1 (25.0%)	<i>p < 0.001</i>
	Neutral	1 (0.6%)	1 (20.0%)	0 (0.0%)	
	Disagree	0 (0.0%)	0 (0.0%)	3 (75.0%)	

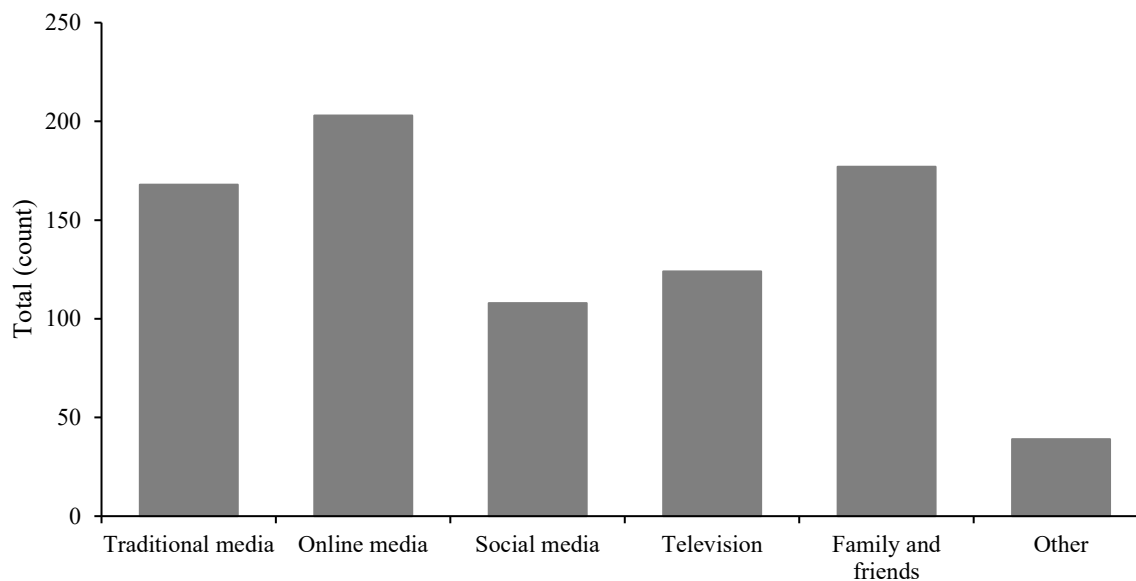
Note. Whole numbers refer to the number per response pair. Percentages show the conditional distribution of the view of AgTech given participant perception of the agricultural industry (i.e., column total). Significance indicated by ***bold italics***.

The Role of Information Source on Connection to and Perception of the Agricultural Industry

The use of different sources to gather information on the agricultural industry is shown in Figure 2. Participants noted the use of online media ($n = 203$), family and friends ($n = 177$) and traditional media ($n = 168$) as major sources of information. Other sources of information were also identified, e.g., politicians ($n = 10$), industry professionals ($n = 9$), peers ($n = 8$), direct connection to the land ($n = 3$). Due to the breadth of responses in the 'other' category, this was excluded from further analysis.

Figure 2

Workshop participants' use of different sources to gather information on the agricultural industry.



Note. Multiple selections were possible. Traditional media: print newspaper, radio; Online media: online newspapers, internet; Social media: Facebook, Instagram, Twitter.

There was a significant association between participants connection to the agricultural industry and the use of traditional media ($p < 0.001$; Odds ratio = 7.3; 95% CI = 3.5 - 15.5), social media ($p < 0.001$; Odds ratio = 5.4; 95% CI 2.5 - 11.9) and family and friends ($p < 0.001$; Odds ratio = 4.9; 95% CI 2.4 - 10.1) as sources of information about the agricultural industry. As shown in Table 5, participants that are more connected to the industry rely on traditional media, social media and family and friends as primary sources of information, compared to those that were more distantly connected. Conversely, there was no significant association between connection to the industry and the use of online media ($p = 0.1$) or television ($p = 0.2$).

Table 5

Connection to the Agricultural Industry and Use of Various Sources of Information Regarding the Agricultural Industry.

		Connection to the agricultural industry		
		Connected	Distant	
Traditional media	True	97 (78.2%)	20 (32.8%)	$p < 0.001$
	False	27 (21.8%)	41 (67.2%)	
Social media	True	77 (62.1%)	14 (23.0%)	$p < 0.001$
	False	47 (37.9%)	47 (77.0%)	
Family and friends	True	93 (75.0%)	23 (37.7%)	$p < 0.001$
	False	31 (25.0%)	38 (62.3%)	
Online media	True	103 (83.1%)	43 (70.5%)	$p = 0.06$

	False	21 (16.9%)	18 (29.5%)	
Television	True	87 (70.2%)	37 (60.7%)	<i>p</i> = 0.24
	False	37 (29.8%)	24 (39.3%)	

Note. Whole numbers refer to the number per response pair. Percentages show the conditional distribution of the use of each information source given participant connection to the industry (i.e., column total). Significance indicated by ***bold italics***. Traditional media: Print newspapers, radio; Social media: Facebook, Twitter, Instagram; Online media: Internet, online newspapers

There was no significant association between participants' positive perception of the industry and the use of any information source (all $p > 0.05$). There was also no significant association between the use of any information source and participants' belief that technology can improve farm animal welfare (all $p > 0.05$), farm profitability and productivity (all $p > 0.05$) or environmental sustainability (all $p > 0.05$).

Impact of Demographic Factors on the Use of Information Sources

There was a significant association between participants' current school location and the use of social media ($p = 0.003$) and family and friends ($p = 0.02$) as sources of information about the agricultural industry (data not presented). For the former, rural locations reported a higher use of social media as a source of information than major cities. Similarly, town and rural locations reported a higher use of family and friends as a source of information than major cities. There was no significant association between current school location and the use of traditional media, online media and television (all $P > 0.05$). Participant childhood location had minimal association with the use of information sources. The exception of this was the use of traditional media ($p < 0.001$), which had a higher proportion of use from rural areas compared to major cities or towns (data not presented). Years of teaching experience also had a significant association with the use of social media ($p = 0.01$; data not presented), which had a higher proportion of use by teachers with less teaching experience.

Discussion

Using the theoretical underpinnings of knowledge, awareness and perceptions (Rock, 1985), this paper explored the awareness and perceptions of NSW TechMand teachers of the agricultural industry, including their understanding of technology use in agriculture. Overall, the results of this study show that most participants have a positive perception of the industry and understand the importance of technology use for improving animal welfare, productivity and profitability, and environmental sustainability outcomes. Though connection to agriculture was associated with use of different types of sources for information on the industry, this was not evident for participants' perception of the industry.

Public perception is extremely important for an industry such as agriculture. Negative perceptions of an industry have the potential to impact consumer purchasing behaviour (Napolitano et al., 2010), for example the growing demand for welfare-friendly animal production systems (Alonso et al., 2020). Public perception can also influence policy making processes, including the design of legislative or other policies that are designed to mirror the values of citizens (Wachenheim & Rathge, 2000). Knowledge and awareness of agriculture is also important, with a lack of awareness making it difficult to make informed decisions (Settle et al., 2017). For teachers, perceptions and awareness can impact student learning (Güven & Sulun, 2017; Kola & Sunday, 2015). In addition, teachers are considered one of the most important influences on whether a student will attend tertiary study (Dyer et al., 1999; Matthews & Falvey, 1999). Thus, to ensure students are aware of all available opportunities, adequate teacher understanding of the agriculture industry is crucial. In this study, most teachers had a positive perception of the agriculture industry,

and this perception was associated with the belief that technology in agriculture can improve animal welfare, profitability and productivity and environmental sustainability. This is a positive finding, suggesting that students, at least for this cohort of teachers, will be provided with agriculture-positive teachings. Within the context of their wider education, this is likely to be important for a student's understanding of the industry, as this may be the only time they are exposed to agricultural content in their secondary schooling.

Industry connection is impacted by numerous demographic factors. For example, participants that either grew up in, or were currently located in, towns (< 50,000 people) or rural towns (< 5,000 people), reported higher levels of industry connection compared to those from major cities. This was particularly true for participants from rural towns, with 90.3% of those growing up in this environment, and 82.7% of participants with a current school location in this environment, reporting an industry connection. In a study of Australian school students (Cosby et al., 2022), exposure to food and fibre industries was skewed to students located in regional and remote areas. Connection to agriculture (e.g., family background) or experience in agriculture (e.g., school farm) has also been found to be a significant driver for career selection in the field (PIEFA, 2020). A similar result was also found by Matthews and Falvey (1999), with a greater proportion of Australian Year 10 students from non-metropolitan schools considering a career in agriculture compared to metropolitan students. These results, and the results of the current study, suggest exposure is key to forming connection to the industry, and, for students, subsequent consideration of the industry as a viable career option. Of course, connection of teachers to agriculture, as reported in this study, does not necessarily equate to a similar connection by their students. Nevertheless, given the relationship between regional residence and agricultural knowledge (Worsley et al., 2015) and teacher awareness and knowledge on student performance (Guyen & Sulun, 2017; Kola & Sunday, 2015), this finding is still valuable. One unexpected result of the current study was the lack of association between participants' connection to agriculture and their understanding of AgTech. Indeed, it was hypothesised that those that were more connected would have a greater awareness of AgTech. However, this was not found to be the case, with most participants acknowledging the benefits of AgTech regardless of their connection to the industry (approximately 97% of participants acknowledged the overall benefit for agricultural businesses). This result likely reflects a limitation in the study design, whereby participants were only surveyed at a single point in time, after the workshop had been completed. As the workshop was focused on AgTech, it is expected that teachers were made aware of the benefits of AgTech through the workshop itself, rather than awareness by way of industry connection.

The use of different sources of information can impact a consumer's awareness or perception of a certain subject. For example, as has been shown throughout the COVID-19 pandemic, information source and trust in each source significantly influences the adoption of health-related behaviours (Figueiras et al., 2021; Zhong et al., 2021). The same can be said for agriculture. In this study, the use of different information sources was evident, and the use patterns differed between those connected or distantly connected to the industry. For all teachers, online and traditional media were commonly identified, including online or print newspapers, radio and the Internet. These are generally considered valuable information sources, though may be problematic if the coverage is negative or produced in response to adverse events (Specht et al., 2014; Specht & Rutherford, 2013). In particular, those with limited exposure to agriculture have been found to be more critical of the industry, due to their limited experience and preconceived attitudes and beliefs (Specht et al., 2014). Trust is another integral factor for effective communication (Settle et al., 2017) and may provide reasoning as to why family and friends were the second most important source of information for teacher participants. This was especially true for those with a connection to the industry, with 75.0% of those connected to the industry reporting the use of family and friends as an information source, compared to only 37.7% of those distantly connected. This was similar to findings by Matthews and Falvey (1999), who noted that students from non-metropolitan regions mostly relied on their parents for information about agriculture, compared to metropolitan students

who relied mostly on their school and the media. While in the current study there was no evidence of association between industry perception and the use of any information sources, this finding is important when considering how to communicate with the general population about farming practice and how the requisite skills for agriculture careers are changing.

The use of workshops as a PD activity for teachers is considered a type of “immersion” learning, where teachers gain knowledge or learn new skills under the guidance of trained professionals (Loucks-Horsley et al., 1998). Awareness and perception of the agricultural industry are important; however, knowledge is also required to ensure the agricultural industry and associated practices are accurately portrayed to students. In the current study, workshops were used to introduce teachers to both content and pedagogy, encouraging teachers to use the livestock tracking module in their teaching program. As previously mentioned, a limitation of the current study was that the survey was administered at a single time point following workshop completion. Thus, given that the workshop presented information on AgTech and was found to improve teacher skills, knowledge and confidence in this field (Manning, Cosby, Fogarty, et al., 2022), it is likely that the responses of participants were impacted by their participation. Indeed, in a similar study, Cosby et al. (2019) reported a larger proportion of neutral responses for surveyed teachers when asked similar questions regarding AgTech pre-workshop (range 7 - 19%), and a decline in neutral responses (in favour of positive responses) when surveyed again at workshop completion. Cosby et al. (2019) state that “visiting farms, talking with researchers and completing the livestock tracking practical ... resulted in participants learning how technology can improve animal welfare” (p. 83), with a similar sentiment expressed for learning of AgTech use cases related to productivity, profitability and environmental sustainability. In another study, Hanley et al. (2012) evaluated the impact of PD on teacher understanding of GPS and their ability to integrate the technology into the curriculum. Similar to Cosby et al. (2019), Hanley et al. (2012) found that teachers had a statistically significant improvement in knowledge in 13 of the 21 tested areas. Teachers also rated their comfort with the technology as above average (6.8/10) following the PD, commenting that the hands-on practice and written instructions were beneficial. In the current study, over 95% of participants had a positive perception of the industry, and 96 – 97% of participants had an awareness of the benefits of AgTech. While it is not known for certain if this knowledge was solely gained throughout the course of the workshop, the results broadly support the findings of Cosby et al. (2019) and Hanley et al. (2012), and advocate for the use of workshops as a valuable form of PD and content learning.

Further to use of workshops as effective PD, the use of authentic data is thought to improve understanding and knowledge of real-world phenomena and deepen the learning experience (Specht et al., 2014). Authentic data refers to true quantitative or qualitative information, in comparison to inauthentic data which is generally synthetic or manipulated in such a way as to exhibit a particular outcome or trend (Kjelvik & Schultheis, 2019). In the classroom, authentic data can help students understand the practical application of knowledge (Kjelvik & Schultheis, 2019). It is also generally more engaging for students (Schultheis & Kjelvik, 2015) and encourages critical thinking (Kjelvik & Schultheis, 2019). The GPS Cows workshop provides teachers with access to authentic livestock tracking data collected from commercial farms across Australia. In addition, when applied in the classroom, students are encouraged to collect data themselves to satisfy their own research questions. In the current study, most participants were able to identify the positive benefits of AgTech application. Although it is unclear if this response was impacted by the workshop itself, and by extension, interaction with the module’s authentic data, this is expected to be the case. The benefits of authentic data were also evident through the open-response questions asked in the current study, including statements regarding the best thing about the workshop being “real life data”, “learning how to use real ag (sic) data” and “relating technology to real world applications”. The benefits of authentic data have also been reported by Sami et al. (2020), noting that the development of the classroom program in that study heavily benefitted from collaboration with university and government colleagues due to them providing interesting examples of the current use of data in agriculture and an authentic experience with commercial data analysis tools.

Qualitative research by Doering and Veletsianos (2008) also reported the benefits of using authentic geospatial data, with students in that study commenting on their newly gained knowledge of Alaskan geography after participation in a lesson utilising authentic data.

Conclusion

Using Rock, 1985 theoretical underpinnings of knowledge, awareness and perceptions, this paper explored the awareness and perceptions of technology use in agriculture of Australian TechMand teachers. Teachers were surveyed following completion of a PD workshop that aimed to introduce teachers to the GPS Cows module and encourage subsequent integration of the module into their teaching program. The current study reinforced our initial hypothesis that teacher perceptions of the agricultural industry impact their awareness regarding the use of AgTech on farms. However, the hypothesis that teacher connection to the industry would also impact awareness was not supported. Instead, teacher connection to the industry was associated with various demographic factors, including the location of their childhood upbringing and their current school, and their years of teaching experience. In addition, connection to the agricultural industry was significantly associated with the use of traditional media, social media and family and friends to gather information on the industry. Overall, the results of this study show that most participants have a positive perception of the industry and understand the importance of technology use for improving animal welfare, productivity and profitability, and environmental sustainability outcomes. Though this study focused on a sample of Australian teachers, these findings have broader implications including in the United States, particularly when we consider the crucial need to attract the next generation of workers to maintain high productivity, and relatedly the significant impact teachers have on student learning (Kola & Sunday, 2015) and selection of post-secondary study or career options (Dyer et al., 1999; Matthews & Falvey, 1999). One limitation of this study was that the survey was completed at the end of the workshop, when participants had already been provided with sufficient background information on AgTech. Future research should therefore use both pre- and post-workshop survey techniques to measure the change in participant awareness and perceptions of AgTech over time. This would provide more definitive proof of the benefits of PD workshops to increase the knowledge of teachers about the agricultural industry. Nevertheless, teachers' positive perception and awareness of the role of AgTech is encouraging and reinforces that continued PD for teacher knowledge building is essential.

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