



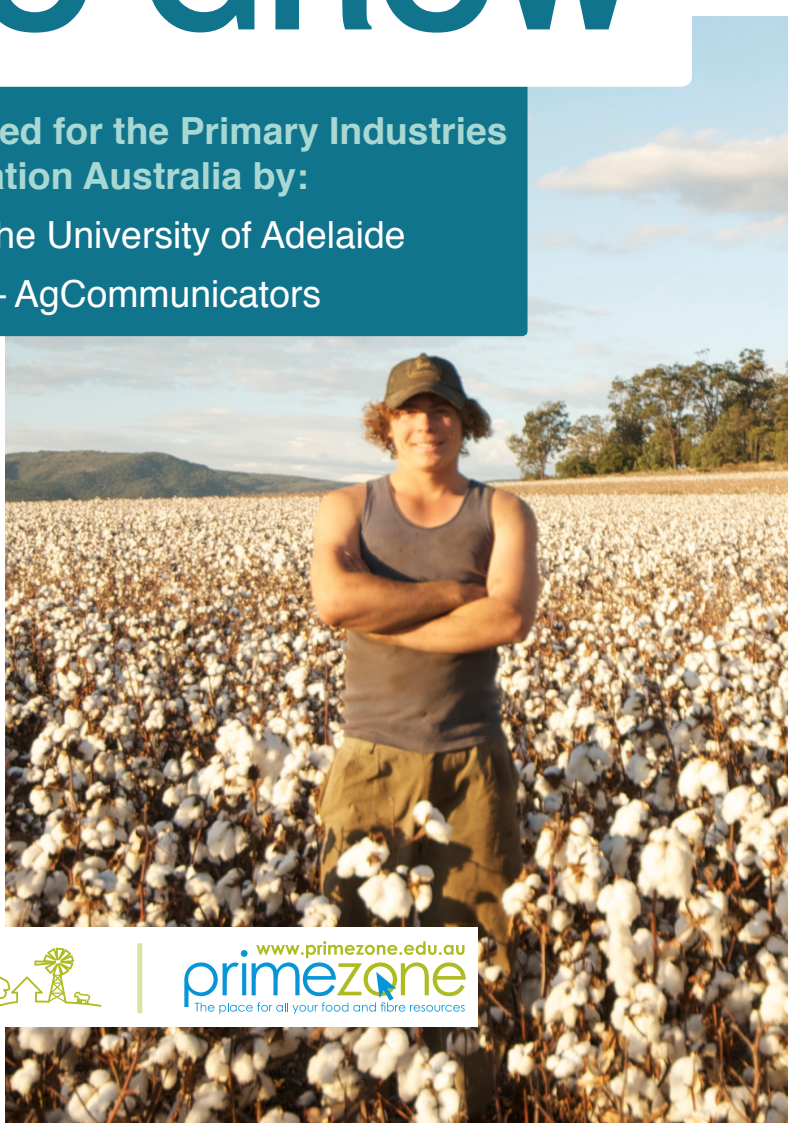
Challenges for the future of food and fibre education  
in Australia.

# ROOM TO GROW

Adapted from a report prepared for the Primary Industries  
Education Foundation Australia by:

DR HEATHER BRAY – The University of Adelaide

MS BELINDA CAY – AgCommunicators



Primary Industries Education  
Foundation Australia



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# PREFACE

I am pleased to prepare a short preface as an introduction to this book. Primary Industries Education Foundation Australia (PIEFA) has been operating now for nearly a decade. During this time, it has met various challenges but through the support of its members, its board, staff and many others in the food and fibre industries and related areas, has addressed these and achieved a great deal.

There has always been a feeling within the Board that there was a need to accumulate evidence about the general sphere in which PIEFA operates. PIEFA addresses an issue which has long been identified but never really tackled in a national and industry wide way. There is always a feeling that what we are trying to do is a legitimate and worthy ideal but on what evidence are we basing our *raison d'être*?

Dr Heather Bray and Ms Belinda Cay have been involved with PIEFA from its very beginning through conferences, workshops and professional contact. They have been active in promoting greater learning about food and fibre production in schools. As well, their experience in working with scientific researchers, schools, agricultural organisations and the primary industries production sector gave them a sound understanding as to what PIEFA has been attempting to do.

It was therefore appropriate that PIEFA commission them to undertake a review of the literature relating to learning about food and fibre production in schools. It was the Board's view that this would assist PIEFA to make strategic decisions as much as possible on evidence based research.

Following the preparation of the report to the PIEFA Board it was felt that there was much information in it which ought to be publicly accessible. As a result, the report has been edited to present it in way that it can be of value to those interested in this field of endeavour nationally or internationally.

I acknowledge and thank Dr Bray and Ms Cay for the effort they put into this report. I also thank my fellow directors and PIEFA CEO, Ben Stockwin, for their contribution to the initiative.

I hope that this will be a way of improving the learning about food and fibre production in schools in Australia and elsewhere in the world.

I commend it to you.

**Cameron Archer PhD AM**

Chair  
Primary Industries Education Foundation Australia

April 2018

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## 1.0 EXECUTIVE SUMMARY

The Primary Industries Education Foundation Australia (PIEFA) has successfully operated for the last three years under its 2016-2019 Strategic Plan. To support and inform the implementation of the next strategic plan, PIEFA sought a review of the national and international operating space to identify current issues related to education in agriculture, fisheries and forestry in Australia, with a view to identifying threats and opportunities which organisations such as PIEFA could address.

A comprehensive review of current research literature and recent relevant reports suggests that the national education sector must continue to evolve and adapt, offering innovative and creative ways to engage teachers, students, the community and policy makers in understanding sustainable food and fibre production. Failure to do this successfully may hinder the sector's ability to respond to global and local pressures, in particular the role of digital technologies, the ongoing need to produce enough nutritious, safe, affordable food in a changing climate, and maintaining the sector's social licence to operate.

It has been well documented that the food and fibre sector has an aging workforce, with lower numbers of students than estimated demand enrolling and completing agriculture and related courses at both vocational and higher educational levels. These concerns have driven the investment in a range of different government and industry agricultural education initiatives throughout Australia. It appears the investment in these initiatives may be beginning to 'pay off', with data from universities reporting the numbers commencing agricultural courses have almost doubled to over 1,500 enrolments in 2016, up from just 900 in 2012 (Pratley 2016).

There has been an overarching shift in the skills needs in primary industries to a demand for STEM (Science, Technology Engineering and Mathematics) based skills. A shift in perceptions of primary industries careers is also required, and new strategies to address the sector's skill shortages need to be implemented. The AgriFood Skills Council of Australia's Environmental Scan (2015) suggests the workforce requires world-class business capability and risk management expertise, motivated, smart and adaptive workers, with the ability to adopt new technologies and research outcomes. Food and fibre production is increasingly reliant on technology to drive productivity and efficiency gains in research, production, throughout the value chain and in market operations. Agricultural production and marketing are increasingly knowledge-intensive activities, drawing on technological developments in computing, engineering and data analysis (Daly et al. 2015). Also, sector innovation requires partnerships between producers and the support sector that can be facilitated through technology (Daly et al. 2015).

The move to a more technology orientated primary industries sector seems to divide community attitudes. Those in the food, fibre, fisheries and forestry sector are excited and enthused about the opportunities of 'big data', new technologies, and increasing automation; whereas the broader Australian community, which is highly urbanised, is disconnected from the day-to-day operating environments of these industries. Farmers

## 1.0 EXECUTIVE SUMMARY

are highly trusted by the community (Henderson et al. 2011) and agriculture is viewed as important to the future of Australia, (McAllister 2009); however, Meyer et al. (2012) document that the growing gap between the production and consumption of food is linked to the decline in consumer trust in food production, which in turn is related to a desire for increased regulation of food. This call for increased regulation also suggests that the sector's social licence to operate is at risk. Media focus on the treatment of animals, treatment of agricultural workers, and the use of chemicals in the food and fibre sector may also contribute to a belief within the broader community that the values held by those within the food and fibre industries are no longer aligned to broader community values.

The development of educational resources for schools alone is not enough to engage students, teachers and the community in food, fibre, fisheries and forestry. To achieve impact within school education, Tytler 2008 states that successful professional learning programs require commitment over an extended period of time (one lesson is not enough), leadership and mentoring, access to expertise, and links between learning and curriculum renewal. In addition, new thinking about science capital (Archer et al. 2015)<sup>1</sup>, and its importance for engaging young people in science, offers insight into thinking about 'food and fibre capital' as a way to measure engagement with agriculture as well as to design new engagement programs.

With PIEFA's PrimeZone website now hosting over 500 education resources, it is clear that the delivery of resources in schools is not a limiting factor; however there is a wide range of agricultural education providers who currently work in isolation. This, combined with limited funding, has resulted in competition, rather than collaboration.

Given these paradigm shifts, a literature review, which reviewed 72 different reports and publications, has identified five main threats, which in turn can be viewed as opportunities for lead organisations such as PIEFA:

- Work with curriculum experts (ACARA / Office of the Chief Scientist): ensure food, fibre, fisheries and forestry studies are recognised as a context for delivering STEM teaching principles and remain an integral component of the national curriculum;
- Work collaboratively: share information and ideas with international bodies of interest and work with local education research providers to attract both government and industry grants to undertake essential research with a national, state and regional focus;
- Be creative: develop new and engaging initiatives and resources, which are thoroughly evaluated, to inspire both teachers and students;
- Consider future workforce needs: work proactively to attract and develop the future skilled employees and graduates to support the industries in predicted areas of growth (i.e. STEM jobs); and

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<sup>1</sup> Science capital is the collection of knowledge, attitudes, skills and experiences a student has about science.



- Consider perceptions: the sector's social licence to operate relies on engagement with community, students and teachers to present current food and fibre production techniques and technologies within their social, political and economic contexts, i.e., to produce nutritious food, and safe, affordable food and fibre in a changing climate in a sustainable and humane way.

## 2.0 SUMMARY OF FINDINGS



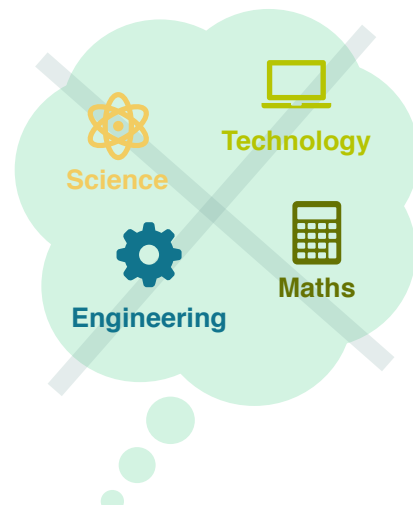
**1.** There is a need for a common, contemporary narrative for food and fibre careers, including the growth in new technology-based roles in support of primary production, and a need to share that narrative with students, teachers and careers advisors.



**2.** There is a need for a shared, positive vision and narrative for food and fibre production in Australia. The place of food and fibre in contemporary society needs clarifying via articulation of shared societal values regarding issues critical to agriculture's future, including technology, health, rural and regional development, and education.



**3.** Although food and fibre are now within the Australian Curriculum, we don't know if this will impact on student's food and fibre literacy/citizenship/capital.



**4.** Food and fibre are not widely recognised as a context for delivering STEM education.

## 3.0 ABOUT THE REVIEW

The purpose of this review is to identify current issues related to education in agriculture, fisheries, and forestry in Australia, with a view to identifying threats and opportunities for PIEFA to address in the implementation of its strategic objectives, or more specifically, factors external to PIEFA that influence its operating environment. In addition, the analysis aims to reveal the 'state of play' in perceptions of and attitudes to food, fibre, fisheries, and forestry production more broadly within the Australian community. The focus of this analysis is on four main areas:

- Reports and studies highlighting the current and future workforce needs of the Australian food, fibre, fisheries, and forestry sector;
- Reports and studies that explore community perceptions and knowledge of food, fibre, fisheries, and forestry in Australia;
- Reports and studies that examine how the inclusion of food, fibre, fisheries, and forestry production in the school curriculum influences attitudes to the sector among students and teachers in Australia;
- Consideration of the new National STEM School Education Strategy and the role of primary industries education in the current emphasis on STEM education in schools.

Specifically, the researchers (Dr Heather Bray and Mrs Belinda Cay) were contracted to conduct a desktop scoping report which provided PIEFA with an overarching document to contribute to defining its future operating direction. The brief, developed with PIEFA, stated that the report was to investigate:

- The gaps in food, fibre, fisheries, and forestry education investment in Australia and what this means for PIEFA (which gaps can it address?);
- National and international literature with regards to engaging teachers, students and the community in food, fibre, fisheries, and forestry (and to explore PIEFA's role in communicating or acting on these gaps);
- The leadership role in primary industries education that PIEFA should be playing from a national coordination point of view;
- The curriculum development role of PIEFA, i.e., should the Foundation be operating at a high strategic level, working with ACARA defining curriculum direction, or should it be delivering on the ground 'food and fibre education' services?

The report provides a series of recommendations, which may consider research gaps, conference feedback and literature.

## 4.0 ABOUT PIEFA

The Primary Industries Education Foundation Australia is a tripartite not-for-profit company limited by guarantee, formed through the collaboration of the Australian Government, primary industries organisations, and the education sector.

Primary Industries Education Foundation Australia's vision is to be the preferred provider of credible, relevant and factual information on all matters relating to agriculture, fisheries and forestry for Australia's teachers, students and the community.

### 4.1 Objectives

The Foundation's objectives are to:

- Provide national leadership and coordination of initiatives to encourage primary industries education in schools through a partnership between industry, government and educators;
- Commission, coordinate, facilitate and manage national projects to encourage primary industries education in schools;
- Provide a source of credible, objective and educational resources for schools to maintain and improve community confidence in Australia's primary industries; and
- Communicate primary industries research and development outcomes in a format accessible for schools and encourage interest from schools in primary industries related careers.

### 4.2 Corporate environment

The Foundation is managed by a skills-based board, chosen by a selection committee representing the three categories of membership. The Foundation will operate with minimal overheads to ensure that member contributions are focused on 'adding value' and real outcomes.

## 5.0 CURRENT OPERATING ENVIRONMENT

Food, fibre, fisheries and forestry production is vital to Australia's economy. In 2014-15, the gross value of Australian agriculture increased by \$2.8 billion to \$53.6 billion, despite large areas of the country reporting very dry conditions for much of the year (Australian Bureau of Statistics 2016). In its annual update, ABARES (2016) projected farm production would be worth \$60.3 billion in 2016-17, which

## 5.0 CURRENT OPERATING ENVIRONMENT

represented a 3 per cent increase on the previous financial year.

Australia's agrifood industries currently utilise 405 million hectares, of which 32 million hectares are used to grow crops (Barlow 2014). The food produced on this area can feed 60 to 80 million people, depending on their diet (Barlow 2014).

The commercial fisheries value of production was worth around \$2.5 billion in 2013–14 (Savage and Hobsbawn 2015). This increased by 4 per cent from the previous year and was driven by an increase in the value of wild-caught products (Savage and Hobsbawn 2015). Australian fisheries export a range of high unit value products, with export earnings accounting for 46 per cent of the total production value (Savage and Hobsbawn 2015).

Forestry is another sector that is poorly understood, yet vital to all Australians. It has been estimated that in 2012-13 each Australian used around 0.81 cubic metres of lots per year in their daily lives (i.e., in buildings, homes, workplaces and schools) (ABARES 2014a, Commonwealth of Australia 2015). The sector's export worth is over \$2 billion and impressively, it generates over \$20 billion worth of manufacturing sales and services domestically (ABARES 2014a, Commonwealth of Australia 2015). It is estimated that over 70 500 Australians (ABARES 2014a, Commonwealth of Australia 2015) are employed in the forestry sector. Many of these are located in regional Australia (ABARES 2014a, Commonwealth of Australia 2015).

Looking at the face of Australian food, fibre, fisheries and forestry, it is clear that technology and innovation have underpinned the advances we have seen in terms of yield and productivity increases. For example:

- Since the Green Revolution in the early 1960s, production has increased nearly two and a half times, from 1.84 billion tonnes to 4.38 billion tonnes in 2007, achieved on only 11 per cent more cropped land (Langridge 2014). Today's farming systems are sophisticated and highly technical. Australian farmers have remained competitive in a global food market despite Australia having low levels of subsidies relative to our major competitors (Langridge 2014). The adoption of precision agriculture, no-till cropping systems, new varieties, new automated technologies, improved genetic selection, and better feeding regimes, have seen Australian farmers adapt and innovate.
- Science and technology have also contributed to driving new wood processing, forest management and conservation practices (Commonwealth of Australia 2015). Product focus is on renewable, recyclable and sustainable leading to a more dynamic industry.
- Changes in fisheries management have seen commercial fishers make more sustainable fishery management decisions, explore new aquaculture systems, and open new markets. Given that Australia is responsible for the third largest



## 5.0 CURRENT OPERATING ENVIRONMENT

global marine jurisdiction, best practice management backed with research and innovation is a must.

In addition to the financial value of food, fibre, fisheries and forestry to Australia's economy, it is important to consider the importance of these industries to Australia's landscape and culture. These primary industries occupy more than half of Australia's land mass and contribute to both the economic viability and social fabric of Australia's rural and regional towns.

Australia is becoming increasingly urbanised. This distance from food, fibre and forestry (and to a lesser extent fisheries) production is often connected with increasing community interest in, and scrutiny of, producers. The welfare of farm animals has become particularly prominent in the media, and technology-based farm practices, such as the use of pesticides or genetic modification, are important consumer concerns (Kriflik & Yeatman 2005; Meyer et al. 2014). Although the community often has little knowledge of these practices or how they are regulated, these concerns may reflect broader social trends, and may be contributing to a distrust of our food production systems (Henderson et al. 2011; Meyer et al. 2012).

To support further growth and maintain productivity, it is essential that the sector consider:

- **Perceptions:** the basis for the sector's social licence to operate relies on engagement with the community, including school students and teachers, presenting current food and fibre production techniques and technologies within their social, political and economic contexts, i.e., to produce nutritious food, and safe, affordable food and fibre in a changing climate in a sustainable and humane way;
- **Curriculum:** work with curriculum experts (ACARA / Office of the Chief Scientist), to ensure that food and fibre studies are recognised as a context for delivering STEM teaching principles and remain an integral component of the national curriculum;
- **Collaboration:** share information and ideas with international bodies of interest and work with local education research providers to attract both government and industry grants to undertake essential research with a national, state and regional focus;
- **Innovation:** develop new and engaging initiatives and resources, which are thoroughly evaluated, to inspire both teachers and students;
- **Future workforce needs:** work proactively to attract and develop the future skilled employees and graduates to support the industries in predicted areas of growth (i.e., STEM jobs).

## 6.0 GLOBAL AND LOCAL FACTORS INFLUENCING THE FOOD AND FIBRE PRODUCTION SECTOR

There have been numerous reports that have identified global and local factors that are shaping both the current and the future of Australia's food and fibre industries. These factors also influence PIEFA's operating environment. We do not intend to cover all of these issues in detail; instead we present a list of prominent issues raised in a few key reports to provide context for our analysis of threats and opportunities for PIEFA and selected issues will be covered in further detail later in this report.

### 6.1 Global factors

- Global demographic factors, such as world population growth, ageing populations, ensuring access to food for those who continue to go hungry (AgriFood Skills Council of Australia 2015);
- Changing planetary factors, such as water security, climate variability and adaptation (AgriFood Skills Council of Australia 2015);
- Shifting economic forces, such as the uneven recovery from recent global financial crises, shifting manufacturing base (including in Australia), free trade agreements, exchange rates, growing Asian markets (AgriFood Skills Council of Australia 2015; Pratley 2013);
- The emergence of biofuels (Centre for International Economics 2015);
- Changing technology - the use of the internet and social media and 'disruptive' technologies such as mechanisation and automation, intelligent and remote sensing, etc. (AgriFood Skills Council of Australia 2015; Daly et al. 2015; Liao and Martin (2009) cited in Pratley 2013). This factor has direct influence on the sector's workforce needs and is discussed further in section 8;
- Global food trends such as consumer desire for increased transparency, convenience, and nutritious food (AgriFood Skills Council of Australia 2015). This factor also has an influence on community perceptions of agriculture and will be discussed further in section 9;
- Changing export and import patterns for Australian fisheries. For example, Australian fisheries currently export a range of high unit value products, with export earnings accounting for 46 per cent of the total production value in 2013–14 (Savage and Hobsbawn 2015). Export destinations have changed from Japan as the major export destination; most fisheries exports are now sent to Hong Kong, China and Vietnam (Savage and Hobsbawn 2015). It should also be noted that in 2007-08 Australia became a net importer of fisheries and aquaculture products (Savage and Hobsbawn 2015).

## 6.0 GLOBAL AND LOCAL FACTORS INFLUENCING THE FOOD AND FIBRE PRODUCTION SECTOR

### 6.2 National factors

- Consolidation and bifurcation of production. There is a move to specialisation within the production sector to both high volume production, and/or niche, value-added production. Specific challenges face producers/businesses that adopt either strategy (AgriFood Skills Council of Australia 2015; Daly et al. 2015) although it is suggested that the production of bulk commodities will remain the most important contribution to the economy;
- Retail concentration to only 2-3 major retailers, and vertical integration in production chains (AgriFood Skills Council of Australia 2015);
- Biosecurity, especially in light of increasing global movement (AgriFood Skills Council of Australia 2015);
- Policy environment, in particular current policies to develop Australia's north, improving Agricultural competitiveness (AgriFood Skills Council of Australia 2015, Daly et al. 2015);
- Contestable resources, for example hydraulic fracturing, managing the Murray-Darling basin and marine reserves (AgriFood Skills Council of Australia 2015);
- Changing training environment, in particular VET sector reform and RTO performance (AgriFood Skills Council of Australia 2015);
- A trend of declining enrolments in the Higher Education Sectors has flow-on effects – not only do student numbers decline but the viability and range of education service providers decline, which may mean the sector is unable to respond to the shortage of skilled labour (Allen Consulting Group 2012). It should be noted that in 2016 there was a slight increase in student enrolments, however, this does not mean we can be complacent;
- Multiculturalism - the Australian foodscape has changed radically due in large part to post-war migration initially from Europe and subsequently from Asia, the Middle East, and Africa. One in four Australians was born overseas (Australian Bureau of Statistic 2012).

In addition, these factors will be addressed in more detail in the following sections:

- Growing gap between producers and consumers which in turn creates a 'deficit in consumer knowledge and control over the foods they purchase'(Meyer et al. 2012);
- Erosion of 'social licence to operate', e.g., animal welfare issues due to increasing scrutiny of animal industries, as retailers and others use animal

## 6.0 GLOBAL AND LOCAL FACTORS INFLUENCING THE FOOD AND FIBRE PRODUCTION SECTOR

welfare to gain market share (AgriFood Skills Council of Australia 2015), and awareness of the impact of food and fibre production on the environment (Daly et al. 2015);

- Urban greening, including an emphasis on urban food production and maintenance of peri-urban food and fibre production areas (AgriFood Skills Council of Australia 2015);
- Labour supply, including temporary and holiday workers (AgriFood Skills Council of Australia 2015);
- Perceptions of agricultural careers and agriculture as a ‘sunset’ industry, as well as that the family farm is the preferred model of farm ownership (Daly et al. 2015);
- Current access to technology: Australian farmers are operating close to the limits of technical efficiency (Daly et al. 2015).

## 7.0 FUTURE WORKFORCE NEEDS OF THE FOOD AND FIBRE PRODUCTION SECTOR

### 7.1 The agricultural workforce in Australia

It should be emphasised that the food and fibre sector (including fisheries and forestry) is not alone in the need for a highly skilled and technologically savvy workforce; this underpins economic development across the economy. However, addressing the future workforce needs of the sector has been one of the motivating factors for inclusion of food and fibre production within the school curriculum.

Understanding the workforce needs of the food and fibre production sector is complex, given that the sector includes those involved directly in primary production (e.g., owner-operators, employees in primary production businesses), those who provide services to primary producers (e.g., consultants and advisors, and arguably those involved in research and development to support food and fibre production), as well as those involved in value chains from producer to end-user (e.g. processors, marketers). In addition, the education and training needs of the food and fibre production sector encompass schools, the Vocational Education and Training (VET) sector and the Higher Education (University) sector, which further complicates the picture.



## 7.0 FUTURE WORKFORCE NEEDS OF THE FOOD AND FIBRE PRODUCTION SECTOR

### 7.2 Will predicted workforce shortages limit food and fibre sector productivity?

Several reports have suggested that the ageing population within the agricultural sector and a declining rural population may inhibit sector growth and productivity (Industries Development Committee Workforce, Training and Skills Working Group 2009; Allen Consulting Group 2012). Three in five workers are aged 45 years or older with many in agriculture, fisheries and forestry continuing to work beyond the normal retirement age (Australian Government Department of Education, Employment and Workplace Relations 2013). The agricultural production sector is predicted to lose at least 30 per cent of its workforce over the next ten years, mainly due to ageing (Australian Farm Institute 2010 cited in Allen Consulting Group 2012). In addition, movement of youth from rural areas to the city (the 'flight to the bright city lights' syndrome; Argent and Walmsley 2008) over the last 20 years has been attributed to perceived economic and social inequity between rural and urban areas (Kettlewell 2010), a perception that heading to the city is a natural progression, and that remaining in rural areas would represent failure (Geldens 2007; Eacott and Sonn 2006 cited in Kettlewell 2010), and limited education and employment opportunities (Geldens 2007; Eacott and Sonn 2006; Alston 2004 cited in Kettlewell 2010).

However, research undertaken by Neil Barr (2014) suggests that the aging workforce and declining rural population can be easily explained by a number of broader changes within agriculture and the workforce and pose no threat to food security or maintaining agricultural productivity:

- 68% of the decline in the young farmer population (under 35) can be explained by fewer number of farms due to farm aggregation;
- A fall in the recruitment of under 25s relative to other entrants also contributes to the declining number of farmers, however this is in line with other parts of the labour market;
- Fewer farmers over 65 are leaving the workforce, both increasing the median age, and decreasing the relative proportion of younger farmers.

Barr (2014) emphasises that *despite a 60% decline in the number of farmers since 1976, and the rise in the average farmer age, agricultural productivity in Australia has continued to increase. Hence farmer number and age are not linked directly to agricultural productivity.*

### 7.3 Participation in education and training

A low proportion of workers in agriculture, forestry and fisheries hold post-school qualifications and females make up a relatively low proportion of the workforce

## 7.0 FUTURE WORKFORCE NEEDS OF THE FOOD AND FIBRE PRODUCTION SECTOR

(Australian Government Department of Education, Employment and Workplace Relations 2013). Low levels of industry participation in education and training, low numbers of under-graduates and graduates in tertiary agriculture courses, poor awareness of agricultural career pathways and the limited capacity of the current education and training system to deliver innovative training solutions are contributing to industry skills shortages (Industries Development Committee Workforce, Training and Skills Working Group 2009). In addition to the national reports mentioned above, there have been several reviews of agricultural education and training at state and national level in recent years. All of these reports have 'more agricultural education in schools' as a recommendation to address sector needs, although there is little evidence that inclusion in the school curriculum will directly lead to increasing numbers undertaking post-secondary education and training:

- Review of Post-Secondary Agricultural Education in Western Australia (Cowan 2010);
- Parliament of Victoria Education and Training Committee Inquiry into Agricultural Education and Training (Parliament of Victoria Education and Training Committee 2012);
- Review into Agricultural Education and Training in New South Wales 2103 (Pratley 2013);
- The Senate Standing Committee on Education, Employment and Workplace Relations Higher education and skills training to support agriculture and agribusiness in Australia (Senate Standing Committee on Education, Employment and Workplace Relations, 2012).

A number of recent reports have highlighted a shortfall in graduates in agriculture and related disciplines, with Pratley (2012) reporting that Australian universities are producing only 700 graduates a year, when the market requires around 4000. Further, the National Farmers' Federation (NFF) estimates the sector needs to find close to 90,000 workers to reflect pre-drought levels, and more than 15,000 workers annually to replace those exiting the industry (NFF, cited on page 42 of The Blueprint for Australian Agriculture, 2013-2020). Enrolments in agriculture and related courses at Universities had been declining since 2001 from approximately 4,500 to below 2,500 students nationally (Allen Consulting Group 2012; Bryceson and Cover 2012), contributing to a shortage of qualified professionals in the agriculture sector, and reduced enrolments in postgraduate programs (Pratley 2013). This also reduces government funding to Universities, which is calculated on the basis of student numbers, affecting the Universities' ability to run viable agricultural programs. However in 2016 the numbers commencing agricultural courses almost doubled to over 1,500 (Pratley 2016).

## 7.0 FUTURE WORKFORCE NEEDS OF THE FOOD AND FIBRE PRODUCTION SECTOR

The difficulty in attracting young people into agricultural careers has been attributed to:

- a lack of knowledge and understanding of the agricultural sector within the community (Sefton & Associates 2013);
  - the sector failing to promote the courses and opportunities on offer (McColl et al. 1991);
  - low levels of industry involvement in education and training (McColl et al. 1991);
  - limited capacity of the current education and training system to deliver innovative training solutions.
- These factors all reinforce negativity about working in agriculture (McColl et al. 1991).

In addition, there are negative perceptions of agricultural careers held by the general public (McColl et al. 1991; Bryceson and Cover 2012; Pratley 2008; Hargraves 2011) and a lack of understanding of what such a career entails, as described further in the next section.

### 7.4 Perception of agricultural careers

Students and key influencers such as teachers, careers advisers and parents do not have a clear understanding of what a career in agriculture means. Most people equate agriculture with farming, but in reality it refers to the whole food and fibre value chain, from the pre-farm gate supply sector, to on-farm production, to post-farm gate processing to the marketing, advisory and finance sectors (Australian Council of Deans of Agriculture 2014). This perception impacts career decision making because when agriculture is perceived as farming, then careers in agriculture are associated with being a farmer. While this is not a negative per se, further perceptions that you need to own a farm to be a farmer exacerbate notions that it is an unobtainable career for many. This perception can mean many students do not contemplate a career in agriculture (Education and Training Committee, 2012 pp xxi). Other barriers include perceived lack of career paths, ability to transfer skills (Commonwealth of Australia 2014 p 90), peer pressure, and lack of guidance.

Research conducted in South Australia (Hargraves 2011) found that students had mixed perceptions of the agricultural industry and its associated careers, and that these perceptions were influencing youth interest and uptake of careers in agriculture. As part of an Honours project at the University of Adelaide, 144 secondary school students, teachers and careers advisers were interviewed to gauge how the South Australian agricultural industry could better attract students.

## 7.0 FUTURE WORKFORCE NEEDS OF THE FOOD AND FIBRE PRODUCTION SECTOR

Research found that many students did not see agriculture as much more than farming and food production. It also found that the majority of urban students had never thought about agricultural careers or had them suggested at school. In comparison, rural and agriculture students were more interested in entering the industry. However, even some of these rural students reported that it may be difficult to enter the industry, especially female students (Hargraves 2011).

While many students suggested that they respected and understood the need for the industry, only 25% said they would actually consider a career in the sector (Hargraves 2011). Students were confused by what 'agriculture' and 'agricultural' careers meant or involved. In fact, only 54% of students were aware that agriculture could be studied at university and some students thought they had to be born into the sector to work in it (Hargraves 2011).

Industry image is also a major issue, with 56% of students discouraged from a career in agriculture by negative news reports. Students were concerned about industry challenges such as drought, environment, cost-price squeeze and corporatisation of farming (Hargraves 2011). Many of the students in urban focus groups thought that if they became a farmer they would 'go broke' (Hargraves 2011). There were also concerns raised about 'isolation' and 'lack of services' with living rurally.

Of further concern was the data that found that only 31% of students (N = 144) had been presented with agriculture as a possible career path to follow, and only 41% of students had had any agriculture careers presented to them (Hargraves 2011). Careers counsellors suggested that students are encouraged to research careers themselves, but they would pass on information to the students they were sent (Hargraves 2011). However, unpublished data collected by Cay (2016) found that careers advisers had little knowledge of careers in agriculture and specifically in the grains industry (which was the focus of that research). In fact, when asked to rate their own level of knowledge and ability to advise students on careers in agriculture (grains), 75 % said they had only little or fair knowledge (N=72).

When considering a career, students suggested that 'starting salary' and 'job satisfaction' were most important, followed by 'location' and the 'ability to make a positive difference to society' (Hargraves 2011). Students also suggested that they could be engaged about careers via their careers counsellors, through career days, career books, websites, posters and brochures. The use of 'web sites' and 'discussion with families' was their preference for independent career research, followed by 'career books' and 'brochures'. It is important to observe, however, that if students are unaware of agricultural careers, then self-directed research via websites is unlikely to achieve the desired outcome.



## 7.0 FUTURE WORKFORCE NEEDS OF THE FOOD AND FIBRE PRODUCTION SECTOR

Addressing these barriers is essential to attracting young people into agriculture. Research suggests engaging with students as early as possible is integral to influencing their perceptions of the primary industries / agricultural sector. Andrews (2009) reports that 'most existing students will have made their career choice at a young age, probably based on a perception of the profession as it may have existed decades ago'. Pratley (2013) also stated that students must be engaged in science before the age of 10 or 11, as interest is strong at this age and will more likely persist into secondary school. It was stated that a rapid decline in interest occurs from around 11 years of age. Considering this, while it is important that any initiatives and campaigns utilise modern marketing principles to engage a primary and secondary audience, they must also work to engage key influencers of career – such as parents.

Low enrolments in agricultural courses and concerning perceptions of the agricultural sector are not an issue unique to Australia. Work in the USA suggest that to 'sustain the agricultural workforce, colleges of agriculture must invest in recruiting students to agricultural majors' (Scott and Lavergne, 2004 cited in Frazee et al. 2011). Similar to the work by Hargraves (2011) mentioned above, White et al. (1991) found that 'urban youth believe careers in agriculture are only for those who had an agricultural background, worked outdoors, and participated in on-the-job training'. A range of other studies also suggests that students do not equate agriculture with computers, engineering or teaching (Conroy, 2000; Newsom-Stewart and Sutphin, 1997).

### 7.5 What are sector workforce needs?

Shifts in the nature of food and fibre production globally and locally appear to be emphasising the role of technology both in production, the value chain, and market intelligence. Agricultural production and marketing are increasingly knowledge-intensive activities, drawing on technological developments in computing, engineering and data analysis (Daly et al. 2015). Also, sector innovation requires partnerships between producers and the support sector that can be facilitated through technology (Daly et al. 2015)

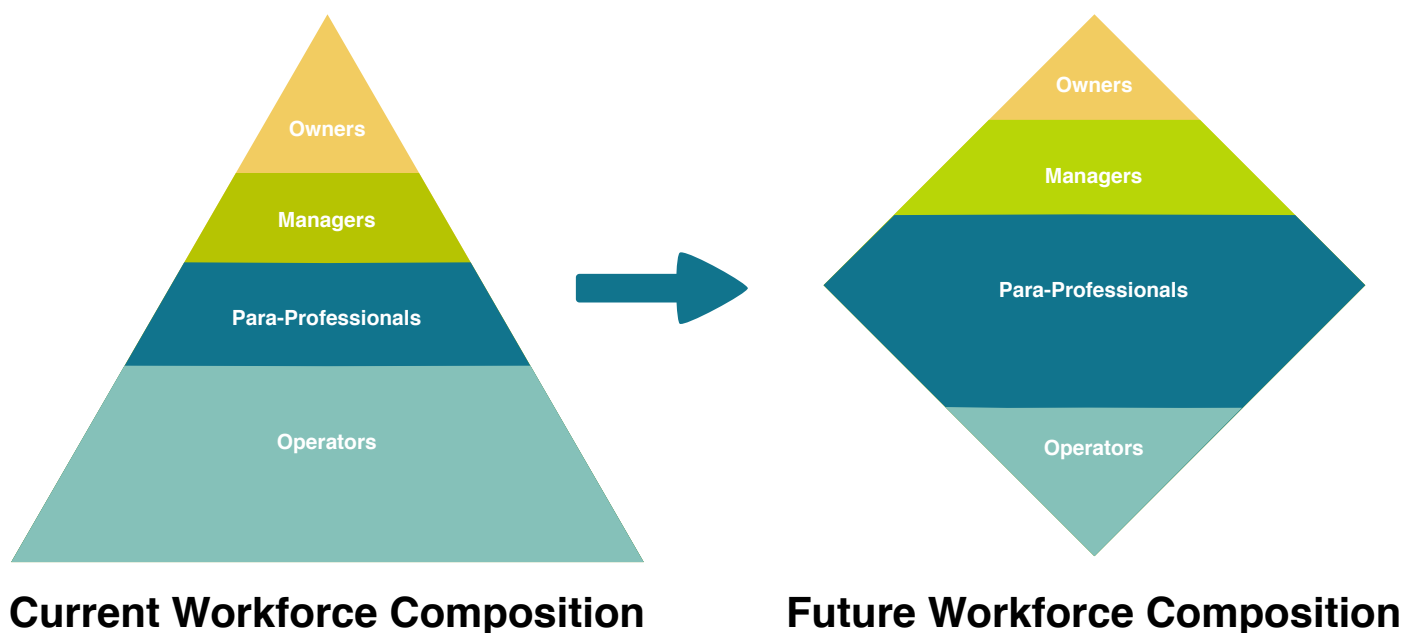
The AgriFood Skills Council of Australia's recent Environmental Scan (2015) suggests the following workforce needs:

- building world-class business capability and risk management expertise;
- attracting motivated, smart and adaptive workers;
- increasing enterprise's capability to adopt new technologies and research outcomes;

## 7.0 FUTURE WORKFORCE NEEDS OF THE FOOD AND FIBRE PRODUCTION SECTOR

- building higher level skills and knowledge within the existing workforce;
- retaining the best and brightest workers.

Once again it should be emphasised that these are not specific to the food and fibre production sector. However, it is the changing needs of the sector, perhaps best represented by Figure 1, that highlights the particular shift in both actual needs, and **perceptions of industry needs** that need to occur in the future.)



*Changing sector workforce needs (AgriFood Skills Council of Australia 2015)*

### 7.6 Recommendations to address workforce needs

The Agrifood Skills Council of Australia, (2015) recommended the development of 'a national brand and common, contemporary narrative for agrifood careers for customisation by each sector'. We suggest that organisations such as PIEFA have a role in developing and sharing this narrative, including the growth in new technology-based roles in support of primary production, to students, teachers and careers advisors. In addition, there is a need to develop an evidence base for factors that influence the perception of careers in the food and fibre sector. We propose a research strategy to address this in section 9.5, related to greater direct experiences with food production by consumers.

## 8.0 PERCEPTIONS AND UNDERSTANDINGS OF FOOD AND FIBRE PRODUCTION IN AUSTRALIA

### 8.1 Studies of community perceptions of food and fibre production in Australia

Peer reviewed studies that examine broad community perceptions and knowledge of food and fibre production in Australia are surprisingly limited given the economic, social and historical importance of the sector. For example, in a recent attempt to identify scholarly articles on the perceptions of agriculture in Australia, we searched Scopus, the largest abstract and citation database of peer- reviewed literature covering the fields of science, technology, medicine, social sciences, and arts and humanities. Using the search terms ‘Australia\*<sup>1</sup> AND agriculture\* AND perception OR attitude’ in the ‘Article Title, Abstract or Keywords’ field we identified 347 articles written between 1975 and 2016. By examining the titles and abstracts of the articles we were able to determine that some were not related to agriculture or Australia and that most were on farmers’ attitudes to issues such as wellbeing, environmental management and climate change. Only seven articles were found to be relevant to this study and have been cited in the relevant sections.

Disappointingly, several articles that we knew from our knowledge of the field were not identified in the search above (for example Meyer et al. 2012, Cockfield and Botterill 2012). The lack of articles found using scholarly databases meant that we had to use alternative search strategies such as citation-based searches (who the researchers cited, who they were cited by), alternative specific keywords (such as ‘rural’) and alternative search tools such as Google and Google Scholar as well as our own knowledge of research in the field.

Where possible we have included peer-reviewed work, but to increase coverage we have also included reports, media articles and websites where relevant. Individual industries may undertake market research, but this research rarely enters the public domain.

### 8.2 Studies show broad support for primary producers

The summary of the key points from the limited studies of attitudes to agriculture are that Australian adults think that farmers:

- are good contributors to Australian society (Worsely et al. 2015);
- look after their livestock well (Worsely et al. 2015; Cockfield and Botterill 2012);
- are well educated about agriculture (Worsely et al. 2015);

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<sup>1</sup> These search terms were chosen to give the most number of articles relevant to this literature review. The asterisk within the search term means that any ending of the word is included, i.e. Australia, Australian, Australians; agriculture, agricultural, etc. Any work on the Australian public, teachers or students that examined attitudes or perceptions of agriculture that included those words in the abstract should have been captured with this search.

## 8.0 PERCEPTIONS AND UNDERSTANDINGS OF FOOD AND FIBRE PRODUCTION IN AUSTRALIA

- use technology to improve their business (Worsely et al. 2015);
- are good stewards of the land (Worsely et al. 2015);
- do a good job of managing the environment; however, agreement with this statement is lower than others (60%; Worsely et al. 2015) and varies with the political leanings of the respondent (Cockfield and Botterill, 2012);
- are good business operators, although agreement with this statement is lower than the others (59%) (Worsely et al. 2015);
- are producing clean, safe food (Cockfield and Botterill, 2012).

However, there are some areas of concern, and findings in conflict with the above that will be explored further in the sections below.

### 8.3 Specific knowledge of agriculture is low

In their recent paper, Worsely, Wang and Ridley (2015) claim that agricultural knowledge is low based on a series of multiple-choice questions about the sector; for example, the value of farm exports, or the number of jobs the sector provides (see Fig 2 below). They acknowledge the questions may have been difficult (and without knowing the multiple choice options, it is difficult for the reader to assess how difficult they were), but for a number of questions the response was far lower than chance, in particular questions related to sustainability, water use in the rice industry, greenhouse gas emissions and natural resource management. It is important to note that perceptions of environmental management are still positive, despite a lack of specific knowledge. This relationship between perceptions and knowledge of agriculture, also noted by Cockfield and Botterill (2012) warrants further investigation; both are important for maintaining social licence (see the next section).

Items	% (n = 1,026)
1. Compared to other countries, the Australian grain industry uses less fertilizer and less tilling	17
2. Australian rice growers use up to 50% less water than the worldwide average	6
3. In Australia, almonds uses the most water to produce it	3
4. Most agricultural land in Australia is suited to grazing of sheep and cattle	49
5. A lot of land in Australia is arid with low rainfall and unsuited to cropping. Beef cattle and sheep are best farmed on this type of land	62
6. Most Australian beef cattle are fed on grass and rainwater for most of their lives	32
7. Australian farmers receive minimal government support to grow food	43
8. Approximately 1.6 million jobs do farming and associated industries provide in Australia	12
9. Approximately 12% of the national gross domestic product does agriculture account for	16
10. In 2010-2011 the value of farm exports was \$33 billion	7
11. About 60% of Australia's total agricultural production is exported	23
12. Wheat is Australia's most valuable export	27
13. 90% of Australian agricultural land is Australian owned	11
14. Overall, Australian farmers manage and care for 60% of the Australian landmass	18
15. About 90% of Australia's daily domestic food supply is produced by Australian farmers	10
16. Since 1990 Australian farmers have decreased their GHG emissions by 40%	5
17. 94% of Australian farmers have undertaken self-funded natural resource management on their properties	3

**Figure 2 Percentages of correct answers to the items in the consumer knowledge of farming and agriculture in Australia survey from (Worsley et al., 2015).**



## 8.0 PERCEPTIONS AND UNDERSTANDINGS OF FOOD AND FIBRE PRODUCTION IN AUSTRALIA

### 8.4 Studies of community perceptions of food and fibre production in Australia

Food and fibre sector activities in urban and peri-urban areas are likely to be influencing community perceptions. Although food and fibre production in Australia has arguably always taken place in urban and peri-urban areas, with increasing urban sprawl in our capital cities, the need to protect productive land close to cities has become an important aspect of land use policy. In addition, the movement of residential land into peri-urban areas has created new tensions that may be influencing perceptions.

Peri-urban regions produce almost 25% of Australia's total gross value of agricultural production from less than 3% of the agricultural land base (Houston 2005), a statistic that is unlikely to be broadly known, and suggests that people living in urban areas are living closer to food and fibre production than they think. This may present opportunities for engagement with the urban community, including schools that are currently under-utilised.

Additionally, there is increasing importance being placed on producing food within cities and the importance of green, food producing spaces within urban areas in recent years. Lyons et al. (2013) argues that a plethora of 'ethical' food movements have emerged in response to the 'food crisis' (rise in global food prices, expansion of biofuels, increasing global hunger and the impact of climate change), including those involved in urban food production. Some proponents of urban food production oppose conventional agriculture (calling it 'industrial agriculture'). It is unclear whether these activities are impacting on perceptions of 'large scale' food and fibre production in a positive way (for example, by demonstrating that food production is part of urban landscapes as well as rural ones) or in a negative way (for example, by positioning small-scale production as 'good' in contrast to large scale production).

### 8.5 Trust in the food system is decreasing

Public trust in the food system has been examined by researchers at Flinders University in South Australia. In their study on consumer trust along the food chain (Henderson et al. 2011), trust in 'farmers' was found to be the highest (93%), compared with supermarkets (66%), the media (54%) and politicians (44%). These results are quite different from European studies, which the authors suggest could be due to less media coverage associated with food scares such as BSE. Meyer et al. (2012) found that the decline in consumer trust in food production, and a desire for increased regulation of food, are linked to shifts in food production trends (increased food miles, mass production etc.) that have resulted in a growing gap between producers and consumers which in turn creates a 'deficit in consumer knowledge and control over the foods they purchase' (Meyer et al. 2012, p 634). The research found that consumers in rural areas, in comparison to those in metropolitan

## 8.0 PERCEPTIONS AND UNDERSTANDINGS OF FOOD AND FIBRE PRODUCTION IN AUSTRALIA

areas, were more trusting of food production, which is a result of their direct experience with the food production sector (Meyer et al. 2012). It is suggested that if consumers have a direct relationship to food production then their trust will increase. The link between a lack of trust and a desire for increased regulation is closely linked to the concept of social licence to operate.

### 8.6 Community attitudes to the fishing industry

A search of the scholarly literature (using Scopus and the terms ‘attitudes’ and ‘fish\*’ and ‘Australia’) did not identify any papers on attitudes of the Australian public to the Australian Fishing Industry. In addition, there are few non-scholarly reports; however a summary of two key reports is presented below.

(i) The key findings from the ‘Community attitudes towards Australian Fisheries Management. Market Research Report’ (Department of Agriculture, 2015) are:

- That fisheries management is not an issue that is top of mind for many Australians;
- There are both positive and negative perceptions of the fisheries industry;
- Current signals (or a lack thereof) indicate that fisheries are well managed;
- Sustainability is important to the fisheries industry;
- Scientists are the most trusted authority on fisheries (more trusted than environmental groups).

Interestingly, consumption of fish appears not to influence perceptions of the management of fisheries, but for those who regularly consume fish, country of origin labelling (which facilitates consumption of locally-caught fish) provides a level of comfort and confidence in the safety of the product they consume.

In comparison to other primary industries, seafood was seen as having less volume and influence; however, people who fish more frequently or who live in coastal towns are more engaged in fisheries.

Participants in this research listed employment opportunities and a source of healthy food as benefits of fisheries, although negative perceptions include over-fishing, exported fish (the best go overseas), accessibility and price (and quality), confusion over labelling, ecological damage, commercial interests come first, lack of visibility, and bycatch.

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The authors of this report noted (p27) ‘that discussion creates unease about what people do not know and we saw this occurring in the focus groups as participants realised their current lack of knowledge about the industry’; and that there was a ‘consensus among participants that compared to other industries, the fisheries industry is largely invisible, and lacks a profile’ (p29). Once engaged in the topic, participants wanted to hear about positive steps being made in innovation and sustainability.

(ii) The second report ‘Community perceptions of the sustainability of the fishing industry in Australia’ (Fisheries Research and Development Corporation 2013) found that 42% of the Australian community thought that the fishing industry was sustainable, 20% believed it was not and 38% were unsure. Interestingly, the perception of sustainability was highest for the aquaculture sector (76%) and lowest for commercial fishing (30%). In addition, the fishing industry was seen as less sustainable than other agricultural industries, specifically eggs (57%), dairy (52%), beef (51%), and horticulture (47%).

### 8.7 Community attitudes to the forestry industry

A search of the scholarly literature (using Scopus and the terms ‘attitudes’ and ‘forest\*’ and ‘Australia’) identified a limited number of papers on attitudes of the Australian public to the forestry industry. Of these, the work of Kathryn Williams from the University of Melbourne and the CRC for Forestry is the most revealing (and described further below). Reports that examined broader public attitudes to forestry (for example, the perceptions of those located in cities) were not found.

Williams (2011) found in surveys of residents in southwest Western Australia and Tasmania that plantation forests were significantly less acceptable than all forms of traditional agriculture, as well as less acceptable than wind farms. Only residential development was less desirable than plantation forestry. In her 2014 paper, Williams notes that previous research undertaken by herself and others shows that the public differentiates between the impacts of pine plantations and eucalypt plantations, as well as ownership of the plantations. Williams (2014) found that plantations were more acceptable when (pp 351-352):

- planted on only part of a property rather than the whole;
- planted in areas with local processing facilities rather than for woodchips for export;
- planted in areas that had only a few plantations;
- planted by a landowner on land they owned, rather than on land leased to a company.

## 8.0 PERCEPTIONS AND UNDERSTANDINGS OF FOOD AND FIBRE PRODUCTION IN AUSTRALIA

In addition, eucalypt plantations for timber were more acceptable than pine plantations or eucalypt plantations for pulp and paper. Williams (2014) suggests that residents in the study regions (and where the industry is located) are seeking stronger environmental and social benefits from plantations.

### 8.8 The social licence to operate for some industries is at risk

The *social licence to operate* refers to the freedom that individuals or organisations have to use resources for private purposes (Martin & Shepherd 2011; Rooney, Leach, & Ashworth 2013; Leach, Gallois, & Ashworth forthcoming). The term has typically been used in relation to debates about the mining sector, but is becoming increasingly applied to other primary industries including agriculture, fishing and forestry. These industries rely on the use of natural resources such as soil and water which many consider public assets. They employ many seasonal workers, often involve the use of animals in which the general public has considerable interest, and have an impact on natural ecosystems. The interactions that managers within these industries have with resources, animals, and the environment are governed by formal regulations as well as more informal policies and practices including self-regulation. Lower levels of formal regulation indicate relatively low levels of societal concern about particular practices and/or high levels of trust, and hence a more robust basis for farming's social licence to operate (Martin & Shepherd 2011). However, in cases of crisis, governments can intervene very quickly on behalf of society to regulate, as was seen recently with the live animal export trade (Munro 2015). Although the specific terms of the food and fibre production social licence are not currently well understood, we know that trust is important for maintaining the social licence, as are shared values (Sapp et al. 2009).

Despite the broad support for food and fibre mentioned previously, Australians are becoming increasingly uneasy about some current agricultural practices and their possible impacts on human health (Kriflik & Yeatman 2005, Lyons 2006), animal welfare (Taylor & Signal 2009), and the environment (Witt et al. 2009). Growing interest in ethical foods, organic foods and activism about farm animal and worker welfare indicate some concerns about certain types of farming practices. Low-carbohydrate diets such as 'Paleo' are linked to beliefs that people were healthier in the past, and that modern farming and food technology are making us 'sick' (Knight 2012). Such concerns are now increasingly prominent in media and popular culture, which have become important sites for the critique of conventional agriculture and its practices (see further below). Sections of the Australian public feel that despite efforts to make operations more efficient and sustainable, agriculture is no longer based on the same shared values that grounded more traditional and small-scale family farming, and that economic drivers have led to a food system aimed at mass production and profit making that has changed too quickly for risks to be fully



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assessed (Kriflik & Yeatman 2005). As discussed previously, very little is known about broader community attitudes to the forestry industry, and the fishing industry is not 'top of mind' for many Australians.

As previously mentioned, trust is important for maintaining social licence to operate. Knowledge becomes important when (if) people become aware that practices do not reflect what they thought occurred in practice. This can be thought of as *habitual trust* (Bildtgaard 2008); i.e., the assumption that events occurring in the world will continue pretty much as they have before, and as long as this assumption is not betrayed, trust will be more or less habitual and automatic. Habitual trust is very different from *reflexive trust*, where a person 'consciously weighs different values and corresponding forms of knowledge against each other, while trying to determine which systems and factors to trust' (Bildtgaard 2008 p118). Although attempts to engage the community in food and fibre production are arguably attempts to move the community from a position of habitual trust to one of reflexive trust, '... habit is possibly our strongest source for trust, in the sense that most of our everyday practices are guided by it' (Bildtgaard 2008 p105).

### 8.9 Role of the media

The media impacts the food and fibre sector's social licence to operate because it is a major source of information about the sector for many urban Australians. There has been intensified media focus on food in recent years, with ideas such as 'paddock to plate,' 'ethical eating,' 'food system in crisis' and 'new urban farming' dominating along with idyllic depictions of small-scale farming, such as those in the popular television show *Gourmet Farmer* (Phillipov 2016).

Research has shown media framing and representation, especially in technical contexts, are important in shaping public discourse about contested issues (Nisbet & Mooney 2007), but media representations of Australian agriculture often have very different, and sometimes contradictory, implications. Within the media, discussion of food and fibre production methods has become increasingly polarised, with organic and genetically-modified foods and other 'industrialised' agricultural practices pitched against each other as the respectively 'natural' and 'agro-industrial' representatives of everything that was good and bad within the food system (Lockie 2006).

Even if Australian agricultural practices and policies may not in fact involve what international exposés depict, documentaries including *Food Inc.* and popular non-fiction writings such as the work of Michael Pollan (2008), have shed light on some of the worst excesses of 'industrial' agriculture, including the health and environmental hazards of chemical fertiliser and pesticide use, poor animal welfare

## 8.0 PERCEPTIONS AND UNDERSTANDINGS OF FOOD AND FIBRE PRODUCTION IN AUSTRALIA

conditions in meat and dairy production, and negative social impacts of corporate control of farming. There has been some examination of how Australians respond to information about food and nutrition in the media, for example Ward et al. (2011), which shows that while media is generally not trusted as a source of information about food, the conflicting messages about food create further distrust of information sources more generally. In addition, consumers tend to trust information about food stories until confronted with counter information. In contrast, there has been little attention to how media influences perception and knowledge of food and fibre production, with only a few exceptions: the impact of the media on the live export of cattle (Tiplady et al. 2013, Munro 2015). In a study conducted by one of the authors of this report, egg consumers spoke about the role of the media in influencing their decisions to purchase free-range eggs (Bray and Ankeny, pending).

### 8.10 Food and fibre production and environmental management

In addition to animal welfare, the impact of food and fibre production on the environment is arguably one of the most important issues placing the food and fibre production sector's social licence to operate at risk. As mentioned previously, conventional, large-scale food and fibre production is often perceived to be in opposition to conservation and environmental management goals. Although food and fibre production has caused damage to Australia's unique environment in the past, most industries have responded to the need to become more environmentally sustainable. However, despite the broad agreement with statements that farmers are good environmental managers in Worsely et al. (2005) and Cockfield and Botterill (2012), other research has revealed that people in urban areas (Brisbane, n=202) felt that waterways, native vegetation, grazing land and cropping land were not in good condition (Witt et al 2009). In this study 45% agreed that current rural land management is unsustainable, but encouragingly there was very strong agreement with the idea that farming and conservation are compatible.

At the heart of the tension between food and fibre production and the environment is the idea that in Australia, in contrast to other countries, agriculture, and arguably forestry production as well, are not seen as part of nature. Saltzman et al. (2011) suggest that this is because of the relatively short period of time that (European) food and fibre production activities have taken place in Australia and that the species of plants and animals used in agriculture have all been introduced. This idea influences environmental management policies, where maintenance of agricultural landscapes is deemed conservation in European contexts but less so in Australia. However, agricultural landscapes contribute to our national identity (Lennon 2011) and with continual agricultural change, 'traditional' agricultural landscapes, and our agricultural heritage (for example, technology and infrastructure from the 20th century) may be lost unless it is also considered a resource worth protecting in some

contexts (Lennon 2011). Productive landscapes, including managed forests and fisheries, need to be repositioned as part of Australia's environment and heritage within the broader agricultural narrative.

### 8.11 Recommendations to address community perceptions

The combination of generally positive perceptions, generally high levels of trust but low specific knowledge of food and fibre production leaves the sector's social licence to operate in a precarious position.

Perceptions of food and fibre production may be based on romantic and 'outdated' notions of farming (in particular), however at this point there is little empirical evidence to support this.

While it may be tempting for the sector to address the lack of knowledge with current information, this 'new' information may cause the community to feel that current food and fibre production methods do not align with their values, creating distrust.

Daly et al (2015) states:

***'There is a need for a shared, positive vision and narrative for agriculture in Australia. This must be constructed through dialogue and consultation with various stakeholders, including the general public, and should not rely on an over-romanticised idea of farming. The place of agriculture in contemporary society needs clarifying via articulation of shared societal values regarding issues critical to agriculture's future including technology, health, rural and regional development, and education.'***

Organisations like PIEFA have a role in ensuring that education about agriculture is not just about facts, but places agriculture within its social context. Production methods have changed, and will change, in response to social trends, and organisations like PIEFA have a role in ensuring that both those that enter the food and fibre sector for employment, as well as the broader community, are equipped to manage that change.

## 9.0 PERCEPTIONS AND KNOWLEDGE OF FOOD AND FIBRE PRODUCTION IN SCHOOLS

### 9.1 Studies of food and fibre knowledge of school children

The study commissioned by PIEFA and undertaken by Hill and Buckley (2011) remains one of the most significant investigations into school students' knowledge of agriculture and will not be summarised here. However, two key reports from the US and the UK highlight that this issue is not unique to Australia, and provide a broader perspective.

Research undertaken in the USA, where there are similar changes in agricultural production and the agricultural workforce, investigated the agricultural literacy of three schools which varied in their level of exposure to agriculture and its linked industries; i.e., one school was in a rural setting with an agricultural science program, one an urban school with no agricultural science program, and the other in a rural setting with no agricultural science (Smith et al. 2009). The overall finding was that students in the three schools were not agriculturally literate, even the school with the agricultural science program (Smith et al 2009). It was noted that students in all schools had misconceptions about agriculture, ( including that farmers are poor) and the relevance of certain agricultural commodities (Smith et al 2009). Within each of the schools, the students who were from farms had a more positive view about farming and did not hold many of the stereotypical views (i.e., farmer appearance). The findings of the report indicate that there is considerable work to be done to improve the agricultural literacy of school students. As such, the authors recommend that:

- any new resources or teaching material should avoid any stereotype;
- teachers should more accurately promote farming technologies and practices;
- communities should be engaged in the promotion of agriculture to create better connections and information exchange;
- agricultural industries should participate in careers events and portray the industry in a credible manner;
- agricultural educators should strive to create a community which is agriculturally literate and able to make informed food choices and voting decisions.

In a major UK review of children's knowledge of food, farming and the countryside (Dillon et al. 2003, Dillon et al. 2005), Justin Dillon and his colleagues identified 190 studies that examined school children's knowledge and attitudes and educational interventions aimed at improving them. Among them is a survey of 550 year 10 students in Victoria, Australia, undertaken by Matthews and Falvey (Matthews and Falvey, 1999), who found that more non-metropolitan students felt that agriculture

## 9.0 PERCEPTIONS AND KNOWLEDGE OF FOOD AND FIBRE PRODUCTION IN SCHOOLS

has a negative impact on the environment than metropolitan students. In their paper Dillon et al. (2005) propose a research agenda (based on blind spots identified during their review) that includes:

- identifying what and how children learn about food, farming and land management;
- identifying and removing barriers to learning (including teacher attitudes);
- measuring cost-effectiveness of particular teaching strategies.

It is telling that 10 years on we are still far from undertaking a similar research agenda in Australia, and we have addressed this in our recommendations below.

### 9.2 International case studies

A number of international research papers have demonstrated that food and fibre production provides a valuable context for learning and that through structured education programs, it is possible to change students' perceptions of food and fibre production, including their perceptions of career opportunities in the sector.

Implementation of an awareness program (The Big City, Big Country Road Show (BC2BC)) which focused on leadership, photography, writing, video production, and web design, changed students' perceptions of agricultural careers (Fraze et al 2011). Through pre and post surveys the authors measured the influence of workshop participation on students' perceptions of careers attainable with an agricultural sciences degree and their general agricultural knowledge levels. As workshop participants learned about the connections between agricultural subjects and careers, their perspectives about agricultural careers were changed. Significantly more students perceived attainable agricultural careers, such as public relations officer, loan officer, account representative, web designer, photographer, government official, and landscaper, after participating in the workshops. Significant differences in perceived knowledge levels were also found (Fraze et al 2011).

Enrolment trends in natural resources across the US have varied significantly across time, but research trends have found that they have not increased since 1980 (Sharik et al 2012). There is a vast range of trends that have been noted across studies involving demographic, economic and social factors. Surveys conducted by Sharik et al. 2004, Sharik 2005 (cited in Sharik et al. 2012) found the following reasons were influencing enrolment trends:

- Weak & uncertain job market;
- Low salaries compared to other professions;



## 9.0 PERCEPTIONS AND KNOWLEDGE OF FOOD AND FIBRE PRODUCTION IN SCHOOLS

- Increasing 'disconnect' between natural resources & an urbanizing society (especially among young adults);
- Tendency of minorities to avoid academic programs perceived as tangential to important issues affecting their communities;
- Negative public perceptions of forestry & related natural resource professions;
- Perception of curricula being too narrow & rigid;
- Increased 'science phobia' on the part of students;
- Increasing number of similar degree programs outside colleges of forestry & natural resources;
- Relatively long period beyond a B.S.(B.Sc.) degree needed to obtain a terminal professional degree;
- Lack of intellectual leadership & charisma nationally in forestry & related natural resources areas;
- Limited public awareness regarding social benefits of forestry & related natural resource professions;
- Decreasing enrolments in colleges & universities overall.

The authors state that institutions and public and private sector employers need a better understanding of the factors affecting undergraduate and graduate enrolments plus their job and career opportunities, both now and over the long-term. With greater understanding of these factors, awareness, communication and education campaigns can be designed to improve perceptions and increase enrolment trends.

Esters and Bowen (2004) investigated factors influencing students to enrol in an urban agricultural education program. Students suggested that a primary influencer of career choice was parents (specifically the mother) and/or guardians. Students also indicated events and experiences such as recruitment activities, interest in animals and agricultural career aspirations. The study also mentioned that agricultural teachers play an important role in guiding students into agricultural based careers. Considering this finding, it would appear important, given the limited Australian data to draw upon, that Australian agricultural industry invests and trains agricultural teachers as career advice givers.

The University of California, Desert Research and Extension Center (DREC), local agricultural partners, Southwest High School, and Imperial Valley Regional

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Occupational Group (IVROP) are working to attract and retain students in tertiary agricultural programs and have designed a summer internship opportunity for high school students. This program includes a range of experiential learning opportunities and exposes them to a diverse range of pathways and knowledge (Wills 2016). While there is no peer reviewed data on this program, it has been included as an idea for bridging students between high school and university using an engaging model.

Short experiences that last a few hours or a single day are commonly used to support learning in school environments. Although not directly related to agriculture, fisheries and forestry, Kinder et al. (2015) examined the impact of a 1 hour experiential activity on aquatic ecology that was offered as part of an activity day for 4th Grade students in the US. Evaluations of these kinds of activities are uncommon, and publication of them within scholarly journals is even more so. The researchers compared students who only did the activity against students who also did the pre and post visit activities within the classroom at different time points after the activity, namely two weeks and eight months. Students achieved higher on knowledge scores both two weeks and eight months after the activity when compared to their knowledge pre-activity, but students who did the pre- and post-visit activities scored higher than those who did the activity alone, highlighting the importance of providing supporting materials for teachers for these shorter programs. Ideas of stewardship also increased after the activity.

A paper presented at the 28th Annual National Agricultural Education Research Conference by Balschweid (2002) investigated students' perceptions of agriculture prior to and upon completion of a yearlong traditional biology subject that was taught using animal agriculture as the context. The subject was taught using specialist contextual learning materials/modules. Over 530 students were surveyed. The research found that teaching students a mainstream subject utilising an agricultural context could change perceptions. For example, over 90 % of surveyed students agreed or strongly agreed that participating in the class helped them understand the relationship between science and agriculture. Over 85 % agreed or strongly agreed that they not only appreciated the complex nature of animal agriculture as a result of taking the agricultural based biology class, but the biology class also helped them understand the practices used in animal agriculture; and almost nine out of ten respondents agreed or strongly agreed that they appreciated the importance of agriculture and those who work in agriculture as a result of participating in an agricultural based biology class. This research provides an interesting option for Australian schools to consider – could delivering a mainstream subject using agriculture as the teaching context channel more students into agriculture?

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Although field trips and outdoor learning have been shown to provide benefits to students, there may be barriers to their use by teachers. In a study which examined teacher attitudes to field trips to forests in the US, McCabe et al. 2014 found that the presence of a forest within walking distance of the school (proximity), confidence in teaching forestry concepts (confidence), and involvement in school natural resources related extra-curricular activities (involvement), were significant predictors of forest field trips. When a forest is within walking distance of the school, teachers were over 11 times more likely to have taken a field trip. Open-ended comments about constraints from 136 teachers were grouped into four broad themes: (1) standardized curriculum; (2) money; (3) testing, training, interest, and infrastructure; and (4) time. However, the cross-tabulated qualitative comments indicated that many had led a trip despite noting these factors and the overall reported use of field trips was somewhat equally balanced. The authors suggest that these results suggest that constraints such as time and money may not necessarily be related to field trip use, however an alternative interpretation is that for some teachers a lack time and money does not prevent field trip use, because their confidence overcame these barriers. Teacher confidence was also linked to having a forest close to the school. The authors of this study suggest that building teacher confidence and facilitating access to forests are the main ways to help teachers overcome institutional barriers to providing field trips.

A unit aimed at high school students was developed by the University of Florida's School of Forest Resources and Conservation to engage students in understanding the role of woody biomass in energy production. Should We Use Wood for Energy? A High School Education Program (<http://sfrc.ufl.edu/extension/ee/woodenergy/index.html>) examines three aspects of sustainability – environment, economy, and society by examining a local industry. Evaluation showed increased student knowledge of woody biomass, advantages and disadvantages of using wood for energy and factors a community should consider, although the program was less successful at helping students reflect on what sustainability is and how this concept relates to using wood for energy. Limitations of the program were found to be the time required to deliver all components of the unit and the amount of required prior knowledge. The program developers have since addressed these limitations and the activities were accessed over 25,000 times in 2012.

Overall, it is evident that new resource and initiative development must consider developing learning materials that provide an opportunity for students to learn in context. They must be relevant to their life and must motivate the student to learn. These reports also emphasise the need for teachers to be supported and trained in teaching science in a food and fibre context and stress the need for food and fibre subjects to incorporate mainstream science in their lessons.

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### 9.3 Attitudes to agriculture within Australian schools

There are few reports of student perceptions of agriculture as a subject at school, which also presents an opportunity for further investigation, i.e., what do students who study agriculture enjoy about it? One anecdote in the recent review of agricultural education in New South Wales undertaken by Professor Jim Pratley (2013) is telling. Discussions with students revealed that many had felt viewed as 'second-class' by students who did not do agriculture, and even sometimes by staff. The students also commented that when agriculture was used as a context in non-agriculture classes (for example, in environmental studies) agriculture was presented in a negative light.

Bray, Cay and Allan (2015, in press) investigated how Australian teachers use grains/agriculture in teaching and their attitudes towards grains. Research (n=342) found that teaching grains, or agriculture, is not common practice in mainstream subjects. Teachers cite that this is due to their not knowing where to source information, 'just not thinking' of agriculture as a context to teach mainstream subjects, thinking it was someone else's role and believing that agriculture was not relevant to their school. Only 23 % of secondary teachers and 18.3 % of primary school teachers used any agricultural education resources in their teaching. Those who do teach agriculture or grains are usually specialist agricultural teachers, with 91 % utilising agricultural resources such as fact sheets from the GRDC, CSIRO, DPI or state departments, plus the Dynamic Agriculture Years7-10 and Dynamic Agriculture Years 11-12 textbooks by Lisle Brown, Robert Hindmarsh, Ross McGregor. They stated they have limited 'off the shelf' resources to choose from, especially for teaching grains.

Interestingly, 64 % of home economics/food & nutrition/textiles teachers stated they use agricultural resources (but note this was predominantly wool and cotton and that grains resources were not highly cited). Primary school teachers who do teach grains cite that this is in the context of nutrition and is usually mentioned within the context of the food pyramid (a source of carbohydrates) with the subject matter not exceeding one lesson. Despite grains being taught in the context of food, grains are not a feature of many kitchen or school gardens. While 63% of primary schools have a 'garden', only 2% include grains. Barriers to growing grains include lack of support, they simply had not been considered, and the perception that they required expert knowledge and extra space. In secondary schools, growing grains was seen as an activity for agriculture students.

### 9.4 The rise of kitchen gardens in Australia

The term 'kitchen garden program' refers to programs that, in addition to a garden with edible plants, include student participation in the preparation and cooking of

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meals in the kitchen–classroom, using food harvested from the garden (Gibbs et al. 2013a). School-based food gardens are primarily seen as a useful nutrition education tool (Somerset and Markwell 2008), and although school garden programs have been examined for their impact in a number of areas such as nutrition knowledge, personal development aspects and environmental attitudes (Gibbs et al. 2013a), interestingly attitudes to and knowledge of agriculture are not listed, nor are they listed among the goals of the one of the most well-known programs, the Stephanie Alexander Kitchen Garden (SAKG) program.

An examination of the impact of the SAKG program (the only scholarly evaluation of any named food and fibre education program we have been able to find in Australia) revealed that children were more willing to taste a range of new foods. In addition, the researchers found that children appreciated the freshness of fruit and vegetables, as well as that they were grown organically (Gibbs et al. 2013b). This is similar to Somerset and Markwell's 2008 paper on a year-long study of children in one school in Brisbane where the presence of a school garden led to the attribution of added value towards vegetables and fruits that were 'garden grown', as well as the substantial increase in the ability of children to identify specific vegetables and fruits. Hence the impact of these programs on attitudes to conventional horticulture and other food and fibre production activities is unknown.

School-based cooking programs aimed at increasing food literacy were recently reviewed by Markow et al. (2012). They found that there is a significant gap in the evaluation of such programs, particularly in secondary school. However, most programs seemed to positively affect cooking skills. None of those reviewed appeared to link cooking with agriculture.

### 9.5 A comment on literacy vs citizenship

It is interesting to note that in the USA, agricultural literacy has been on the research agenda since 1988 following a publication by the National Research Council entitled 'Understanding Agriculture – New Directions for Education (Kovar & Ball 2013). In their review of research into agricultural literacy amongst US teachers, students, and non-teacher adults, Kovar & Ball (2013) were able to find 49 studies, most of which were published in agricultural education journals. A person who is literate in agriculture should, according to Frick, Kahler, and Miller (1991, cited in Smith et al. 2009) 'possess knowledge and understanding of our food and fibre system. An individual possessing such knowledge would be able to synthesize, analyse, and communicate basic information about agriculture. Some have suggested that agricultural literacy should extend to being able to understand the effect of dietary choices on human health, i.e., enabling the community to make 'good' food choices.



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In Australia, the Australian 2012 National Assessment Program – Science Literacy (NAP–SL) Year 6 report (Kesidou et al. 2012) states that ACARA (The Australian Curriculum, Assessment and Reporting Authority) assesses ‘scientific literacy in the context of a student’s ability to apply broad conceptual understandings of science in order to make sense of the world, to understand natural phenomena and interpret media reports about scientific issues’. It also includes asking investigable questions, conducting investigations, collecting and interpreting data and making decisions. The National Assessment Program monitors trends in scientific literacy performance over time against three main areas of scientific literacy. Testing results gained in 2006, 2009 and 2012 found ‘no statistically significant differences in mean student achievement and in the proportion of students performing at or above the Proficient Standard in most jurisdictions’ (other than Western Australia where the mean student achievement increased by 25 score points (Kesidou et al. 2012). A student survey was also conducted which found that over 80% of students surveyed ‘appear to be interested in learning new things in science, learning about science and doing science-based activities’ (Professor Barry McGraw pp x11, Kesidou et al. 2012). While these results provide a strong foundation to build upon, the education sector is always considering new ways to engage and enthuse students in science. Interestingly, within science education research and scholarship there has been a shift towards developing scientific citizenship (as opposed to scientific literacy) to enable people to fully participate in democratic societies (Sturgis and Allum 2004; Tytler 2007). This shift has also included an emphasis on engagement, where engagement implies ‘thoughtfulness, deliberation and reasoned decision making, frequently aimed towards action, and most often in the context of formal organised groups’, and arises from a presumed link between civic engagement and a healthy democracy (Bagdonis et al. 2009). While the quote below mentions ‘literacy’, we feel it is more representative of the ideas of ‘agricultural citizenship’ (Smith et al 2009 p22):

*‘The implications of agricultural illiteracy in our schools and communities have direct impacts on agricultural policy and economics. Students who lack an understanding of the importance of agriculture or who hold various misconceptions and stereotypes about agriculture will become adults who make poor, misinformed decisions about political candidates, agricultural policy, and food and fibre decisions in their own homes. Agricultural illiteracy in youth translates into agricultural illiteracy in adults, yet these adults may have significant impacts on various aspects of food and fibre’.*

To further highlight this point, we suggest that the work of Brophy et al. (2003) provides a more revealing picture of school students’ understanding of food production. Brophy et al. (2003) describe understanding where food comes from as a ‘cultural universal’ and as a way for understanding a society or to make

## 9.0 PERCEPTIONS AND KNOWLEDGE OF FOOD AND FIBRE PRODUCTION IN SCHOOLS

comparisons across societies. In their investigation of primary grade students' knowledge of food origins and production methods, they interviewed 96 K-3 students in the US about food production, including particular questions that involved deeper thinking. Rather than identifying agricultural production, children were asked questions such as 'why does a pound of cereal cost more than a pound of apples?' They found that the children's responses related more to their age and experiences out of school, but tended to be focused more on the finished product than the transformations. Brophy et al. (2003) highlight the potential for curriculum links to history, geography and society and culture.

### 9.6 Should we be talking about 'food and fibre capital?'

It is clear that the challenges of engaging school students in food and fibre production to develop literacy/citizenship and/or become interested in careers in the sector are complex and require more than one single approach. Perhaps the most useful way of thinking about this problem can be 'borrowed' from recent work by Kings College London in the UK that looked at student engagement with science (Archer et al. 2015). Their work is also summarised (including a simple video) at [www.kcl.ac.uk/sspp/departments/education/research/cppr/Research/currentpro/Enterprisin g-Science/01Science-Capital.aspx](http://www.kcl.ac.uk/sspp/departments/education/research/cppr/Research/currentpro/Enterprisin g-Science/01Science-Capital.aspx)

Essentially, the dimensions of Science Capital are:

- **Scientific literacy:** a young person's knowledge and understanding about science and how science works. This also includes how confident they feel that they know about science;
- **Science-related attitudes, values and dispositions:** this refers to the extent to which a young person sees science as relevant to everyday life (for instance, the view that science is 'everywhere');
- **Knowledge about the transferability of science:** understanding the utility and broad application of science qualifications, knowledge and skills used in science (e.g., that these can lead to a wide range of jobs beyond, not just in, science fields);
- **Science media consumption:** the extent to which a person, for example, watches science- related television, reads science related books, magazines and engages with science-related internet content;
- **Participation in out-of-school science learning contexts:** how often a young person participates in informal science learning contexts, such as science museums, science clubs, fairs, etc.;

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- **Family science skills, knowledge and qualifications:** the extent to which a young person's family has science-related skills, qualifications, jobs, and interests;
- **Knowing people in science-related roles:** the people a young person knows (in a meaningful way) in their family, friends, peer, and community circles who work in science-related roles;
- **Talking about science in everyday life:** how often young people talk about science out of school with key people in their lives (e.g., friends, siblings, parents, neighbours, community members) and the extent to which young people are encouraged by key people in their lives to continue with science.

By substituting the word 'science' for 'food and fibre production' in the above, it is possible to see that no single interaction with food and fibre production, for example only at school, would provide enough 'capital' to engage a young person in food and fibre enough to consider it as a career choice and/or to move to a position of reflexive trust (see section 4.3) when choosing what to buy or who to vote for. This framework explains why a child from an urban area, probably from a non-English speaking background, with no family members working in the food and fibre sector, and little engagement with the sector outside of school, would be less likely to think about food and fibre than a child from a rural area, with family members working in the sector, who is frequently exposed to the importance of the sector out of school. This latter scenario was highlighted in the work of Hargraves (2011) described in section 3.4.

Recognition of the 'food and fibre capital' concept provides a framework for recognising the multiple ways young people can engage with food and fibre, developing a research strategy to understand the influence of these multiple ways of engagement, and ultimately for designing strategies that can influence these factors to increase a young person's food and fibre capital. While it may not be possible to influence whether a young person has a family member in the sector, other strategies, in particular enabling students to see food and fibre production as ubiquitous and relevant to their daily lives, will be vital in raising food and fibre capital.

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### 9.7 Recommendations to address perceptions and knowledge of school children

During the last 10 years since the first scoping study undertaken by Scarlett Consulting in 2005 on agricultural resources, and the publication of Dillon et al.'s (2005) research agenda, we have progressed little in our understanding of how to enhance understanding of food production amongst school children and the broader community. We are not saying that successful programs have not been developed and there may already be improvements in agricultural literacy as a result of activities by groups such as the Primary Industries Education Foundation Australia. This is more an observation that despite the importance of the agricultural sector to Australia, the role of agriculture in education appears to have been largely overlooked by the education research community, compared to other areas such as environment and sustainability education.

Now that potentially more children are being exposed to food and fibre production at school, it is important to evaluate the impact of these programs.

## 10.0 FOOD AND FIBRE PRODUCTION IN THE AUSTRALIAN CURRICULUM

Food and fibre studies are embedded in the new Australian Curriculum and are defined as 'the process of producing food or fibre (including forestry) as natural materials for the design and development of a range of products'. The Australian Curriculum Assessment and Reporting Authority (ACARA) worked collaboratively with representatives from the primary industry sector, including PIEFA, throughout the curriculum development process to ensure food and fibre were appropriately included and recognised.

ACARA states that students have opportunities across the learning areas from Foundation to Year 10 to learn about the production of the food they eat, fibres they use, and the environment in which they live. This learning addresses key processes such as production, marketing, consumption, sustainable use of resources and waste recycling (ACARA 2014). Specifically, food and fibre concepts are embedded within Design and Technologies, Science and Geography.

## 10.0 FOOD AND FIBRE PRODUCTION IN THE AUSTRALIAN CURRICULUM

Recent research by Bray, Cay and Allen (2015 in press) and focused on the grains industry found that teachers do not regularly teach agriculture in mainstream subjects. In fact, 75 % of teachers surveyed (N=342) said they did not use third party agricultural education resources in their teaching. The barriers for including agriculture include:

- *'we/I don't teach agriculture'*
- *we don't have the resources'*
- *'I don't know about the grains industry'*
- *we don't have the resources or agronomic support*
- *limited budget*
- *I don't have the background knowledge/confidence*
- *it's not my role – it's the ag teachers*
- *don't know where to source credible resources...*
- *I just didn't think of it!*

Teachers stated that they need to be further engaged and supported to deliver agriculture in the classroom. They would like a point of reference and professional learning to increase their knowledge and confidence to deliver these topics.

Teachers were asked about their preferred formats to receive new resources – these include:

- hard copy / kit – 68 %
- email resources – 64 %
- YouTube clips – 50 %
- Smart Board ready – 30 %

They also clearly stated that any new resources need to be curriculum linked, classroom ready and flexible.

The need for greater teacher engagement and support is further supported by the work conducted by Hilman and Buckley (2011) that found that most teachers did not have background qualifications, and therefore knowledge of primary industries. Their research found that 85% of primary and secondary teachers they surveyed did not study any primary industries subjects while at university. They had low levels of familiarity with issues related to primary industries that would affect teaching.



## 10.0 FOOD AND FIBRE PRODUCTION IN THE AUSTRALIAN CURRICULUM

While there is clear research to demonstrate that both primary and secondary school teachers lack the confidence to successfully teach agriculture (food and fibre), there is no literature available on how teachers view agriculture as a context for teaching Science, Technology, Engineering and Mathematics (STEM).

### 10.1 STEM investment

The Education Council has presented their National STEM Education Strategy (2015) that clearly states that STEM is a priority for Australian schools. The Australian Government has committed an extra \$12 million to increase student interest and engagement in STEM subjects in primary and secondary schools. This investment builds on the \$5 million allocated in the 2014-15 Budget for the Primary Connections and Science by Doing programs.

The STEM investment works to encourage students to study STEM and is ultimately working to ensure Australia's young adults are equipped with the necessary skills for the economy of the future. It is recognised that STEM careers underpin Australian's future skills needs. The STEM funding will address:

- Providing innovative mathematics curriculum resources for primary and secondary school students, focusing on inquiry-led teaching;
- Supporting the introduction of computer coding across different year levels in Australian schools, leading to greater exposure to computational thinking, and, ultimately, expanding the pool of ICT-skilled workers;
- An innovative approach to education based on the United States 'Pathways in Technology Early College High School' (P-TECH) model; and
- Summer schools for STEM students, to increase the number of girls and disadvantaged students attending — including Indigenous students and those from regional and remote areas.

The National STEM Education Strategy presents a number of goals and recommendations that could be readily addressed by PIEFA, and the wider education providers in the food and fibre sector. The areas for consideration (as documented in the Education Council's National STEM Education Strategy (2015) include:

- Lift the quality of initial teacher education to support teacher confidence and STEM content expertise;
- Facilitate STEM engagement through effective curriculum, teaching approaches and assessment resources to improve learning outcomes in the classroom;

## 10.0 FOOD AND FIBRE PRODUCTION IN THE AUSTRALIAN CURRICULUM

- Work with universities to improve the pathway for STEM graduates into teaching, for example, through financial incentives and inclusion of teaching pedagogy components in STEM-related degrees linked to school/university partnerships;
- Facilitate greater engagement between industry and STEM teachers, for example, industry work placements and programs for pre-service teachers.

The STEM Country Comparisons Final Report, published by Marginson et al. (2013) also included a range of recommendations that could be considered and addressed by the food and fibre education sector these include:

- Key finding 6.1: building awareness of STEM disciplines and STEM-related occupations among young people. i.e., enrichment programs whereby students are engaged in science or mathematics projects that entail linking to members of local communities;
- Key finding 8.1: inquiry, reasoning, and creativity and design in STEM curricula;
- Key finding 12.2: establishing STEM mentoring programs to encourage female participation in STEM;
- Key finding 14.1: STEM Partnerships.

Other areas organisations such as PIEFA could address to align with the STEM Strategy include:

- facilitating effective partnerships with schools and food and fibre STEM businesses and industries;
- scoping the STEM food and fibre jobs available and update careers advisers, students and teachers of these opportunities;
- liaising with Australia's Chief Scientist to ensure that food and fibre (the wider primary industries sector) are considered as important STEM industries;
- developing a strategy for how the food and fibre sector's education providers, businesses and industry can best support schools to deliver effective STEM learning outcomes;
- developing scholarship initiatives to offer teachers accredited training in STEM (with a focus on food and fibre);
- developing an initiative which upskills scientists to deliver training in schools to

## 10.0 FOOD AND FIBRE PRODUCTION IN THE AUSTRALIAN CURRICULUM

support teachers to deliver their STEM teaching components (i.e., supported learning). This might include collaboration with CSIRO Scientists and Mathematicians in Schools (SMiS) program.

There are a number of strategies that document the risks of Australia not supporting STEM education. For example, a statement cited in the Office for the Chief Scientist (2013, p. 10) states that 'Most nations are closely focused on advancing STEM, and some have evolved dynamic, potent and productive strategies. In world terms Australia is positioned not far below the top group, but lacks the national urgency found in the United States, East Asia and much of Western Europe, and runs the risk of being left behind'.

The Office for the Chief Scientist (2013) also states that 'By 2025 we should have reached a point where Australians will understand and value the science they use in everyday life, and where the STEM enterprise will be widely accepted as a central and visible source of solutions to societal challenges. The education system will provide all Australians with the capacity and confidence to make informed choices on complex matters where STEM offers options that have ethical, economic or environmental dimensions'.

With a number of these strategies 'agriculture', 'food' and 'water' are referred to as topics underpinned with science. As such, it is integral as an industry that initiatives are developed which are largely focused on supporting teachers to deliver and engage students in STEM in the context of food and fibre.

### 10.2 Recommendations to align food and fibre with STEM

Current investment in STEM provides opportunities to increase food and fibre in the curriculum through greater alignment, and in addition addresses another key issue already identified in this report, i.e., the perception of careers in the food and fibre sector and the need to produce a STEM-enabled workforce for the benefit of the sector. Food and fibre should be in a privileged position within the STEM narrative and should be among the top three industry sectors mentioned in conjunction with STEM.

## 11.0 THE POTENTIAL ROLE OF PEIFA IN RESPONDING TO THE KEY ISSUES

On the basis of our review, the authors of the original research report identified key issues for PIEFA to consider while implementing their future strategic direction.

**ISSUE 1:** There is a need for a common, contemporary narrative for food and fibre careers, including the growth in new technology-based roles in support of primary production, and to share that narrative with students, teachers and careers advisors.

**Potential Role for PIEFA:** a leadership role in developing and sharing this narrative in consultation with stakeholders, to students, teachers and careers advisors.

**ISSUE 3:** Although food and fibre is now within the Australian Curriculum, we don't know if this will impact on student's food and fibre literacy/citizenship/capital.

**Potential Role for PIEFA:** a leadership role in setting and delivering the research agenda to establish the evidence base for the inclusion of food and fibre in the school, leading to food and fibre literacy/citizenship/capital.

**SSUE 2:** There is a need for a shared, positive vision and narrative for agriculture in Australia. The place of agriculture in contemporary society needs clarifying via articulation of shared societal values regarding issues critical to agriculture's future including technology, health, rural and regional development, and education.

**Potential Role for PIEFA:** a leadership role in constructing this narrative through dialogue and consultation with various stakeholders, including the general public. PIEFA will ensure that education about food and fibre is not just about facts, but places production within its social context. It should not rely on an over-romanticised idea of farming.

**ISSUE 4:** Food and fibre is not widely recognised as a context for delivering STEM education.

**Potential Role for PIEFA :** a leadership role to ensure that the food and fibre production sector is seen as a STEM based profession, providing real-world STEM applications.

## 12.0 REFERENCES

- ABARES (2014), Australian forest and wood products statistics, March and June quarters 2014, Overview report and data tables, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, available at [http://www.agriculture.gov.au/abares/publications/display?url=http://143.188.17.20/anrdl/DAFFService/display.php?fid=pb\\_afwpsd9abfe20141111\\_11a.xml](http://www.agriculture.gov.au/abares/publications/display?url=http://143.188.17.20/anrdl/DAFFService/display.php?fid=pb_afwpsd9abfe20141111_11a.xml)
- ABARES (2016) ABARES Media Release - Australia's farm production forecast to top \$60 billion Viewed online at: 1/08/16 <http://www.agriculture.gov.au/abares/media-releases/2016/farm-production>
- AgriFood Skills Council of Australia (2015) Environmental Scan 2015 of the Agrifood Industry viewed 27/7/16 at [http://www.fas.org.au/wp-content/uploads/2016/04/ESCAN\\_2015.pdf](http://www.fas.org.au/wp-content/uploads/2016/04/ESCAN_2015.pdf)
- Allen Consulting Group (2012) Rebuilding the agricultural workforce Report to the Business/Higher Education Round Table. Viewed 1/8/16 at <http://www.bhert.com/publications/reports/Rebuilding-the-Agricultural-Workforce-Report-Jan2012.pdf>
- Andrews FM (2009) Veterinary school admissions in the United Kingdom: attracting students to veterinary careers to meet the expanding needs of the profession and of global society. *Rev Sci Tech* 28(2):699-707
- Archer L, Dawson E, DeWitt J, Seakins A & Wong, B (2015) 'Science Capital': A conceptual, methodological, and empirical argument for extending Bourdieusian notions of capital beyond the arts. *Journal of Research in Science Teaching* 52(7) 922-948.
- Argent N and Walmsley (2008) Rural Youth Migration Trends in Australia: an Overview of Recent Trends and Two Inland Case Studies. *Geographical Research* 46(2):139-152.
- Australian Bureau of Statistics (2012) 2011 Census reveals one in four Australians is born overseas. Viewed 3/8/16 at <http://abs.gov.au/websitedbs/censushome.nsf/home/CO-59>
- Australian Bureau of Statistics (2016) 7503.0 - Value of Agricultural Commodities Produced, Australia, 2014-15. Viewed online 1/8/16 at <http://www.abs.gov.au/ausstats/abs@.nsf/mf/7503.0>
- Australian Government Department of Education, Employment and Workplace Relations (2013) Australian Jobs. Viewed 3/8/16 at: <http://www.cdac.org.au/ContentUpload/Docs/australianjobs2013.pdf>



## 13.0 REFERENCES

- Barlow S (2014) Food and Fibre - Australia's Opportunities. Australian Research Council Australian Academy of Technological Sciences and Engineering (ATSE). Viewed online at <http://www.atse.org.au/Documents/Publications/Reports/Agriculture/atse-food-and-fibre-full-report.pdf>
- Barr N (2014) New entrants to Australian agricultural industries –Where are the young farmers? Rural Industries Research and Development Corporation. Viewed 27/7/16 at <https://rirdc.infoservices.com.au/items/14-003>
- Bildtgard T (2008) Trust in food in modern and late-modern societies Social Science Information 47(1):99-128.
- Balschweid MA (2002) Teaching Biology Using Agriculture as the Context: Perceptions of High School Students. Journal of Agricultural Education, Volume 43, Number 2 pp 56-67. Viewed online at: <http://www.jae-online.org/attachments/article/373/43-02-56.pdf>
- Bray H & Ankeny R (pending) 'Happy chickens lay happy eggs': Motivations for buying free-range eggs in Australia. Anthrozoos
- Bray H, Cay BA and Allan K (pending) 'I just didn't think of it.' Factors that influence Australian teachers' use of grains production examples in their teaching. In preparation for the Journal of Agricultural Education and Extension <http://www.tandfonline.com/toc/raee20/current#.VyK7-fl95Ql>
- Bryceson K & Cover M (2012) The University of Queensland's Agricultural Education Survey Report 2012. Viewed 1/8/16 at: <http://www.uq.edu.au/agriculture/docs/UQ-Agricultural-Education-Report-Final.pdf>
- Centre for International Economics (2015) Drivers of demand for Australian agricultural products. Report prepared for the Australian Council of Learned Academies. Viewed on 27/7/16 at <http://www.acola.org.au/PDF/SAF07/drivers%20of%20demand.pdf>
- Cockfield G, & Botterill LC (2012). Signs of Countrymindedness: A Survey of Attitudes to Rural Industries and People. Australian Journal of Political Science, 47(4), 609-622. doi:10.1080/10361146.2012.731482
- Commonwealth of Australia 2015, Meeting Market Demand: Australia's Forest Products And Forest Industry, Forest Industry Advisory Council, Department of Agriculture, Canberra. CC BY 3.0.

## 13.0 REFERENCES

Cowan H (2010) Review of Post-Secondary Agricultural Education in Western Australia. Viewed 19/5/15 [http://www.parliament.wa.gov.au/publications/tailedpapers.nsf/displaypaper/3812579a453038438c668362482577a70001dba1/\\$file/tp2579.pdf](http://www.parliament.wa.gov.au/publications/tailedpapers.nsf/displaypaper/3812579a453038438c668362482577a70001dba1/$file/tp2579.pdf)

Daly J, Anderson K, Ankeny R, Harch B, Hastings A, Rolfe J & Waterhouse R (2015). Australia's Agricultural Future. Report for the Australian Council of Learned Academies, viewed 27/7/16 at <http://www.acola.org.au/pdf/SAF07/SAF07%20full%20report.pdf>

Esters LT and Bowen BE (2004). Factors influencing enrolment in an urban agricultural education program. Journal of Career and Technical Education. Viewed online at: <https://ejournals.lib.vt.edu/JCTE/article/view/645/936>

Fraze LB, Rutherford T, Wingenbach G, and Wolfskill LA (2011) Urban High School Students' Perceptions about Agricultural Careers and General Agricultural Knowledge. NACTA Journal. Viewed online at: [https://www.nactateachers.org/attachments/article/1653/14\\_Fraze\\_Dec2011.pdf](https://www.nactateachers.org/attachments/article/1653/14_Fraze_Dec2011.pdf)

Hargraves A (2011) Attracting Youth into Agricultural Careers: Factors Influencing Youth Interest in South Australia. A thesis submitted for the partial fulfilment of the requirements of the Bachelor of Agriculture with Honours with the University of Adelaide.

Henderson J, Coveney J, Ward PR, & Taylor AW (2011). Farmers are the most trusted part of the Australian food chain: results from a national survey of consumers. Australian and New Zealand Journal of Public Health, 35(4), 319-324. doi:10.1111/j.1753-6405.2011.00725.x

Hillman K and Buckley S (2011) Food, Fibre and the Future Report on surveys of students' and teachers' knowledge and understanding of Primary Industries. A report prepared for the Primary Industries Education Foundation by the Australian Council for Educational Research. Viewed online at: <http://www.primaryindustrieseducation.com.au/resources/reports/foodfibrefuture.pdf>

Holmes J (2006). Impulses towards a multifunctional transition in rural Australia: Gaps in the research agenda. Journal of Rural Studies, 22, 142-160.

Houston, P. (2005). Re-valuing the Fringe: Some Findings on the Value of Agricultural Production in Australia's Per-Urban Regions. Geographical Research, 43(2), 209-223.

## 13.0 REFERENCES

- Industries Development Committee Workforce, Training and Skills Working Group (2009) Workforce, Training and Skills Issues in Agriculture Final Report. A report to the Primary Industries Ministerial Council. Viewed 3/8/16 at <http://www.farmingahead.com.au/uploads/00003/document/work-train-skills-pdf.pdf>
- Ireland JJT and Monroe MC (2015) Should we use wood for energy? An education for sustainable development case study. *Applied Environmental Education and Communication*, 14:82-89.
- Kettlewell (2010) The Impact of Rural to Urban Migration on Wellbeing in Australia. *Australasian Journal of Regional Studies*, 16(3): 187. Viewed 3/8/16 at: <http://anzrsai.org/assets/Uploads/PublicationChapter/485-1632KettlewellFINAL.pdf>
- Kesidou, S., Sadeghi, R. and Marosszeky, N. (2012) Assessment Program – Science Literacy Year 6 Report. Australian Curriculum, Assessment and Reporting Authority 2013. Viewed online at: <http://www.nap.edu.au/results-and-reports/national-reports>
- Kinder T, Mesner NO, Larese-Casanova M, Lott KH, Cachelin A and LaLonde K. 2015. Changes in knowledge and attitude from a short-term aquatic education program. *Natural Sciences Education*, 44: 18-25.
- Knight C (2012) ‘An alliance with Mother Nature’: Natural food, health and morality in low- carbohydrate diet books. *Food and Foodways* 20: 102–22.
- Kovar KA & Ball AL (2013). Two decades of agricultural literacy research: A synthesis of the literature. *Journal of Agricultural Education*, 54(1), 167-178.
- Kriflik LS, & Yeatman H (2005). Food scares and sustainability: A consumer perspective. *Health Risk & Society*, 7(1), 11-24. doi:10.1080/13698570500042439
- Langridge P (2014) The Conversation - Agriculture in Australia: growing more than our farming future. Viewed online 1/8/16 at: <http://theconversation.com/agriculture-in-australia-growing-more-than-our-farming-future-22843>
- Leach J, Gallois C., & Ashworth P (forthcoming) The language of social licence to operate: Communication of science or business as usual? *Journal of Language and Social Psychology* (accepted 22 Dec 2015)
- Lennon JL (2015). Changes to Continuing Landscapes: Industrialisation of Australia’s Productive Rural Lands. *Landscape Research*, 40(6), 684-700.

## 13.0 REFERENCES

Lyons K (2006). Environmental Values and Food Choices: View from Australian Organic Food Consumers. *Journal of Australian Studies*, 87, 155-166.

Lyons K, Richards C, Desfours L & Amati M (2013) Food in the city: urban food movements and the (re)- imagining of urban spaces, *Australian Planner*, 50:2, 157-163, DOI: 10.1080/07293682.2013.7769

Marginson, S, Tytler, R, Freeman, B and Roberts, K (2013). STEM: Country comparisons. Report for the Australian Council of Learned Academies, [www.acola.org.au](http://www.acola.org.au).

Martin P & Shephard M (2011) What is meant by the social licence? In *Defending the Social Licence of Farming: Issues, Challenges and New Directions for Agriculture*, edited by J Williams & P Martin, pp. 3–11. Collingwood: CSIRO Publishing.

McAllister I (2009) Public Opinion Towards Rural & Regional Australia Results from the ANU Poll Report 6 October 2009. viewed 1/8/16 at [http://politicsir.cass.anu.edu.au/sites/politicsir.anu.edu.au/files/2009-11-20\\_ANUpoll\\_rural\\_and\\_regional\\_report\\_0.pdf](http://politicsir.cass.anu.edu.au/sites/politicsir.anu.edu.au/files/2009-11-20_ANUpoll_rural_and_regional_report_0.pdf)

McCabe SM, Munsell JR and Seiler JR (2014) Forest Field Trips Among High School Science Teachers in the Southern Piedmont. *Natural Sciences Education*. 43:44-50.

McColl J, Robson A, & Chudleigh J (1991). Review of Agricultural and Related Education. Volumes 1 and 2. AGPS, Canberra: Department of Employment, Education and Training and Department of Primary Industries and Energy.

Meyer SB, Coveney J, Henderson J, Ward PR, & Taylor AW (2012). Reconnecting Australian consumers and producers: Identifying problems of distrust. *Food Policy*, 37(6), 634-640. doi:10.1016/j.foodpol.2012.07.005

Meyer, S. B., Mamerow, L., Henderson, J., Taylor, A. W., Coveney, J., & Ward, P. R. (2014). The importance of food issues in society: Results from a national survey in Australia. *Nutrition & Dietetics*, 71(2), 108-116. doi:10.1111/1747-0080.12076

Munro L (2015) The live animal export controversy in Australia: A moral crusade made for the mass media. *Social Movement Studies: Journal of Social, Cultural and Political Protest* 14: 214–29.

## 13.0 REFERENCES

- National Stem School Education Strategy (2015) A Comprehensive Plan for Science Technology, Engineering and Mathematics Education in Australia. Viewed online at: [www.educationcouncil.edu.au](http://www.educationcouncil.edu.au)
- Nisbet MC & Mooney C (2007) Framing science. Science 315: 56. Parliamentary of Victoria Education and Training Committee (2012) Inquiry into agricultural education and training in Victoria. Viewed 19/5/15 [http://www.parliament.vic.gov.au/file\\_uploads/ETC\\_Inquiry\\_into\\_Ag\\_Education\\_Final\\_Report\\_c3r44B0Q.pdf](http://www.parliament.vic.gov.au/file_uploads/ETC_Inquiry_into_Ag_Education_Final_Report_c3r44B0Q.pdf)
- Phillipov M (2016) The new politics of food: Television and the media/food industries Media International Australia 158(1):90-98
- Pollan M (2008) In Defense of Food: An Eater's Manifesto. New York: Penguin.
- Pratley J (2008) Workforce Planning in Agriculture: Agricultural Education and Capacity Building at the Crossroads. Farm Policy Journal, 5(3)
- Pratley J (2013) Review into Agricultural Education and Training in New South Wales – Issues Paper. Viewed 3/8/16 at: <https://www.det.nsw.edu.au/media/downloads/about-us/statistics-and-research/public-reviews-and-enquiries/agricultural-education/full-report.pdf>
- Pratley J (2016) Graduate supply for agriculture – a glimmer of hope. Viewed 3/8/16 at <http://www.farminstitute.org.au/newsletter/2016/May/feature>
- Rooney D, Leach J, & Ashworth P (2013) Doing the social in social license. Social Epistemology 28: 209–18
- Savage J & Hobsbawn P 2015, Australian fisheries and aquaculture statistics 2014, Fisheries Research and Development Corporation project 2014/245. ABARES, Canberra, December. CC BY 3.0.
- Sefton & Associates (2013) The Blueprint for Australian Agriculture 2013. National Farmers' Federation and Sefton & Associates. Viewed online 1/08/16 at [www.nff.org.au/blueprint](http://www.nff.org.au/blueprint)
- Senate Standing Committee on Education, Employment and Workplace Relations (2012) Higher education and skills training to support agriculture and agribusiness in Australia. Viewed on 19/5/15 [http://www.ruralskills.com.au/uploads/file/http\\_eet\\_ctte\\_agribuisness\\_report\\_report.pdfwopared\\_aph\\_gov\\_au\\_senate\\_committee](http://www.ruralskills.com.au/uploads/file/http_eet_ctte_agribuisness_report_report.pdfwopared_aph_gov_au_senate_committee)
- Sharik TL, Lilieholm RJ and Richardson WW (2012) Factors influencing undergraduate enrollment trends in natural resources. Presentation delivered at



## 13.0 REFERENCES

- the 9th Biennial Conference on University Education in Natural Resources Fort Collins, CO, March 23, 2012. Viewed online at: <http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1244&context=cuenr>
- Smith E, Park T and Sutton M (2009) High School Students' Perceptions and Knowledge about Agriculture based upon Location of the High School. NACTA Journal, September: 17-23. Viewed online at: [https://www.nactateachers.org/attachments/article/1653/14\\_Fraze\\_Dec2011.pdf](https://www.nactateachers.org/attachments/article/1653/14_Fraze_Dec2011.pdf)
- Taylor N & Signal TD (2009) Willingness to pay: Australian consumers and 'on the farm' welfare. Journal of Applied Animal Welfare Science 12: 345–59.
- Tiplady CM, Walsh D-AB and Phillips CJC (2013) Public response to media coverage of animal welfare. Journal of Agricultural and Environmental Ethics 26: 869-885.
- Tytler R. (2007) Re-imagining Science Education Engaging students in science for Australia's future. Australian Education Review. Viewed online 28/07/2016 <http://research.acer.edu.au/cgi/viewcontent.cgi?article=1002&context=aer>
- Ward PR, Henderson J, Coveney J & Meyer S (2011). How do South Australian consumers negotiate and respond to information in the media about food and nutrition? The importance of risk, trust and uncertainty. Journal of Sociology, 48(1), 23-41.
- White C, Stewart BR and Lindhardt RE (1991) Career opportunities in agriculture as perceived by inner-city high school students. Jour. of Agr. Education 34(4): 55-63. Viewed online at: <http://pubs.aged.tamu.edu/jae/pdf/vol32/32-01-30.pdf>
- Wills S (2016) Engaging students in agriculture. Blog. Viewed online at: <http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=22141>
- Wilson A, Coveney J, Henderson J, Meyer S, Calnan M, Caraher M, . . . Ward P (2013). Trust makers, breakers and brokers: building trust in the Australian food system. BMC Public Health, 13. doi:10.1186/1471-2458-13-229
- Witt G, Witt K, Carter R, & Gordon A (2009). Exploring the 'city-bush divide': what do urban people really think of farmers and rural land management? Australasian Journal of Environmental Management, 16(3), 168-180.
- Worsley A, Wang W, & Ridley S (2015). Australian adults' knowledge of Australian agriculture. British Food Journal, 117(1), 400-411. doi:10.1108/bfj-07-2013-0175