SUSTAINING AGRICULTURE IN NSW HIGH SCHOOLS - AN ASSESSMENT OF THE USE OF EXAMPLES FROM ALTERNATIVE AGRICULTURE AND INVESTIGATION INTO THE ROLE OF HIGH SCHOOL AGRICULTURE IN MEETING THE FUTURE NEEDS OF THE INDUSTRY.

by
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ABSTRACT

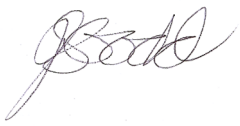
The lack of explicit reference to alternative agricultural systems in the syllabi for high school agriculture in NSW and concern regarding the ability of agricultural education to meet the needs of the industry are the basis for this research. An online survey of teachers was used to assess the extent to which examples from alternative agriculture are used in teaching, opinions on the amended HSC syllabus, and identify professional development needs. Overall, teachers 'sometimes' use examples from alternative agriculture, support the amended syllabus, and feel that they require 'a little' professional development with regards to alternative agriculture. Semi-structured interviews with stakeholders from agricultural education from primary through to tertiary levels were undertaken to gain a rich picture of the current state of agricultural education in Australia. Interviews revealed a need for industry and government to be more proactive in the support of agricultural education and promotion of agricultural careers. All stakeholders supported the need for students to be exposed to alternative agriculture, however, stressed the need for a balanced view of the industry as a whole rather than promoting particular systems. Further research into teacher and student perceptions of agriculture and agricultural careers is recommended to identify further teacher professional development and resource development needs.

DECLARATION

I certify that this dissertation does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any university. It does not contain any material previously published or written by another person except where due reference is made in the text.

This dissertation does not exceed 13,000 words.

Signed:



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Introduction

Agriculture is a constantly changing industry, particularly in the context of sustainability and the demands of economic, social and environmental issues (Williams & Dollisso 1998). The dynamic nature of the industry presents challenges for education to keep pace as well as be able to predict future demands for knowledge and skills (Peters, 2009). For agriculture to meet the challenge of sustaining food production for a growing global population there is a need to view agriculture as a knowledge industry, one that requires:

> *"people of an especially high standard of education and training who can manage not only the basics of production, but also sophisticated technologies, the agro-ecological environment, the sociology and economics of their business."*
>
> *Professor Julian Cribb, September 2008.*

In order for this high standard of education to be achieved there needs to be a change in perception. Often tagged as non-academic and inferior (Stephenson, Warnick & Tarpley, 2008), agricultural education suffers from the negative perceptions of agriculture in the wider community (Peters, 2009, National Farmers' Federation, 2008). Agriculture needs to bury the 'hick' image of rural labour and seek a higher academic status (Cribb, 2008).

Agricultural education in Australia and other parts of the world is at a critically important stage (Pratley, 2008). The current estimated demand for tertiary agriculture graduates in Australia is around 2000 per year, the supply of only around 800, leaves the industry in a position where only 7% of the workforce hold a degree compared to 22% in the overall workforce (Pratley, 2008). Declining university enrolments are a major issue for the agricultural sector with the potential for significant impacts on productivity and the ability of the industry to address climate change and sustainability challenges (Pratley & Copeland, 2008). The development of a modernised secondary curriculum in the United States of America (USA) has lead to an increase in tertiary enrolments, particularly from students from urban or

non-farming backgrounds (Dyer, Breja & Andreasen, 1999, Greene & Byler, 2004). In Australia, the next generation has limited comprehension of the significance of agriculture and the scope of agricultural careers due to the little agricultural content in curricula and elimination of specific agriculture subjects (Pratley, 2008). The 30% decline in tertiary agriculture graduates observed from 2001 to 2006 is expected to continue unless there is a significant increase in enrolments (Pratley & Copeland, 2008). With the global demand for food predicted to increase by 110% as the population grows towards 9.1 billion in the next 40 years (Cribb, 2008), the current state of tertiary agricultural education can be considered to be at a crisis point.

The aim of this research was to investigate the use of examples from alternative agriculture in the teaching of sustainable agriculture and examine factors influencing the writing of the New South Wales (NSW) high school agriculture syllabi. Whilst sustainable agriculture is prominent throughout the NSW Board of Studies syllabi (Board of Studies NSW, 2003b, Board of Studies NSW, 2009a), there is no explicit reference to alternative agricultural systems such as organic and Biodynamic farming or Permaculture. Organic agriculture is one of the top five growth industries in Australia worth $416.3 million in 2010 with a predicted revenue growth of 14% ($58.35 million) for 2011 (Agriculture Today, 2011). Soils managed using organic and biodynamic methods have been shown to have double the water holding capacity of conventionally managed soils (Azeez, 2009, Niggli, Fließbach, Hepperly, & Scialabba, 2009) and organic farming has been demonstrated to emit less greenhouse gases, be more energy efficient and have higher soil carbon sequestration potential (MacRae, Lynch & Martin, 2010). Agroecology is identified by De Schutter (2010), as the mode of agricultural development with proven abilities to address food security and broaden economic development in vulnerable communities. Given that lack of information is identified as a major barrier to the adoption of sustainable agriculture (Pretty, 1995, Agbaje, Martin & Williams, 2001) the inclusion of ecologically based alternative agriculture in education programs could be considered as essential to meeting the needs of future food security in an increasingly variable climate.

To understand the process of curriculum development and topic selection the initial aim of this research was to interview syllabus writers, however, the Board of Studies' privacy policy prevented the identification of writers and the research was subsequently broadened to interviewing stakeholders in agricultural education from primary through to tertiary levels. In the course of interviewing stakeholders it became apparent that wider issues relating to agricultural education and the image of the industry warranted investigation in order to place high school agriculture in context. Given that tertiary enrolments generally follow the trend in high school participation in agricultural education (Dyer et al. 1999) the teaching of agriculture in high schools is of critical importance. Participation in gardening programs at the primary school level could develop positive attitudes towards agriculture and encourage students towards high school courses and careers in the industry (Cannon, Broyles, Siebel & Anderson, 2006). The need to address agricultural education at the secondary level is therefore twofold; sustaining student interest from experiences in primary school and continuing this engagement to ensure students understand the career potential agriculture offers through tertiary studies. This research is particularly pertinent at this time as the Australian Curriculum Assessment and Reporting Authority (ACARA) embark on the shaping of the Australian Curriculum: Technologies (Information and Communication Technology and Design and Technology) in which agriculture will be included (Australian Curriculum Assessment and Reporting Authority, 2011).

Sustainable Agriculture

The definition of sustainable agriculture continues to evolve and be a matter of debate, a situation that may be disconcerting for people who require a conclusive definition (Parr, Trexler, Khanna & Battisti, 2007). Bawden (2007) suggests that the contestability of sustainability reflects the complexity and contextual nature of different worldviews and gives rise to practical questions about how we choose to live. Whilst sustainable agriculture may be defined in terms of being a goal or a set of particular practices, most definitions agree that it should be economically sound, socially acceptable and protective of the environment (Agbaje et al. 2001). Williams

(2000) proposes that sustainable agriculture is still more a philosophy rather than a prescribed set of approved farming practices. Pretty (1995) states that a precise definition is impossible, it is a socially constructed concept 'in the eye of the beholder' and should be considered as a process for learning. Agbaje et al. (2001) suggest that 'management by thinking' is an underlying principle of sustainable agriculture, supported by an overarching and interconnected framework of practices and technologies developed in response to problems. In order for sustainable agriculture to develop, Pretty (1995) suggests that a favourable policy environment must exist in which local institutions and groups are supported by enabling external institutions to develop and use resource-conserving technologies. These 'conditions for sustainable agriculture' are represented in Figure 1.

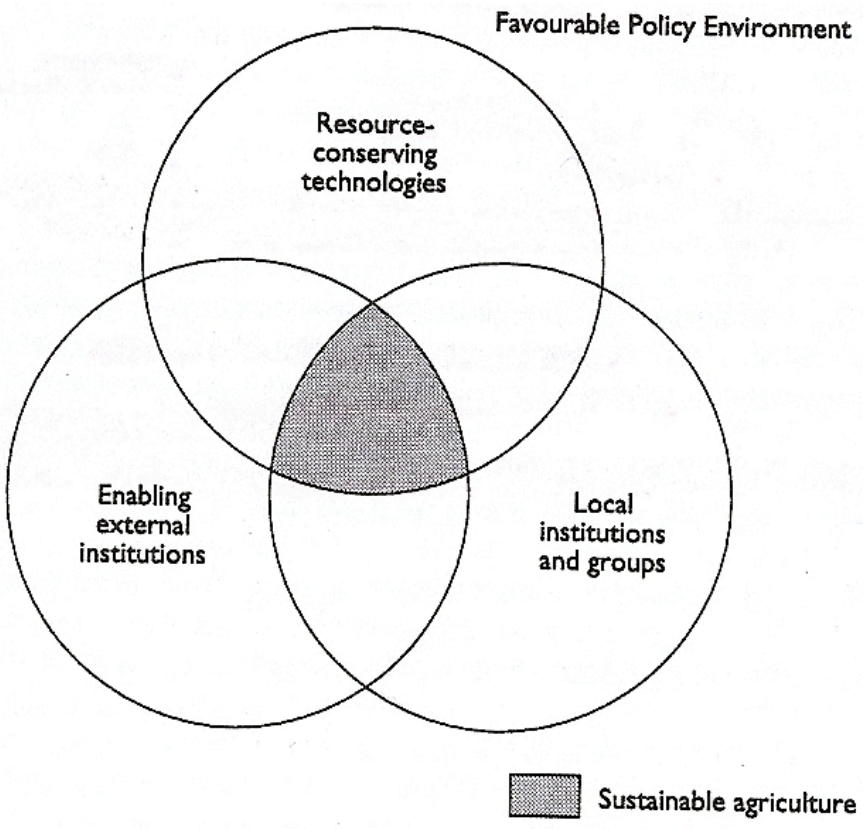

Figure 1: Conditions for Sustainable Agriculture (Pretty, 1995)

The paradigm of alternative agriculture is characterised by Beus and Dunlap (1990) as independent, community focussed, in harmony with nature, diverse, decentralised and restrained in resource use. Harding (1988) proposes that such characteristics are based on an ecocentric ideology. Gibbon and Jakobsson (1999) attribute this ideology to the low-input, ecological, Biodynamic, natural farming and Permaculture movements. Organic agriculture is generally considered as sustainable, however, some organic systems rely on high inputs, fossil fuels and threaten biodiversity, which raises questions about their sustainability in a wider context (Tisdell, 2007). Pretty (1995) cites examples where organic practices may be considered unsustainable, however, concludes that organic agriculture is generally sustainable but not the only form of sustainable agriculture. Rather, Pretty (1995) recommends that we adopt appropriate technologies and move beyond the simplistic argument between organic and industrialised systems.

Sustainable Agriculture in Education

To achieve the goals of sustainable agriculture, agricultural education needs to be integrated into the school curriculum and agriculture subjects upgraded to meet the needs of the 21st Century food and fibre system (Williams, 2000). Agbaje et al, (2001) advocate an approach in which learners are confronted with the severe problems facing mankind in every discipline. Real-world application to learning used by Alvarez and Rogers (2006) found the definitive and reductive approaches to sustainability to be inadequate, whereas an approach where sustainability was presented as a contested discourse suitably reflected the complexity of sustainability issues. Williams and Dollisso (1998) and Parr et al. (2007) suggest that sustainable agricultural education requires integrated, interdisciplinary, experiential, systems-oriented and progressive curricula in which social and environmental contexts are used to ground theory to practice. Fortunately the evolution of agroecology and sustainable agriculture has coincided with the emergence of alternative educational theories and practices suited to interdisciplinary learning (Parr et al., 2007).

Education programs can influence the attitudes and behaviour of learners, fostering a deep relationship with nature and leading to greater environmental responsibility (Agbaje et al., 2001, Williams & Dollisso, 1998). Agriculture provides an avenue through which students can make connections with the natural world and learn about ecosystems in an authentic learning environment (Knobloch, Ball & Allen, 2007). The pedagogy of 'experiential education' as described by John Dewey (1916, cited in Lieblein, Østergaard, & Francis, 2004), further examined by Kurt Lewin (1946, cited in Bawden et al., 1985) and revisited by David Kolb and colleagues (1975, cited in Bawden et al., 1984) is based on the theory that learning is drawn from the experiences of the student and follows a cycle of concrete experience, reflective observation, abstract conceptualisation and active experimentation. The constructivist theories of learning proposed by Piaget and Vygotsky (Pritchard, 2010) are supported by experiential education strategies also referred to as learn-by-doing, real-world learning, problem-based learning, and child-centred learning (Desmond, Grieshop and Suramaniam, 2004). Other educational theories such as Howard Gardner's theory of multiple intelligences and Daniel Goldman's theory of emotional intelligence are also relevant as the range of activities involved in experiential education that support different learning styles (Desmond et al, 2004).

Sustainable Agriculture in Primary Education

Food gardens represent the main form of education linked to agriculture in primary schools. Gardens offer student-centred hands-on experiences that promote positive attitudes towards science, improve science achievement, and develop the higher learning skills of analysis, synthesis and evaluation (Dirks & Orvis, 2005, Klemmer, Waliczek & Zajicek, 2005), as well as enhance understanding of nutrition, and improve and interpersonal skills (Smith & Motsenbocker, 2005). These benefits, however, are less likely to occur if not followed by adequate discussion and explanation of the experiences (Smith & Motsenbocker, 2005), highlighting the need to address the 'reflective observation' phase of the learning cycle. A review by Desmond et al. (2004) advocates garden based learning (GBL) as a tool for improving; academic skills, personal development, social and moral development,

vocational and/or subsistence skills, life skills, community development, food security, sustainable development, and school grounds greening. In addition, GBL is ideal for developing the ecological literacy needed for sustainable development and

> *"teaches not only the science of life but also the interconnected nature of the web of life and how everyday actions can have profound effects on the long-term health of the system."* (Desmond et al., p. 76).

The contextual use of agriculture in science curricula in primary and middle schooling could provide opportunities to develop positive attitudes towards agriculture as an industry and potential career path (Cannon et al., 2006). Desmond et al. (2004) advocate a global initiative to institutionalise GBL into the educational mainstream and suggest that this should occur when children show a natural curiosity about the world from the age of 5 to 12 years, before the 'storms of adolescence'. Research by Klemmer et al (2005) indicates that students in higher primary grades benefit more from GBL than students in the lower grades due to their being developmentally advanced and therefore able to relate concepts in gardening to the general science concepts taught in the classroom. Whilst curriculum may vary according to culture, geography and climate, the global application of teaching of sustainable food production is essential in the context of globalised food systems (Cribb, 2010). Cribb (2010) suggests that a 'food year' in primary schooling is needed to raise a healthier generation of educated consumers, sustainable farmers, and informed policy makers, bankers, and business people aware of the consequences of their actions. In 'high-consuming' urbanised societies Cribb (2010) suggests an additional 'food year' in secondary schooling to maintain interest in science beyond the age of thirteen when most students find science too dull and 'switch off'.

The Primary Industries Education Foundation (PIEF) (2010a) and NSW Farmers Association (2010) are calling for Primary Industries to become a context for cross-curriculum studies in the Australian Curriculum. Desmond et al. (2004) observed that the 'best products' GBL programs were those with detailed examples of how the programs are integrated into the curriculum, including scheduling within the school calendar, scope and sequence planning, and lesson or whole unit plans. Gardening without integration can lead to frustration and the downfall of the school garden;

however, examples of integrated activities in the language and maths curricula suggest benefits to literacy and numeracy objectives (Dirks & Orvis, 2005). The teaching of agriculture in an interdisciplinary way engages deeper thinking about the role of agriculture in society and allows students to see the 'big picture' (Knobloch et al., 2007). Bellah and Dyer (2009) found that elementary school teachers in the USA had generally positive attitudes towards integrating agriculture but said that they lacked the time, skills and knowledge to apply agricultural contexts. Knobloch et al. (2007) found that teachers use agricultural contexts if they value agriculture, see the relevance to careers, and believe it can be integrated. According to Knobloch et al. (2007) teachers feel the need to know more about specific agricultural practices and topics and perceive a lack of specific teaching resources. Bellah and Dyer (2009), however, suggest that the challenge is not a lack of resources, rather, developing them into easy to deliver student-centred packages.

As Desmond et al. (2004) note, when working with children the safest way to garden is organically. In Australian primary schools there has been a revival of school gardens in recent years facilitated by programs such as the Stephanie Alexander Kitchen Garden (SAKG) Program and the Organic School Gardens Program (OSGP). Whilst both programs are run on organic principles, the underlying objectives and delivery differ. The SAKG Program began in 2001 and is based on a philosophy of engaging children in growing and preparing food to provide positive experiences that lead to life-long healthy eating habits (Stephanie Alexander Kitchen Garden Foundation, 2011a). The program has been introduced in 191 schools to date and is tied to grants for the development of kitchens and gardens and wages for specialist staff with additional funding met through the school's budget (Stephanie Alexander Kitchen Garden Foundation, 2011a). In recognition that many schools do not meet the funding specifications for the SAKG Program, the Foundation has developed a Subscription Program that provides teaching resources, access to exclusive online resources, and professional development training for an annual fee (Stephanie Alexander Kitchen Garden Foundation, 2011b). A comparison study found significant improvements in students' willingness to try new foods, their attitudes towards cooking, and knowledge, skills, and confidence in cooking and gardening for students in the SAKG Program schools (Block & Johnson, 2009). Additional benefits included; effective engagement of students with challenging

behaviours and 'non-academic learners', transfer of benefits to home, and the creation of links with the community (Block & Johnson, 2009). Challenges to the program include pressure to meet literacy and numeracy objectives competing for time and resources, securing ongoing funding, recruitment of volunteers, and increasing integration with the curriculum (Block & Johnson, 2009).

The Biological Farmers of Australia (BFA) OSGP initiative, launched in 2010, is a free program, designed for children aged 8 to 12 years, with a primary focus on environmentally friendly growing rather than nutrition (Biological Farmers of Australia, 2009). The program is not tied to a specific funding and delivery strategy; rather it offers start-up assistance grants through the Schools Starter and Local Schools Local Heroes programs, and additional resources in recognition of achievement through the Leader Schools Program (Biological Farmers of Australia, 2011). The program is designed to provide schools with free access to advice, lesson plans and accompanying notes such that novice gardeners are able to deliver the program (Biological Farmers of Australia, 2009). The OSGP has over 800 registered schools Australia wide and has expanded from school gardening to developing links with local certified organic farmers with the aim of providing on-farm learning experiences and greater understanding of organic farming practices through the Adopt a Farmer Program (Biological Farmers of Australia, 2011).

In addition to the abovementioned programs, alternative agriculture is represented by gardens developed using Permaculture principles or managed using Biodynamic practices. Many schools act independently, building and maintaining gardens with parental and community support. Data on the number of schools independently implementing gardening programs is lacking, however some specific examples deserve mention. In the Illawarra region of NSW, the "Permaculture Partners" program has Permaculture projects at various stages in five public primary schools that are the feeder schools for Warrawong High School (The Warrawong Community of Schools, 2010). The Permaculture garden at Warrawong High School is a valued addition to the Warrawong Community of Schools program that aims to build links with the community and aid the transition of students from year 6 to 7 (NSW Department of Education and Training, 2011). This model of developing gardens in primary schools that feed into a particular high school is a strategy worthy

of further research and development into a program that may be applied elsewhere. Gardens and other hands-on experiences are central to the holistic educational philosophy of Steiner or Waldorf schools (Steiner Schools in Australia, 2002). These schools are the based on the spiritual science philosophy or 'anthroposophy' of Rudolf Steiner the founder of Biodynamic agriculture (Janni & Green, 2010) and as such gardening activities are based on Biodynamic practices.

The lack of research into the use of gardens in primary schools and their impact on students' willingness to undertake further studies in agriculture prevents the prediction of benefits to high school agriculture. The prevalence of alternative agriculture in primary programs is promising for education in sustainable agriculture, however, maintaining this presence into secondary schooling is not guaranteed in high school syllabi.

Sustainable Agriculture in Tertiary Education

Increasing consumer demand for organic and environmentally conscious foods highlights the importance of tertiary education from agroecology and sustainability perspectives (Sriskandarajah et al, 2006). The 'Hawkesbury Model' that used a systems approach to redesign the curriculum for the Bachelor in Applied Science (Agriculture) at Hawkesbury Agricultural College in the 1980's (Bawden et al., 1984) is considered a pioneering model for reforms in tertiary agricultural education (Østergaard, Lieblein, Breland, and Francis, 2010). Sustainable agriculture is now taught throughout the world as single subjects in undergraduate studies (Alvarez and Rogers, 2006, Salomonsson et al, 2008) and postgraduate courses (Kaltoft & Rasmussen, 2004, Jordan, Andow & Mercer, 2005, Francis et al. 2009) through to whole degree and postgraduate courses (Charles Sturt University, 2011a, Charles Sturt University 2011b, Parr et al, 2007). Rather than discuss specific courses it is more relevant to highlight the obstacles that sustainable agriculture presents to tertiary education. Details of the programs used in this discussion are provided as Appendix 1.

The interdisciplinary nature of sustainable agriculture is a significant pedagogical challenge in tertiary settings where agricultural education is rooted in the reductionist philosophy characteristic of industrialised agriculture (Sriskandarajah et al., 2006, Parr et al., 2007). The traditional position of academics as 'sage on the stage' and teaching methods of lectures, reports and exams do not lend themselves to experiential learning (Lieblein, Francis & King, 2000). Østergaard et al. (2010) suggest that the multidimensional and multifunctional system of modern agriculture requires a cooperative approach to education with all stakeholders in the agri-food industry. Bawden et al. (1985) advocate the use of a holistic approach that utilises a hierarchy of research methods from reductionist problem solving through to soft systems methodology to ensure graduates possess the knowledge and skills to tackle the complex problems found in agricultural systems. Agroecology has evolved from the simple application of ecological processes to now include social factors and pre and post-production issues (Francis et al, 2001, Jordan et al., 2005). The study of agroecology therefore encompasses 'the ecology of food systems' including issues such as reliance on finite resources, impacts on ecosystem services, greenhouse gas emissions, human population and food security, and genetic diversity (Francis et al, 2008). A paradigm shift from productionism to sustainablism is needed, however, this presents a challenge to the reductionist paradigm and requires shifts in individual and collective worldviews (Bawden, 2007). A 'future active learning model' suggested by Francis et al. (2001) requires changes in three main areas; 1) the integration of natural and social sciences, 2) a change from disciplinary to systems focus, and 3) the establishment of a broader concept of faculty and use of action-based learning. Sriskandarajah et al. (2006) state that this model is ideally suited to organic farming as it allows a location specific focus applicable to organic systems where there are no 'one size fits all' practices.

Experiential learning and expanding the concept of faculty to include and value the knowledge of farmers and post-production professionals is a feature of many of the tertiary courses that focus on sustainable agriculture, however, this approach may be perceived as a threat by academics and students alike (Sriskandarajah et al., 2006). Academics are required to relinquish complete 'control' of the learning environment (Lieblein et al., 2000), acknowledge the embodied intelligence of their students, have an attitude of trust towards students (Salomonsson et al., 2008, Østergaard et al.,

2010), and be able to take on the roles of facilitator, mentor, co-learner and 'guide on the side' (Wiedenhoeft et al., 2003). Meeting the needs of diverse student groups by using a variety of approaches, developing alternative evaluation tools, and the additional investment of time, energy and funds in planning experiential learning activities are additional challenges for academics (Francis et al, 2009, Lieblein et al., 2000, Salomonsson et al., 2008). Students find difficulty in the divergent open-ended situations offered by experiential learning and have difficulty accepting that personal experience is the focus rather than the passive learning in convergent 'fixed answer' approaches they are accustomed to (Francis et al., 2009, Salomonsson et al., 2008). Sriskandarajah et al. (2006) suggest that students are confronted by having to take greater responsibility for their learning. Wiedenhoeft et al. (2003) note that the use of group learning strategies poses additional challenges to students used to competition as the dominant social force in conventional classes.

Aside from the challenges posed by facilitating effective learning in sustainable agriculture there are additional issues facing tertiary agricultural education in Australian universities. The discrepancy between agriculture graduates and workforce demands is expected to worsen in the near future with predictions of 30% or more increased demand, (Pratley, 2008). More than 50% of the current professional staff in state agencies will reach retirement in the next 5 years and a higher than average attrition rate at 16.3% of agriculture students is given as evidence for this prediction (Pratley, 2008). The leakage of agriculture graduates into other careers exacerbates the problem and results in non-agriculture graduates who may not possess the necessary interdisciplinary and integrative skills taking positions in the industry (Pratley & Copeland, 2008). A further issue is retaining students to undertake postgraduate studies and continue on as research academics (Pratley, 2008). This can be attributed to the Australian Postgraduate Award being only 80% of the Australian minimum wage, the inadequacy of research funds provided to postgraduates, and attractive options in graduate employment (Pratley, 2008).

Secondary Agriculture in NSW

The history of agricultural education in NSW reveals an evolution from a vocational basis in the first half of the 20th century reflecting the demands of rural communities, to a shift towards an approach in line with general educational aims in the 1970's that brought agriculture into an increased number of urban schools (Lindesay, 1988). Currently, Leutton and Jacobsen (2009) suggest that there is sufficient concern about the Agriculture and Primary Industries subjects to warrant the development of an overarching conceptual framework to ensure delivery of the skills and knowledge requirements for "future agricultural practitioners". Agriculture is taught in all States and Territories in Australia with considerable variation from academic to vocational implementation, and individual school formulation to centralised departmental prescription (Lindesay, 1988). The positioning of Agriculture in the development of the national curriculum is a further concern, and with the knowledge and skill demands of the industry the challenge of sustainable food production is '*beyond the scope of the current curricula'* (Leutton & Jacobsen, 2009, p.7).

Agriculture in NSW high schools is covered in four syllabi. The Design and Technology (Mandatory) syllabus (Board of Studies NSW, 2003b) for years 7 and 8 is the only compulsory syllabus in which Agriculture is taught. The syllabus is based on a rationale of design processes and includes essential content knowledge related to agriculture in terms of plant and animal production systems (Board of Studies NSW, 2003b). Given that the course is allocated 200 hours over 2 years and includes all areas of technology (Board of Studies NSW, 2003b), the agricultural component accounts for only small part of the overall delivery of the subject. Further studies in agriculture are covered by the Agricultural Technology syllabus (Board of Studies NSW, 2003a), an elective subject for years 7 to 10 from which students may choose to undertake either the vocationally oriented Primary Industries course (Board of Studies NSW, 2003c) or more science oriented Agriculture course (Board of Studies NSW, 2009a) for their Preliminary and Higher School Certificate (HSC) years (Years 11 and 12 respectively). Whilst Primary Industries is an important subject for addressing the need for skilled agricultural labour, the focus for

this research is the Agriculture course, particularly with reference to sustainable agriculture.

A search of literature revealed a lack of research on agricultural education in Australian high schools, let alone NSW or specific studies on sustainable agriculture. Thomas and Spencer (1996) in reviewing agricultural education found no evidence of investigation into teacher's perceptions, convictions or aspirations for the subject and suggest that the absence of Departmental policy on agricultural education indicates a lack of interest that downgrades the status of the subject and favours declining student numbers to the point where it may be legitimately removed from the curriculum. This lack of policy and direction persists into the 21st century with the Hurlstone Inquiry finding a lack of guidance from the Department of Education and Training (DET) relating to the school farms and boarding facilities examined in the inquiry (Peters, 2009). It should be noted that the Hurlstone Inquiry was commissioned by the NSW Government to investigate the sale of land in order to raise funds (Peters, 2009) rather than to research the current and future needs of agricultural education. The inquiry, however, reveals much about the current state of agricultural education in this and other specialist agricultural high schools in NSW.

Peters (2009) considers Hurlstone Agricultural High School a vital resource for students across the Sydney basin with potential to become a leader in education for the sustainable production of 'Healthy Foods in Healthy Environments'. In order for this to occur, however, Hurlstone needs to decide if it continues to focus on being an academic school or returns to its original purpose of providing agricultural education (Peters, 2009). An adherence to traditional and historical connections with the Ayrshire breed of cattle, outdated facilities and equipment, a casual workforce of farm assistants rather than permanent and adequately qualified staff, and declining commitment to the farm by school leadership were identified by Guest (2009) as indicators that agriculture has become a secondary focus of the school. If the school is to become a showcase for agriculture it will need to undertake rigorous strategic planning, ensure a high level of maintenance and care to demonstrate pride in the school farm, and review the current curricula with the view to providing an holistic approach to program design, delivery and teacher professional development needs (Leutton & Jacobson, 2009). If such rejuvenation is to occur it presents an

opportunity for sustainable agriculture to become a focus in the development of the school.

Sustainable and Alternative Agriculture in NSW Secondary Education

In the NSW Agricultural Technology syllabus, sustainable agriculture is defined as:

> "*practices that conserve soil and water quality and protect the environment, assure adequate and safe food supplies to consumers, while generating profitable returns for producers."* (Board of Studies NSW, 2003a, p. 14).

Whilst there is no explicit reference to organic or biodynamic farming, or Permaculture there is scope to include them in Outcome 5.3.1 *"investigates responsible production systems for plant and animal enterprises"* (Board of Studies NSW, 2003a, p. 22), however, this is a Stage 5 outcome and therefore only applicable to students who move onto years 9 and 10 Agriculture. The investigation of alternative, non-chemical pest management practices, and alternative production methods such as no-dig garden beds, agroforestry, hydroponics, and aquaculture are included as 'Additional Content' in the syllabus and therefore not compulsory content, rather for extension of learning (Board of Studies NSW, 2003a). Although pre-dating the syllabus, the textbook "Enterprising Agriculture" (Bannerman, Thornthwaite and Gant, 2001) includes a section on organic vegetable growing, however, there is negligible mention of sustainable agriculture and as such this text is out of date but may still be in use where schools have not invested in current reference materials. The textbook "Dynamic Agriculture" defines sustainability as:

> *"the ability to farm to maintain and improve its environmental resources, such as soil and biodiversity, and continue to be profitable into the future"* (Brown, Hindmarsh & McGregor, 2005, p. 62).

Suggestions such as responsible disposal of effluent to avoid polluting waterways, rotating types of drenches and antibiotics to avoid resistance, using sensible stocking rates, and ensuring withholding periods are observed, occur throughout the book, however, no reference is made to alternative systems or the social context of

sustainability other than to suggest that consumers don't want chemical residues in their meat products (Brown et al., 2005). Sustainable agriculture as presented in Years 7 to 10 is therefore based on a fairly narrow and production-based definition.

The HSC syllabus was amended in 2009 following concerns about differing workload and practices from other HSC courses, overlap between components, lack of clarity between the Preliminary and HSC content, and the inability of the syllabus to support multiple choice questions in the HSC exam (Randall, 2009). Whilst both the 1999 and 2009 syllabi aim to develop in students the responsible attitudes and skills needed to manage and market agricultural production in a sustainable manner (Board of Studies NSW, 1999a, Board of Studies NSW, 2009a) there is no attempt to provide a definition of sustainable agriculture per se. The textbook written for this syllabus also does not provide a clear definition, however, it expands upon the production-based definition used in Year 7 to 10 to highlight the need to consider wider implications and include stakeholders beyond the farm gate in addressing sustainability (Clark, 2003). This expanded definition is represented in Figure 2.

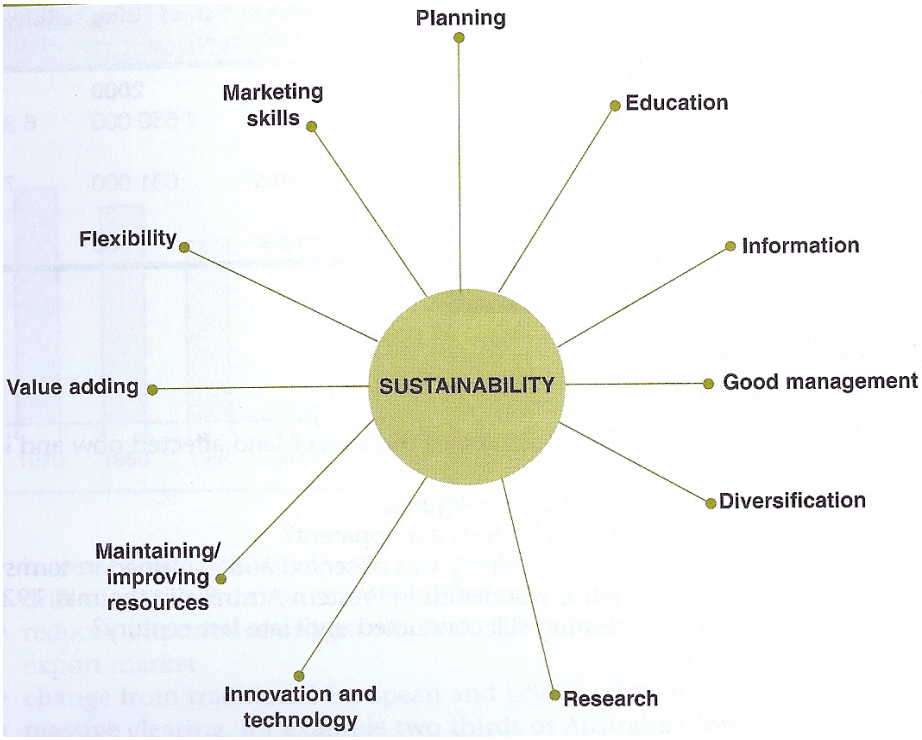

Figure 2: Concept Diagram of Sustainability (Clark, 2003).

Although sustainable agriculture is a focus throughout both HSC syllabi, changes in the structure of the amended syllabus have implications for the inclusion of examples from alternative agriculture. The 1999 syllabus provided scope to include alternative agriculture more explicitly in the electives 'Sustainable Land and Resource Management', and 'Innovation and Diversification' or in the 'Optional Research Project', although no explicit reference to these systems is made within the syllabus itself (Board of Studies NSW, 1999a). The supporting document for this syllabus includes an example programmed unit for the 'Innovation and Diversification' elective that specifies organic production systems as well as genetically modified (GM) crops, and new animal and plant enterprises (alpacas, olives etc) as suitable for use in the elective (Board of Studies NSW, 1999b). References to organic production are, however, omitted from the chapter dedicated to this elective by Clark (2003) and as such students using this text may be limited in their understanding of 'alternative systems'. The 'Sustainable Land and Resource Management' elective discusses whole farm planning as a strategy for addressing land degradation and ensuring appropriate practices according to land capability (Board of Studies NSW, 1999, Clark, 2003). This elective therefore had the potential to include Permaculture, which draws upon P. A. Yeomans' Keyline Farming (Mollison, 1988), and more recently Natural Sequence Farming (Andrews, 2006) as examples of whole farm design processes considered as resource conservative and sustainable. The 'Optional Research Project' was removed from the syllabus, despite concerns from teachers, due to low numbers of students undertaking the elective (Randall, 2009). Leutton and Jacobson (2009) suggest that although only around 30 students undertook the project in 2008 it was a valuable course component highly regarded by the universities for assessing student candidacy for undergraduate studies. This research project presented an opportunity for students interested in alternative systems to research them further through investigating a particular production system.

The 2009 amended syllabus addresses overlap between the electives and core content of the 1999 syllabus by incorporating the 'Sustainable Land and Resource Management', 'Animal Management', and 'Plant Management' electives into the Core content (Board of Studies NSW, 2009b). Whereas the 1999 syllabus had six electives from which two were chosen (Board of Studies NSW 1999a) the amended

syllabus has three electives from which one is chosen (Board of Studies NSW, 2009a). These electives were written as extensions of the core content and are indicative of the future directions of agriculture in Australia being 'Farming for the 21st Century', 'Climate Challenge', and 'Agri-food, Fibre and Fuel Technologies' (Randall, 2009). The scope to incorporate examples from alternative agriculture in these electives appears to be more limited than in the previous syllabus. For example, the elective 'Farming for the 21st Century', from the title alone could include alternative systems, however, there is a qualifying statement that the technologies studied *"have been developed or implemented within approximately the past 10 years"* (Board of Studies NSW, 2009a, p. 32) therefore ruling out alternative systems. The elective 'Agri-food, Fibre and Fuel Technologies' examines the role of biotechnology in modern agriculture including ethical, social and environmental issues (Board of Studies NSW, 2009a) and as such offers little by way of incorporating alternative systems other than to discuss their opposing philosophy and subsequent prohibition of GM organisms. The 'Climate Challenge' elective offers the most potential for using examples from alternative agriculture as it requires the examination of methods to reduce greenhouse gas emissions and sequester carbon in agricultural soils, although no explicit mention of alternative systems is made (Board of Studies NSW, 2009a).

It is worth noting that although there is no explicit mention of alternative systems in the syllabus, sustainable practices throughout the syllabus and the Farm and Product study components present opportunities to use alternative systems as examples. The responsibility for connecting sustainable practices to alternative systems, however, lies with the teacher and as such it is theoretically possible that students could complete their HSC agriculture course without being exposed to such systems. The survey component to this research aims to identify the extent to which these connections are occurring.

Sustainable Agriculture - Research in Secondary Education

The lack of research into high school agricultural education in Australia necessitates looking elsewhere for studies into sustainable agriculture in high schools. Fortunately there have been a number of studies in the United States from which inferences may be made regarding the Australian situation. It is worth noting, however, that none of the literature comments on the use of examples from alternative agriculture in the teaching of sustainable agriculture. As observed in the discussion about the Agricultural Technology and Agriculture syllabi above, there appears to still be a gap in identifying and using alternative agricultural systems as examples of sustainable agriculture.

Studies of teacher and student perceptions in Iowa revealed that teachers perceived themselves as needing to learn more and students rated themselves as knowing 'a little' about sustainable agricultural practices (Williams & Wise, 1997). Agbaje et al. (2001) found that teachers only valued sustainable agriculture if it was profitable and felt that farmers only use sustainable practices for economic reasons. Williams (2000) found that student and teacher knowledge and perceived impacts of sustainable practices paralleled the agricultural industry in general, i.e. social and environment impacts were high (beneficial) but economic impacts not as high. Whilst positive about the impacts of sustainable practices there is a lack of understanding in both teachers and students about interactions between sustainable practices, suggesting a lack of appreciation in the systemic nature of sustainable agriculture and demonstrating the lack of first hand experience (Williams & Wise, 1997). Flint (2000) suggests that lack of recognition of connectedness is partly responsible for many of the environmental, social and economic failures of modern societies and advocates an interdisciplinary approach to curriculum development. Agbaje et al. (2001) found that sustainable agriculture topics with systems or multidisciplinary dimensions such as Integrated Pest Management (IPM), insect-resistant crops, herbicide-resistant crops, and reduced use of chemicals and fertilisers, were only taught to a moderate degree, whereas crop rotation, soil testing, and soil erosion control were taught to a high degree. Peake, Duncan and Ricketts (2007) found that teachers felt the most important competency was teaching about

agriculture's relationship with the environment. This discrepancy between the perceived importance of relationships and the actuality of teaching suggest a need for curriculum development with a focus on sustainable agriculture and sustainable systems.

Curriculum Development in Secondary Agriculture

Agbaje et al. (2001) state that the values of sustainable agriculture need to be infused into the philosophy of secondary agricultural education, however, infusion often lags behind developments in the industry (Williams & Dollisso, 1998). Roberts and Ball (2009, p. 82) pose the question "*In secondary agricultural education classes today, is agriculture the content learned, or the context in which learning occurs?"* The dynamic nature of the current information and technology age requires students to be able to 'think outside the traditional box' and as such information needs to be presented in a meaningful way with respect to context and the connections between scientific, social, economic, cultural and technological issues (Flint, 2000). Atkinson (1988) suggests that without a sound theoretical basis for curriculum development that includes sociological considerations, philosophical criteria and psychological theories it is unlikely that changes will be effective. Further research is required into community awareness, views and support for agricultural education to determine the benefits to students and community when developing the curriculum (Atkinson, 1988, Myers & Washburn, 2008). The curriculum development process contains four essential interacting elements; objectives, content, program of activities, and evaluation (Atkinson, 1988). Tentatively defined objectives are the logical place to begin as these determine the *why* of teaching *what* and *how*, and may be modified as the process considers what 'selections' from culture and knowledge are most relevant now and in the future (Atkinson, 1988). Roberts and Ball (2009) suggest replacing the polarising content versus context argument in agricultural education with a holistic and integrated approach aimed at producing a skilled agricultural workforce and agriculturally literate life-long learners as demonstrated in Figure 3. Interdisciplinary techniques used in environmental education are also relevant to agriculture as they develop the problem solving, critical thinking and decision-

making skills needed to address sustainability (Flint, 2000). For curriculum changes to achieve greater levels of success, teachers need assistance to adjust teaching and learning, (Williams & Dollisso, 1998, Bellah & Dyer, 2009). Methods for evaluating the depth and breadth of innovation adoption that consider teacher concerns, the levels of use, and methods used in implementing curriculum changes are also needed, rather than relying on simple 'use' or 'non-use' as measures of success or failure (Bellah & Dyer, 2009).

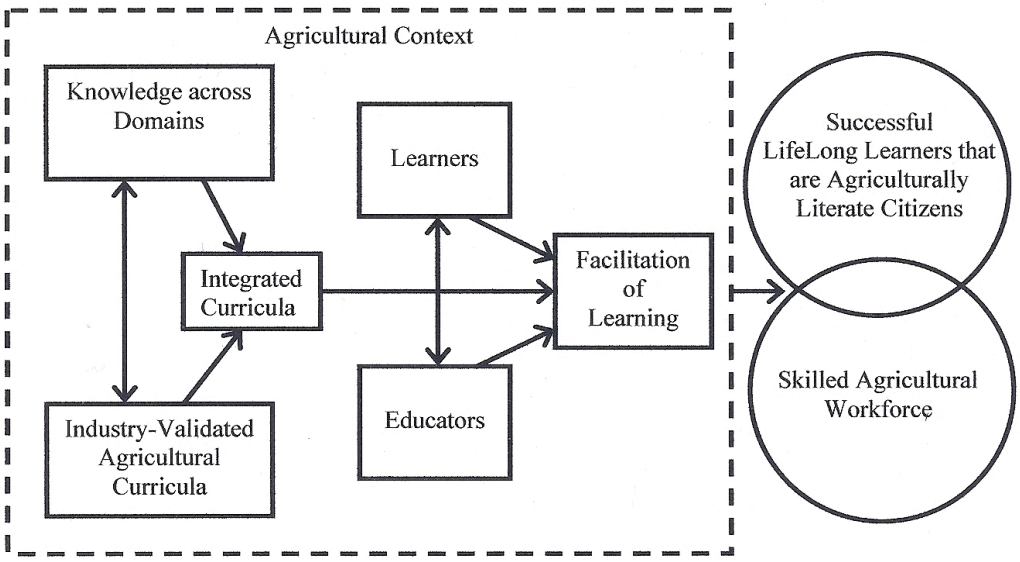

Figure 3: Conceptual Model for Agricultural Curriculum Development

The integration of science into the agriculture curriculum has been demonstrated to enhance student achievement and interest and renew the credibility of agriculture as a subject (Williams & Dollisso, 1998). Teachers have reported that their students have demonstrated improved problem solving abilities (Myers & Washburn, 2008) and enhanced understanding of science when integrated in agriculture (Balschweid, 2002). The redesign of courses with greater focus on the applications of science to agriculture has demonstrated increases in enrolments particularly from higher achieving students (Osborne & Dyer, 2000). Myers and Washburn (2008) question if agriculture is currently serving a disproportionate number of low achieving students and therefore if it is appropriate to target higher achieving students through integrating more science. Scales, Terry and Torres (2009, p. 102) highlight that the support of stakeholders, curriculum and policies require consideration when

integrating science into agriculture curriculum, however, "*the most important factor is the teachers' willingness and ability to teach the content"*.

In addressing the credibility of agriculture as an academic pursuit, Scales et al. (2009) discuss the granting of science credits from studying agriculture in US high schools for admission requirements to University courses. In Australia, it is argued that the situation of agriculture in the Technological and Applied Sciences Key Learning Area (KLA) has resulted in the decline of the science in agriculture (Leutton & Jacobsen, 2009) and when coupled with University preference for students with 'pure science' rather than 'applied science' discourages study of agriculture at senior level (Thomas & Spencer, 1996, Peters, 2009). The lack of an 'Extension' option and the perception that Agriculture has a negative influence on a students' Australian Tertiary Admission Rank (ATAR) are given by Peters (2009) as additional reasons for agriculture's low academic profile. Leutton & Jacobsen (2009) suggest that both Agriculture and Primary Industries need to be realigned with the Science KLA; Thomas and Spencer (1996), however, suggest a transfer to the Human Society and its Environment group of units. Regardless of positioning within the education system, Leutton and Jacobsen (2009) suggest that best practice in specialist agricultural high schools should be an integrated curriculum with agriculture as a focus across all KLAs, including significant collaboration between science and agriculture teachers to ensure that students gain an understanding of the relationships between their subjects and agriculture as an industry. Stephenson et al. (2008) found positive attitudes towards collaboration between science and agriculture teachers, however, both were found to be unaware of the similarities in their respective curricula and cited a lack of collective preparation time as the biggest barrier to collaboration.

Enrichment programs for gifted and talented students have demonstrated a positive influence on the perceptions of agriculture in students who otherwise would not be exposed to the industry given their urban environments (Cannon et al., 2006). In Australia, scholarship camps and industry work placement programs have been used to highlight the career options offered by agriculture (Pritchard & Longnecker, 1998, Russell, 2003). The Agricultural Science Industry Program initiated in 2000 in Tasmania (Russell, 2003), is now referred to as 'The Russell Model' and was

expanded into Western Australia (2003) and South Australia (2006) with associated industry funding and institutional support (Russell, Stone & Green, 2006). This model is now being applied nationally through the Primary Industries Centre for Science Education (PISCE) to attract students to tertiary science and professions in primary industries, through collaboration between universities, local industries and regional communities (Primary Industries Centre for Science Education, 2009).

The abovementioned enrichment programs are examples of promotion of agriculture through the collaborative efforts of tertiary institutions and industry bodies. Williams and Dollisso (1998) suggest that the agricultural education profession needs to take advantage of such opportunities in order to facilitate the infusion of sustainable agriculture into the curriculum. Students who participated in high school agriculture were found by Dyer et al. (1999) to be more likely to complete four-year agriculture degrees and move into the industry as their career. Osborne and Dyer (2000) highlight the need for tertiary and industry direction in educational programs for enhancing recruitment to tertiary studies. Relationships between teachers and tertiary institutions are also important given that 20% of students cite their teacher as the most important factor influencing their decisions to continue studies at the tertiary level (Dyer et al., 1999). In Australia, concern about the lack of national co-ordination in the promotion of agriculture to schools prompted the formation of the PIEF in 2009 (Primary Industries Education Foundation, 2009). A review of existing programs identified aspects of successful initiatives, funding models, the extent of industry and government input, and the need to develop a national strategy to improve the management of agricultural education (Scarlet Consulting, 2005, p.10).

Agriculture as a Cross-Curricular Theme

A lack understanding and awareness of agricultural issues is magnified in urban settings (Warner & Washburn, 2009). This is of particular concern in Australia as the most urbanised nation in the world with only 15% of the population living in rural areas (Pratley, 2008). Halsey (2009) proposes a *city to country* education initiative to address the disconnection between urban and rural populations, giving

urban students positive experiences of rural communities, and therefore awakening them to potential career opportunities. The integration of agriculture as a cross-curricular theme is seen as a suitable solution that can be applied in every school (Cribb, 2010, NSW Farmers Association, 2010). Balschweid (2002) provides evidence in support of integrating agricultural examples through the positive effect on student attitudes towards agriculture following participation in a biology program that used agricultural animals as a basis. Warner and Washburn (2009) outline the main challenges to teaching agriculture in urban settings as a lack of understanding in parents, administrators and guidance counsellors regarding the relevance of agriculture, and the large numbers of students consequentially limiting resources and funding. Bellah & Dyer (2009) highlight the need for pre-service exposure to agricultural contexts for primary teachers for effective integration of agriculture content. It can be assumed that secondary teachers in KLAs outside of agriculture may also benefit from professional development that demonstrates how agriculture can be used as a theme for their subjects.

There are a range of programs aimed at promoting agriculture through other Key Learning Areas (KLAs) such as Science, Maths, Technology, Society and Environment, Health and Physical Education and Careers Education (Scarlet Consulting, 2005). A number of these programs use competitions as a means of generating student interest and collaboration between KLAs. Art4Agriculture run competitions aimed at generating awareness through visual art (the Archibull Prize), design and technology (What can you creATE?) and agriculture, primary industries and natural resource management (Cream of the Crop) (Dairy Youth Australia, nd). The Australian Schools Wine Show presents an opportunity for cross-curricular collaboration with viticulture students producing grapes for wine production, chemistry students monitoring the fermentation process, design and technology students manufacturing packaging and visual arts students designing and printing labels and cartons (Joyce & Newton, 2005). The Go 4 Grains Kids' Design Challenge incorporates the Personal Development, Health and Physical Education (PDHPE), Science, and Design and Technology KLAs in a program to design, develop, and promote a nutritious grain-based food for school canteens (Go Grains, 2011).

Whilst competitions can be of value in the curriculum, a truly cross-curricular theme should be integrated into subject delivery where appropriate. To some extent this has already occurred with agriculture appearing throughout the Years 7-10 Geography syllabus (Board of Studies NSW, 2003d), and as a suggested basis in the 'People and Economic Activity' topic in the HSC Geography syllabus (Board of Studies NSW, 2009c). Examples from agriculture are also found in the 'Plants' and 'Water for Living' topics in the Preliminary course of the Senior Science syllabus (Board of Studies NSW, 2009d). There is, however, scope to include agriculture in other syllabi. For example, agriculture could be incorporated into the 'Global Economy' and "Australia's Place in the Global Economy' topics in the HSC Economics syllabus (Board of Studies NSW, 2009e) and throughout the Society and Culture HSC syllabus (Board of Studies NSW, 2009f), however no specific references occur. Data collected by the PIEF revealed that school farms are being used by a range of KLAs including; maths, science, design and technology, drama, visual arts, food technology, construction, and geography, as well as by primary schools and special needs classes (Primary Industries Education Foundation, 2010b). This would suggest that agriculture is already being used as a cross-curriculum theme; however, further research is required to identify the extent to which this is occurring.

Agriculture Teacher Professional Development

The research literature regarding agriculture in high schools highlights the need to address pre-service and in-service teacher professional development, particularly regarding new practices and advances in technology (Williams & Wise, 1997, Peake, Duncan & Ricketts, 2007, Boone & Boone, 2009). Scarlet Consulting (2005, p.5) identified professional development in Australia as perhaps "*the most pressing issue to address in education about agriculture"*. Peake et al. (2007) suggest that the increasing number of inexperienced agriculture teachers in the US state of Georgia necessitates a re-evaluation of pre-service teacher training and professional development opportunities. Scales et al. (2009) found that although many US teachers felt confident of delivering science content in agriculture, testing revealed the majority were not competent and less then 10% scored high enough to be

considered proficient in biological sciences. Stephenson et al. (2008) identified a need for professional development opportunities to promote collaboration between agriculture and science teachers. Stephens and Little (2008) discuss the value of student teacher exchange programs to address limited exposure to agricultural diversity and thus address the problem of lack of engagement in global societies. Agbaje et al. (2001) stress the need for collaboration with Universities in continuing professional development.

A professional development day held by the PIEF in November 2010 recognised concerns that inaction will lead to decline in the teaching of agriculture in NSW where there is already a shortage of well-trained agriculture teachers, predicted to worsen as many teachers reach retirement age (Primary Industries Education Foundation, 2010b). The PIEF workshop identified several issues that require attention including but not limited to; the need for industry driven professional development, financial support for professional development opportunities, the development of resources appropriate for new technologies and syllabus content, identifying contacts for farm and industry visits, the need to address teacher training in agriculture, re-training of science teachers for agriculture, the place of agriculture and primary industries in the national curriculum, and the importance of helping primary school children with agriculture and assist them to continue into high school agriculture (Primary Industries Education Foundation, 2010b). The success of the workshop indicates that the PIEF is an organisation capable of supporting agriculture teachers and as such they are examining options for other events and extending information to teachers unable to attend, as well as offering programs for primary school and non-agriculture teachers (Primary Industries Education Foundation, 2010b).

Project Description - Methods

Methodology

This research uses a Mixed Methods research methodology that integrates quantitative and qualitative methods in a single study (Tashakkori & Creswell, 2007). This methodology is considered a 'pragmatist paradigm' that allows a flexible and holistic approach to research (Leech, Dellinger, Brannagan, & Tanaka, 2010). Although an evolving research paradigm (Tashakkori & Creswell, 2007) that is yet to realise it's full potential (Onwuegbuzie, Bustamante, & Nelson, 2010) and establish a 'best practice' exemplar (Bryman, 2007), it is used in this research as it allows the flexibility to examine specific aspects of teaching agriculture in high schools through quantitative means, and gain a rich picture of the position of high school agriculture in the whole industry through a qualitative approach.

Survey of NSW Agriculture Teachers

To assess the extent to which examples from alternative agriculture are used in the teaching of sustainable agriculture in NSW an online survey was designed and constructed using the SurveyGizmo™ software. An online survey was chosen over traditional mail, telephone or in-person survey methods, as it is a faster and resource efficient way of reaching large numbers of people (Kalof, Dan & Dietz, 2008). The NSW Association of Agriculture Teachers (NSWAAT) assisted in the distribution of the survey through emailing their member database and posting information and the hyperlink to the survey on the News page of their website. The use of a third-party to promote the research avoided the need to collect names and email addresses, thus addressing some of the ethical challenges in educational research discussed by Foskett (2000) and allowing voluntary and anonymous participation. A total of 105 NSWAAT members were emailed three times throughout the five weeks that the survey was online. The second email was required due to a low number of responses from the initial email, and the final email gave a week of notice of the termination date for participation. A compulsory question regarding how teachers had heard about the survey was included to obtain a response rate from the NSWAAT member database and an indication of referral of the research to colleagues.

The survey was constructed in six sections relating to; demographics and teaching experience, the Agricultural Technology syllabus, the Stage 6 syllabi, pedagogical practices, professional development, and a final section for comments. Questions were carefully worded to ensure clarity and avoid ambiguity and pre-tested by colleagues to validate the design and comprehension of questions (Moser & Kalton, 1971). Given that teachers are often very busy, the survey was designed to take up to ten minutes to complete by using 'radio button' style questions. Four point Likert-type scales from 'never' to 'always' were used to assess the frequency of use of examples from alternative agriculture and use of particular pedagogical practices. A five point Likert-type scale from 'strongly disagree' to 'strongly agree' was used to assess teachers' opinions on the amended HSC syllabus. A five point Likert-type scale from 'don't know' through to 'yes, a lot' was used to assess teachers' perceived professional development needs. Descriptive statistics of means (M) and standard deviations (SD) were applied to the data.

There were a total of 38 respondents to the survey, 32 indicating the NSWAAT as the referring source therefore giving a response rate of 30.5% from the member database of the NSWAAT. This response rate appears low when compared to rates observed in the literature with 61% cited by Peak et al. (2007) and Myers and Washburn (2008), 65.3% by Boone and Boone (2009), and 67.14% and 68% by Scales et al. (2009) and Williams and Wise (1997) respectively, however, these studies used personalised approaches to recruiting research participants via mail and telephone. As the total number of agriculture teachers in NSW was not obtained during the course of the research, an assessment of reliability as a representative sample cannot be made, however, as this research is designed as a purposeful survey the results from a small number of respondents are worthy of examination.

Semi-Structured Interviews of Stakeholders

Stakeholders for interviews were identified through researching the literature, Internet searches and referral from participants. Initial contact was made by email and interviews arranged following the return of Consent Forms either via email or mail. A total of twelve interviews were conducted, three in person and the remaining via telephone. Interviews followed a similar protocol of formal introduction, explanation of the project, reiteration of confidentiality procedures and an opening

question regarding the participants' experiences in agricultural education. Guidelines regarding the conduct of interviews such as those provided by Gamble, (1989), Webber (1991), and Kalof et al., (2008) were followed to ensure participant comfort and allow in-depth examination of stakeholder perspectives. Social science data analysis practices such as identifying common themes and iterative analysis allowed the examination of themes as they emerged and informed questions for subsequent interviews (Saunders, Lewis & Thornbill, 1997, Kalof et al. 2008). In accordance with the requirements of the School of Agricultural and Wine Science Ethics in Human Research Committee's approval of this project the findings from interviews are presented in non-identifying ways.

Results & Discussion

Survey of NSW Agriculture Teachers

Section 1 - Demographics

Demographic characteristics, shown in Table 1, indicate that concerns expressed by Scarlet Consulting (2005) and the Primary Industries Education Foundation (2010b) regarding the number and experience of agriculture teachers are warranted if this is a representative sample of the overall teaching population. With over 40% of teachers reaching retirement age within the next 10 to 15 years and only 13.2% of teachers in the age range of 20-30 years the need to address future demand for agriculture teachers is evident. Another important finding when considering teacher competency is the large number (44.7%) of teachers with 10 or less years of experience. Peake et al. (2007) reported 51.9% of teachers with 10 or less years of experience, however, 41.7% of teachers were under 35 suggesting a larger proportion of young graduate teachers. The demographics of this research, however, suggest a number of people entering the teaching profession at a later age, which may bring greater benefits by way of previous industry experience informing their teaching. Further research is required to determine if this is the case. The gender balance at 36.8% female teachers is a higher proportion than reported by Peak et al. (2007), Boone and Boone, and Scales et al. (2009) at 25%, 16.1% and 29% respectively. This may reflect either a higher number of female agriculture teachers in Australia or

perhaps a higher percentage of females responding to the online-survey as opposed to mail-based survey techniques.

Table 1: Demographic characteristics of participants

	Number	Percentage
Gender		
Male	24	63.2
Female	14	36.8
Age		
20-30	5	13.2
31-40	8	21.1
41-50	9	23.7
51-60	15	39.5
61+	1	2.6
Years of Teaching Experience		
1-5	3	7.9
6-10	14	36.8
11-15	4	10.5
16-20	1	2.6
21-25	5	13.2
26+	11	28.9

Section 2 - Agricultural Technology Years 7-10 Syllabus

The introductory material for the survey included the clarification that for the purposes of this research 'alternative agriculture' is defined as including: organic, Biodynamic, Permaculture, Ecological/Biological, Natural Sequence Farming, Agroforestry, and Aquaponics. As the results in Table 2 indicate alternative agriculture as a whole is referred to most often in the context of overall farm management (M = 2.84) and animal welfare and ethics (M = 2.71). Other questions were worded to assess whether examples were being used to link alternative systems to particular sustainable practices. Natural Sequence Farming is the least referred to alternative system (M = 1.53) which is to be expected as it is the most recent of alternative systems having only received widespread attention in recent years (Andrews, 2006). With the exception of Natural Sequence farming, all other systems are referred to in or very near to the 'sometimes' range. The greatest variation is seen with the examples with mean values closest to 2, being Permaculture (SD = 0.83), Agroforestry (SD= 0.93), and Aquaponics (SD - 0.90). This reflects a higher

percentage of respondents indicating that they 'never' refer to these systems whilst the number citing 'always' remained consistent with other systems. The question regarding student interest shows that they 'sometimes' (M = 2.14) ask questions about alternative agriculture, suggesting there is interest in alternative systems although further research is required to determine perceptions and specific areas of interest.

Table 2: Use of Examples from Alternative Agriculture in Years 7-10

	M	SD
How often do you make reference to organic &/or biodynamic practices for soil fertility?	2.61	0.59
How often do you refer to organic &/or biodynamic pest management practices?	2.52	0.69
I make reference to alternative agriculture systems when discussing farm management.	2.84	0.72
My students ask questions about alternative agriculture. *	2.14	0.63
When discussing marketing I make reference to alternative agricultural systems and their certification requirements.	2.32	0.74
Alternative agricultural systems are discussed when covering the topic of animal welfare and ethics.	2.71	0.84
When discussing whole farm planning I use Permaculture as an example. *	1.97	0.83
I use Agroforestry as an example of integrated farming systems.	1.95	0.93
I use Aquaponics as an example of innovative and diverse agricultural systems.	2.00	0.90
When discussing soil and water conservation I use the example of Natural Sequence Farming.	1.53	0.65

Scale: 1 = Never, 2 = Sometimes, 3 = Frequently, 4 = Always; *n = 37

Section 3 - Stage 6 Syllabi

In examining the use of examples from alternative agriculture in teaching Stage 6, questions included their use in the Farm and/or Product Case Study, explicit reference throughout the course and within particular elective topics. As shown in Table 3, the mean value of 1.86 indicates that the majority (40%) of teachers 'never' use organic or biodynamic examples in the Farm or Product Case Study component of the course. This is likely to be a reflection of the lack of connection between high schools and local organic or biodynamic farmers and presents an opportunity for the BFA Adopt a Farmer program (Biological Farmers of Australia, 2011) to be expanded into high schools. Similarly to the results for Agricultural Technology Years 7-10, teachers make explicit references to alternative systems throughout the Preliminary and HSC courses 'sometimes' for all systems except for Natural Sequence Farming (M = 1.75) as shown in Table 4.

Table 3: Use of Organic and/or Biodynamic Examples in the Farm/Product Case Study

	M	SD
I use organic and/or biodynamic farms/products for the Farm/Product Case Study.	1.86	0.85

Scale: 1 = Never, 2 = Sometimes, 3 = Frequently, 4 = Always; n=35

Table 4: Use of Explicit References to Alternative Agriculture Throughout the Preliminary and HSC Courses.

	M	SD
Organic **	2.54	0.82
Biodynamic *	2.06	0.83
Permaculture **	2.00	0.73
Ecological/Biological **	2.46	0.89
Natural Sequence Farming *	1.75	0.81
Agroforestry *	2.00	0.83
Aquaponics *	2.00	0.79

Scale: 1 = Never, 2 = Sometimes, 3 = Frequently, 4 = Always; *n=36, **n=35

The findings relating to the elective topics from the 1999 syllabus (Table 5) indicate that examples from organic agriculture were most frequently used on the Innovation and Diversification (M = 3.00) and Sustainable Land and Resource Management (M = 2.76) electives. Whilst the value being 'frequently' for the Innovation and Diversification elective is promising for alternative systems, only 5 teachers reported teaching this elective therefore only representing a small percentage of students being exposed to these systems. Alternative agriculture examples were used 'sometimes' in all other electives. The number of teachers undertaking the Plant Management (N = 13), Animal Management (N = 25), and Sustainable Land and Resource Management (N = 21) electives suggest that the amendments to incorporate these elective into the Core of the 2009 syllabus were justified. The small numbers for the other electives also validate the need to restructure the electives in the amended syllabus.

Table 5: Use of Examples from Alternative Agriculture in Electives from 1999 Stage 6 Syllabus.

Elective Topic	Number	M	SD
Agribusiness	5	2.25	0.50
Animal Management	25	2.16	0.80
Horticulture	9	2.56	0.73
Innovation & Diversification	5	3.00	0.71
Plant Management	13	2.38	0.96
Sustainable Land & Resource Management	21	2.76	0.83

Scale: 1 = Never, 2 = Sometimes, 3 = Frequently, 4 = Always

Given the recent amendments to the syllabus, teacher opinions were canvassed regarding the structural and content changes as shown in Table 6. Removing the Optional Research Project was the most variable factor (SD = 1.35) in the amended changes with the most teachers indicating strong opinions (strongly disagree, 11.4%, strongly agree, 25.7%) towards this change than any other. The reduction in elective choice down to one from three also showed high variation (SD = 1.00) but an overall 'neutral' position. The integration of the Sustainable Land and Resource Management elective into the Core demonstrated the highest level of agreement (M = 3.97) of all the changes. The majority of teachers (54.3%, M = 2.57) disagree that the new electives have too much focus on technology and indicated higher agreement for the Farming for the 21st Century (M = 3.94) and Agri-food, Fibre and Fuel Technology (M = 3.89) electives as improvements to the syllabus than for the Climate Change elective (M = 3.66). The results indicate overall disagreement (M = 2.86) with the statement that the new electives offer reduced opportunity to use examples from alternative agriculture. Given that these electives may not have been taught at the time of the survey (early Term 2) teacher opinions may have changed subsequently to their implementation.

Table 6: Opinions on Amended 2009 HSC Syllabus

	M	SD
The reduction to one elective choice from three topics is an improvement.	3.63	1.00
There is too much focus on technology in the new elective topics.	2.57	0.70
Removing the Optional Research Project is a loss of a unique learning opportunity for students.	3.34	1.35
There needs to be a greater focus on ecological approaches to agriculture in the syllabus.	3.23	0.77
Integrating the Sustainable Land Management elective into the core content is an improvement.	3.97	0.82
Including Climate Change as a new elective is an improvement.	3.66	0.94
Including Agri-food, Fibre and Fuel Technology as a new elective is an improvement.	3.89	0.63
Including Farming for the 21st Century as a new elective is an improvement.	3.94	0.64
The opportunities to use knowledge and examples from alternative agriculture are reduced in the new electives compared with the previous syllabus.	2.86	0.91

Scale: 1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree; n=35

Section 4 - Pedagogical Practices

An assessment of Pedagogical practices is included to gain an indication of the extent to which students are exposed to alternative agriculture through third parties and experiential learning practices. Guest speakers from alternative agriculture and excursions to farms managed as alternative systems are rarely used as shown by mean values less than 2 as shown in Table 7. It cannot be assumed, however, that the expanded concept of faculty suggested by Francis et al. (2001) is not facilitated in high schools as the questions were specific to alternative systems and did not include other guest speakers or excursions to conventional farms. Experiments including practices from alternative agriculture, problem solving activities and independent research projects are all being used 'sometimes', and group-based activities are being used 'frequently', suggesting that experiential learning pedagogies are being utilised by teachers. This is to be expected given the requirement for 50% of course time in the Years 7 - 10 syllabus (Board of Studies NSW, 2003b) and 30% of course time in the Stage 6 syllabus (Board of Studies NSW, 2009a) being assigned to practical learning activities.

Table 7: Pedagogical Practices Used by Agriculture Teachers

	M	SD
Excursions to farms managed as alternative agricultural systems	1.97	0.75
Farmers from alternative agriculture as guest speakers	1.60	0.64
Industry or organisation representatives (eg certification bodies, associations) as guest speakers.	1.46	0.77
Experiments on the school farm with practices from alternative agriculture.	2.30	0.85
Group-based activities.	3.11	0.73
Problem solving activities.	2.97	0.72
Independent research projects.	2.82	0.87

Scale: 1 = Never, 2 = Sometimes, 3 = Frequently, 4 = Always

Section 5 - Professional Development

The findings in Table 8 indicate a need to address professional development for all alternative agricultural systems from 'only an update' for organic (M = 3.74), Permaculture (M = 3.82) and Ecological/Biological (M = 3.95) to 'Yes, a little' for all other categories. The most perceived need is for Natural Sequence Farming (M = 4.5), which is supported by the findings in previous sections regarding the use of examples from this system. Further research, similar to that of Williams and Wise

(1997), into teachers' perceptions of alternative agriculture would be a valuable addition to this research, particularly if conducted prior to and after professional development activities.

Table 8: Perceived Professional Development Needs

	M	SD
Organic *	3.74	0.74
Biodynamic **	4.14	0.82
Permaculture	3.82	1.01
Ecological / Biological	3.95	1.01
Natural Sequence Farming	4.50	0.95
Agroforestry	4.03	0.97
Aquaponics	4.13	0.99

Scale: 1 = Don't Know 2 = No, 3 = Only an update, 4 = Yes - a little, 5 = Yes - a lot; *n=35, **n=37

Section 6 - Further Comments

A total of nine teachers commented on the research in this section, five comments did not directly relate to the topic, rather they were comments regarding not teaching Stage 6, or thanks and support for the research. The comments in Table 9 reflect differing attitudes towards alternative agriculture from one teacher considering that sustainability detracts from the of teaching agriculture, to another stating an emphasis on sustainable systems and outlining a range of activities used. Barriers to including alternative agriculture are identified by one teacher as limited funding and proximity to alternative enterprises.

Table 9: Teacher Comments

I personally would not like to see organics etc take over the syllabus. We do address it, when possible and applicable.
Sustainability and environmental issues and concepts have been an embedded part of the syllabus since 1999 and in some ways has reduced the time available to study the science of agriculture and its interactions.
Finances are always a limiting factor for farm visits, product study visits, alternate agriculture excursions etc as many of my students come from disadvantaged backgrounds. We have to rely heavily on activities very close to home or at the school farm. We therefore concentrate on the more traditional practices that are more easily accessed.
We have an aquaponics unit at the school run as a stage 5 (yr 10) student research enterprise. Organic farm practices are used on the school farm- st5 (organic vege garden projects-not certified) School farm is a nursery for propagating native plants indigenous to the area sold to local regeneration groups to plant out. Emphasis on sustainable ag systems- integrating animals for manures/bedding for compost -don't waste our resources running/ showing cattle "non alternative ag" as most expect school ag is about ...appreciated the survey re "alternative ag".

Semi-Structured Interviews of Stakeholders

Stakeholders interviewed included primary and secondary teachers and tertiary academics involved in agricultural education, some of who have participated in syllabus writing and reviewing. Also represented are education providers from industry and government, including former high school agriculture teachers. The issues and concerns raised by interview participants are all consistent with those raised in the literature and whilst interconnected have been grouped into common themes in the following discussion.

Community Perceptions of Agriculture - the Role of the Media

All participants agreed that community perceptions of agriculture are an important issue for the industry. Perceptions suggested include those of; the 'farmer in the field', agriculture as an 'old fashioned profession', farmers 'doing it tough' through drought and floods, the 'European farming vision of rolling green hills and cows', the stereotype of the ignorant 'wheat between the teeth' farmer typical of 'Golden Book' stories, and the 'poor farmer who can't look after themselves if things go wrong'. These perceptions are a far cry from the reality of the industry as diverse, resilient and innovative, and participants cited the media as the main proponents of negative imagery such as; chemical contamination, water management conflict and more recently live animal exports. The Coles supermarket campaign about hormone-free beef was given as an example of misleading the public and portraying the broader beef industry in a negative light. One participant cited increased sales of a regional milk brand in response to the supermarket-branded $1/L milk 'war' as an example that consumers are somewhat aware of agricultural issues. As an agriculture teacher indicated, a generation ago most families had relatives to visit in the country, whereas now the only experience many students have with agriculture is a one-off farm visit. Overall, participants considered the general public to have negative perceptions due to being largely disconnected from their food supplies, to the extent that an academic expressed the view that *"the urban latte set has a jaundiced view about agriculture and what it is"*.

All participants agreed that there is a need for positive stories and images of agriculture in the media, one academic highlighting that 2012 being 'The Year of the

Farmer' is a perfect opportunity to showcase agricultural careers. Many participants suggested the industry be proactive and collaborate across all sectors to ensure that the general public learn to appreciate food in an informed way. Agriculture needs to be promoted as a 'high tech' and knowledge intensive industry that is "*more than just sitting on a tractor and getting dirty"*. The improvement of parents' perceptions of agriculture was mentioned by a couple of participants, particularly in reference to cultural backgrounds where agriculture is viewed as a 'peasant' or 'low caste' occupation. This is consistent with the findings of Peters (2009) in reference to the increasing numbers of students from language backgrounds other than English (LBOTE) at Hurlstone Agricultural College and the implication for students undertaking Agriculture beyond the mandatory Years 7 to 10 studies at that school. Several participants noted the need to promote agriculture in Years 9 and 10 before students decide on HSC subjects.

The Need for Industry, University and Government Action

All participants agree that industry, universities and government need to be more active in the promotion of agricultural careers, particularly through dispelling the perception that agriculture is simply farming and therefore based on low-income manual labour. Industry needs to promote the diversity of agricultural careers such as those in input provision, processing, agribusiness, extension, research and development. Several industry education providers suggested that students are making subject choices based on popularity or perceptions of where the highest incomes are to be found. Other than on-farm labour incomes, the argument of salary was not considered relevant by other participants, as the shortage of graduates has resulted in salaries at comparable rates with other industries. It was suggested that industry could contribute more to teacher professional development, educating careers advisors regarding opportunities in agriculture and work with them to develop work experience placements. A government-based education provider suggested that greater ties between universities and their alumni are needed for ensuring teachers are up to date with the latest information. Industry consultation with teachers regarding the development of appropriate resources and subsequent promotion of resources was suggested by one teacher who expressed frustration that, *"there's only so much room for posters on a classroom wall"*. Many participants

acknowledged the value of the PIEF in co-ordinating industry and tertiary involvement.

The role of Government in supporting agriculture through funding upgraded school agriculture facilities, supporting the primary school gardens movement, and increasing investment in agricultural research to return it to a position of 'serving the public good' rather than corporate interests, were identified by participants. One industry-based education provider suggested Government must understand why it needs to invest in agriculture when literacy and numeracy are bigger priorities and that, *"until production becomes a big issue, agriculture is not going to gain the attention of the government"*. An academic cited the lack of a peak body able to compete with the political power of the Minerals Council as a barrier to receiving Government support. Politicians need to be made aware of the current issues in agriculture and agricultural education.

Agriculture as a Cross-Curricular Theme

The use of food as a tool for developing an appreciation of agriculture, unifying students from different cultural backgrounds, addressing the disconnection from nature in urban environments, and as a basis for understanding the wider implications of our actions, were given as justification for greater inclusion of agriculture in both primary and secondary education. Some participants, however, expressed doubt over the effectiveness of this being in the form of a cross-curricular theme. One academic with experience in teacher training and syllabus writing suggested *"cross-curricular is the death of anything"* as teachers look past the cross-curricular objectives and concentrate on syllabus content. A teacher with experience in syllabus development questioned the relevance of current cross-curricular themes to some subjects, using Chemistry and the Aboriginal and Torres Straight Islander theme as an example. This participant also noted that the majority of students learn isolated facts and only the smarter students demonstrate the ability to integrate concepts, thus questioning the validity of cross-curriculum themes. Many participants suggested including more agriculture specific content in the most relevant syllabi rather than as a cross-curricular theme that would otherwise be overlooked by teachers with no interest in or experience of agriculture.

All participants agreed that the kitchen garden movement in primary schools is a beneficial step, however, funding, support for teachers, and the pressure of the National Assessment Program - Literacy And Numeracy (NAPLAN) were identified as barriers to wider adoption. An academic cited that Science and Technology is one of the worst taught KLAs in primary schools due mainly to the humanities backgrounds of teachers as an additional problem. Several participants expressed the need for more explicit reference to the relationships between food, agriculture and people in the Science and Technology, PDHPE and Human Society in its Environment (HSIE) syllabi. An industry-based education provider identified that a key factor in successfully engaging schools in gardening was demonstrating how it fits into the curriculum through scope and sequencing charts. The use of age appropriate methods for engaging students, appropriate terminology such as 'soil governance', and relating the best experiences of growing food back to students' efforts as 'soil stewards' were highlighted by a primary teacher as ways of attaching greater meaning to gardening activities. There was general agreement regarding the importance of building intimate relationships with food growing in the formative years of primary schooling, and that continuing this into the high school years was an important challenge to address.

The Place of Agriculture and Primary Industries in High School Education

All participants agreed that there is a need to preserve Agriculture and Primary Industries as specialist subjects. Several teachers and academics noted the tension between the two subjects with regards to student numbers. Where a small number of students wish to study either subject, and resources are only available to support one, Primary Industries usually prevails, particularly in rural areas. One teacher suggested that around 10-15% more students are unable to study Agriculture due to small class sizes. The faculty position of Agriculture within schools was not considered an important issue, however, one teacher noted that many schools maintain the position in science which allows the subject to be more readily promoted to higher achieving students. An academic expressed a desire to see brighter students in Agriculture, however, its image as a second-class subject perpetuates the pushing of lower achieving students towards it. An industry-based education provider suggested that the lower academic status of agriculture is not a problem given that students from science and environmental science backgrounds

can be recruited into agricultural careers. One academic noted that the pushing of the science side for greater academic credibility neglects the fact that agriculture 'is a lot about people', a view shared by an industry-based education provider who stressed the importance of promoting the 'human face' of agriculture.

Teacher Competency and Professional Development

Teacher competency was an issue raised by several participants, a government-based education provider citing non-compliance with National Livestock Identification Scheme on school farms as an example of the lack of contemporary knowledge. A teacher cited the DET retraining of unsuitable candidates as agriculture teachers *"just to put people in front of a class"* as having *"caused the subject in NSW a deal of harm"*. Teacher competence also affected syllabus amendments to ensure teachers without agricultural backgrounds were capable of delivering the subject. The responsibility for teacher professional development lies with the two (public and private) systems, one academic noted that the government, however, did little more than putting some resources on their website. Many participants praised the efforts of the NSWAAT in providing assistance, however, felt the Association could do more. Several participants acknowledged the PIEF as a long-needed co-ordination body, however, one government-based education provider expressed concern regarding potential conflicts of interest and ethics that come with corporate funding of such organisations. One teacher suggested greater use could be made of video conferencing facilities for guest speakers from universities and industry, and developing firmer relationships in the regional branches of the NSWAAT as potential avenues for improving professional development.

Syllabus Writing and Alternative Agriculture

Several participants noted the unique position of NSW as *"the only state where agriculture is functional in high school education"*, one academic highlighting that there are more agriculture students in NSW than all the other states combined. With a total of 1441 students in 2010 (Board of Studies NSW, 2010) Agriculture is only undertaken by a small contingent of all students in NSW. The position of agriculture in the Australian Curriculum was a concern for participants given the limited number of students choosing agriculture nationally and competition with other topics in the Technology area.

A few participants with experience in syllabus writing offered insights into the process and influences on syllabus content. An academic discussed the comprehensive process employed in the past where syllabus committees met three or four times a year and the whole process from drafting, consultation, consideration of the 150-200 responses, and final syllabus document release took a year to complete. This is now streamlined with ad-hoc committees and narrower consultation, resulting in less ownership of the syllabus by teachers according to this participant. A teacher conceded that the writing of the 1999 and 2009 syllabi were rushed and poorly funded. This participant expressed that teachers didn't feel ownership of the syllabus, rather, they regard it as *"something someone writes and throws at you to teach"* and don't generally respond well to the consultation process due to being busy with the additional workload of running school farms etc.

Participants also highlighted that the Agriculture syllabus is unique in comparison to other HSC syllabi as it is purposefully designed to be contextual rather than content driven. An academic noted that in the 1960's the course was more prescriptive with every student learning the same content regardless of location. In the early 1980's a systems approach was taken and so the syllabus was *"couched in conceptual terms and localised philosophy"* and as such exams had to be written without reference to particulars. A teacher highlighted that syllabus writing is subject to political influence, citing the rush to release the 1999 was due to the need to launch the 'New HSC' in 2000 as a political highlight of the government at the time. This participant stressed that the 1999 syllabus was regarded as *"the Sydney syllabus"* due to being written by teachers in Sydney area, a problem remedied by the NSWAAT when three country area teachers and one from the Sydney basin were selected for the 2009 amendments. The amended syllabus is an improvement, however, this participant expressed that a rewrite of all agriculture syllabi is needed as they lack continuity and to expect students to *"design something without knowledge of production"* in the Technology Mandatory syllabus is impractical. As this participant also pointed out, *"predicting the future is risky"* and as such the logical framework used to determine elective topics in the 2009 amendments was the question *"what sort of issues will agriculture face in the future?"*

When considering sustainable agriculture a government-based education provider suggested; *"teachers might feel threatened by the research because they might feel that they're not doing enough to address sustainability*". An academic expressed difficulty with the terminology 'sustainable' as it is still difficult to define, and examples of sustainable practices are often replacing one evil with another, such as the case of minimum tillage resulting in increased chemical use. Several participants considered that alternative systems should be explicitly mentioned but not necessarily promoted in the syllabus. Most respondents expressed that a balanced view is required and that students need evidence-based examples from which to make their own decisions about agricultural systems. A few academics cited the view that organic farming is not capable of feeding the world, as it cannot produce bulk commodities to the same scale as conventional growing. One academic was of the view that there are currently no sustainable agricultural systems and that organic agriculture and Permaculture operate from bases of 'belief' and 'religion' and need to put science behind them for greater credibility. A primary school teacher highlighted that Permaculture is a 'thinking tool' rather than farming system, with applications across all KLAs as well as social benefits ideal for urban contexts. The overall consensus from participants was that integrating practices from alternative agriculture into conventional systems is largely beneficial and the best way to present a balanced view to students. Several participants noted that the scope for including alternative agriculture is limited by the number of practical examples available to schools. However, as one academic expressed, *"syllabus developers are in the hands of the syllabus users"* and ultimately the implementation of the syllabus lies with the teacher. An agriculture teacher noted, *"if you dish up resources in a usable form then people will take them"* and suggested that a teacher-friendly resource package for organic vegetable growing would be readily accepted and used.

Conclusions

The two components of this research demonstrate a need to address agricultural education in high schools. Survey results indicate that teachers are mostly 'sometimes' using examples from alternative agriculture to address sustainable agriculture, and most feel the need for professional development regarding alternative systems. Further research into teacher perceptions and knowledge of alternative systems is recommended to determine barriers to greater use of examples, guide professional development and address resource needs. Research into student perceptions of sustainable and alternative agriculture and agriculture as a career option would be of further benefit to the industry. The PIEF have recognised this need and have commissioned Australian Council of Educational Research to undertake studies to assess teacher and student perceptions of primary industries and understanding of career options (Primary Industries Education Foundation, 2011).

Interviews of stakeholders reveal concern for the future of agricultural education and the need to address community perceptions of the industry in order to meet current and future demand for agricultural professionals. Most stakeholders agree there is a place for alternative agriculture in high school agriculture; however, it needs to be balanced such that students have an overall picture of the industry. The sustainability of agriculture as a subject at high school level is a further concern as indicated by decreasing student numbers, teacher competency, and out-dated facilities and technology. The increasing interest in food growing in primary schools is considered to be of benefit in addressing the disconnection of children from agriculture, the challenge lies in sustaining this interest into high school and then tertiary studies in agriculture. All stakeholders agreed that the formation of the PIEF is a positive step towards addressing many of the issues facing agricultural education today. In order for alternative agriculture to ensure representation it is recommended that the relevant organisations foster relationships with the PIEF, the NSWAAT, and high school agriculture teachers.

References

Agbaje, K. A. A., Martin, R. A. & Williams, D. L., (2001). Impact of sustainable agriculture on secondary school agricultural education teachers and programs in the north central region. *Journal of Agricultural Education*, 42(2), pp. 38-45. doi: 10.5032/jai.2001.02038

Agriculture Today, (2011, March 3rd). Organic farming top growth industry in Oz, says a little bird. *Agriculture Today*, p. 2.

Alvarez, A. & Rogers, J., (2006). Going "out there": Learning about sustainability in place. *International Journal of Sustainability in Higher Education*, 7(2), pp. 176-188. doi: 10.1108/14676370610655940

Andrews, P., (2006). *Back From the Brink: How Australia's Landscape can be saved.* Sydney: ABC Books.

Atkinson, W. D., (1988). Curriculum Development in Tertiary Agriculture and Horticulture. *Agricultural Systems*, 26, pp. 165-177.

Australian Curriculum Assessment and Reporting Authority, (2011). Curriculum development process for the Australian Curriculum: Technologies (Information and Communication Technology and Design and Technology). Retrieved from: http://www.acara.edu.au/curriculum/technologies.html

Azeez, G. (2009). Soil Carbon and Organic Farming: A review of the evidence on the relationship between agriculture and soil carbon sequestration, and how organic farming can contribute to climate change mitigation and adaptation. UK: Soil Association

Balschweid, M., (2002). Teaching biology using agriculture as the context: perceptions of high school students. *Journal of Agricultural Education,* 43(2), pp. 56-67. doi: 10.5032/jae.2002.02056

Bannerman, S., Thornthwaite, S. & Gant, L., (2001). *Enterprising Agriculture*. South Yarra, Victoria: Macmillan Education Australia Pty. Ltd.

Bawden, R. J., Macadam, R. D., Packham, R. J. & Valentine, I., (1984). Systems Thinking and Practices in the Education of Agriculturalists. *Agricultural Systems*, 13, pp. 205-225.

Bawden, R. J., Ison, R. L., Macadam, R. D., Packham, R. G. & Valentine, I., (1985). A research paradigm for systems agriculture. In J. V. Remenyi (Ed.), *Agricultural systems research for developing countries: Proceedings of an International workshop held at Hawkesbury Agricultural College, Richmond, NSW, May 1985* (pp. 31-42). Canberra: Australian Centre for International Agriculture Research.

Bawden, R. J., (2007). A paradigm for persistence: a vital challenge for the agricultural academy. *International Journal of Agricultural Sustainability,* 5(1), pp. 17-24.

Bellah, K. A. & Dyer, J. E., (2009). Attitudes and stages of concern of elementary teachers toward agriculture as a context for teaching across grade level content area standards. *Journal of Agricultural Education*, 50(2), pp. 12-25. doi: 10.5032/jae.2009.02012

Beus, C. E. and Dunlap, R. E. (1990). Conventional versus alternative agriculture: the paradigmatic roots of the debate. *Rural sociology,* 55(4), 590-616.

Biological Farmers of Australia, (2009). *About the BFA Organic School Gardens Program.* Retrieved from: http://www.organicschools.com.au/About/tabid/157/Default.aspx

Biological Farmers of Australia, (2011). *2011 eNewsletters*: *Organic School Gardens Email Newsletter.* Retrieved from: http://www.organicschools.com.au/News/2011eNewsletters/tabid/259/Default.aspx

Block, K. & Johnson, B., (2009). *Evaluation of the Stephanie Alexander Kitchen Garden Program. Final Report to: The Stephanie Alexander Kitchen Garden Foundation.* Retrieved from: http://www.kitchengardenfoundation.org.au/about-the-program/proving-it-works

Board of Studies NSW, (1999a). *Agriculture Stage 6 Syllabus*. Sydney: Board of Studies NSW.

Board of Studies NSW, (1999b). *Agriculture Stage 6, Support Document.* Sydney: Board of Studies NSW.

Board of Studies NSW, (2003a). *Agricultural Technology Years 7-10 Syllabus*. Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_sc/

Board of Studies NSW, (2003b). *Technology (Mandatory) Years 7-8 Syllabus*. Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_sc/

Board of Studies NSW (2003c). *Primary Industries Curriculum Framework, Stage 6 Syllabus Part A*. Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/primary-industries.html

Board of Studies NSW, (2003d). *Geography Years 7 - 10 Syllabus*. Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_sc/#geography

Board of Studies NSW, (2009a). *Agriculture Stage 6 Syllabus, Amended 2009.* Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/syllabus2000_lista.html

Board of Studies NSW, (2009b). *Agriculture Stage 6 Syllabus: Amendments 2009.* Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/agriculture.html

Board of Studies NSW, (2009c). *Senior Science Stage 6 Syllabus.* Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/senior-science.html

Board of Studies NSW, (2009d). *Geography Stage 6 Syllabus*. Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/geography.html

Board of Studies NSW, (2009e). *Economics Stage 6 Syllabus*. Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/economics.html

Board of Studies NSW, (2009f). *Society and Culture Stage 6 Syllabus.* Retrieved from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/society-culture.html

Board of Studies NSW, (2010). *Media Guide 2010 - Higher School Certificate and School Certificate*. Retrieved from: http://www.boardofstudies.nsw.edu.au/bos_stats/media-guide-2010.html#trends

Boone, H. N. Jr. & Boone, D. A., (2009). An assessment of problems faced by high school agricultural education teachers. *Journal of Agricultural Education,* 50 (1), pp. 21-32.

Brown, L., Hindmarsh, R. & McGregor, R., (2005). *Dynamic Agriculture Years 7-10*. (3rd ed.). North Ryde, NSW: McGraw-Hill Australia Pty. Ltd.

Bryman, A., (2007). Barriers to Integrating Quantitative and Qualitative Research. *Journal of Mixed Methods Research, 1(1), pp.8-22. doi: 10.1177/2345678906290531*

Cannon, J. G., Broyles, T. W., Seibel, G. A., & Anderson, R., (2006). Summer Enrichment Programs: Providing Agricultural Literacy and Career Exploration to Gifted and Talented Students. *Journal of Agricultural Education*, 47 (4), pp. 27-38

Charles Sturt University, (2011a). *Bachelor of Ecological Agricultural Systems*. Retrieved from: http://www.csu.edu.au/courses/undergraduate/ecological_agriculture/course-overview

Charles Sturt University, (2011b). *Master of Sustainable Agriculture*. Retrieved from: http://www.csu.edu.au/courses/postgraduate/sustainable_agriculture/course-overview

Clark, A., (2003). *Senior Australian Agriculture* (3rd ed.). Glebe, NSW: Pascal Press

Cribb, J., (2008). Tackling the Global Farm Crisis. *Agri-Food National Conference: 'It's all about skills', 25-26 September 2008*.

Cribb, J., (2010). *The Coming Famine: The global food crisis and what we can do to avoid it.* Collingwood, Vic.: CSIRO Publishing.

Dairy Youth Australia, (nd). *Art4Agriculture*. Retrieved from: http://www.dairyyouthaustralia.com.au/index.html

De Schutter, O., (2010). *Report submitted by the Special Rapporteur on the right to food, Olivier De Schutter*. United Nations General Assembly Human Rights Council. Retrieved from: http://www.srfood.org/images/stories/pdf/officialreports/20110308_a-hrc-16-49_agroecology_en.pdf

Desmond, D., Grieshop, J. & Subramaniam, A., (2004). *Revisiting garden-based learning in basic education.* Food and Agriculture Organisation of the United Nations & UNESCO International Institute for Educational Planning. Retrieved from: http://www.fao.org/sd/erp/revisiting.pdf

Dirks, A. E. & Orvis, K., (2005). An Evaluation of the Junior Master Gardener Program in Third Grade Classrooms. *HortTechnology*, 15(3), pp. 443-447.

Dyer, J. E., Breja, L. M. & Andreasen, R. J., (1999). Attitudes of college agriculture freshmen toward agriculture. *Journal of Agricultural Education*, 40(2), pp.1-10. doi: 10.5032/jae.1999.02221

Flint, R. W., (2000). Interdisciplinary education in sustainability: links in secondary and higher education. The Northampton Legacy Program. *International Journal of Sustainability in Higher Education*, 1(2), pp. 191-202.

Foskett, N. (2000). Dancing with the devil: Ethics and research in educational markets. In H. Simons & R. Usher (eds.), *Situated ethics in educational research* (pp. 133-145). London: Routledge Falmer.

Francis, C. A., Lieblein, G., Helenius, J., Salomonsson, L., Olsen, H. & Porter, J., (2001). Challenges in designing agriculture education: A Nordic perspective on change. *American Journal of Alternative Agriculture*, 16(2), p. 89-95.

Francis, C. A., Lieblein, G., Breland, T. A., Salomonsson, L., Geber, U., Sriskandarajah, N. & Langer, V., (2008). Transdisciplinary Research for a Sustainable Agriculture and Food Sector. *Agronomy Journal*, 100(3), pp. 771-776. doi: 10.2134/agronj2007.0073.

Francis, C., King, J., Lieblein, G., Breland, T. A., Salmonsson, L., Sriskandarajah, N., Porter, P. & Wiedenhoeft, M., (2009). Open-ended Cases in Agroecology: Farming and Food Systems in the Nordic Region and the US Midwest. *Journal of Agricultural Education and Extension,* 15(4), pp. 385-400. doi:10.1080/13892240903309645

Gamble, D. (1989). *Two techniques for gathering data and building rich pictures in rural and community development action research projects*. [Agpak No. RD3]. Hawkesbury, NSW: Faculty of Agriculture and Rural Development, University of Western Sydney.

Gibbon, D. and Jakobsson, K. (1999). Towards sustainable agricultural systems. In A. Dragun and C.Tisdell, *Sustainable agriculture and environment: globalisation and the impact of trade liberalisation* (pp.101-124). Cheltenham: Edward Elgar

Go Grains, (2011). *Go 4 Grains Kids' Design Challenge*. Retrieved from: http://www.gograins.com.au/?page_id=1123

Greene, B. B. & Byler, B. L., (2004). Effects of Pre-College Agricultural Background on Student Performance in College Introductory Agricultural Courses. *NACTA Journal*, 48(3), pp.14-18.

Guest, B. (2009). *Hurlstone Inquiry Report: A report on the agricultural assets and their use in the delivery of the agricultural curriculum at Farrer Memorial Agricultural High School, Hurlstone Agricultural High School, James Ruse Agricultural High School, Yanco Agricultural High School, Gosford High School, Oxley High School.* Retrieved from http://www.hurlstoneinquiry.nsw.gov.au/consult_reps.htm

Halsey, R. J., (2009). Australia's sustainability: A new policy front for rural education? *Education in Rural Australia*, 19(2), pp. 11-22.

Harding, R. (1988). Values systems and paradigms. In R. Harding (ed) *Environmental decision-making: the roles of scientists, engineers and the public* (pp.61-72). Federation Press

Janni, N. & Green, S., (2010). *Bringing the Steiner Waldorf Approach to your Early Years Practice*. Retrieved from EBook Library.

Jordan, N. R., Andow, D. A. & Mercer, K. L., (2005). Agroecology: A Service-Learning Course. *Journal of Natural Resources and Life Sciences Education*, 34, pp. 83-89.

Joyce, A. & Newton, C., (2005). Top vintage in South Australia. *Teacher*, November 2005.

Kalof, L., Dan, A. & Dietz, T., (2008). *Essentials of Social Research*. Maidenhead, England: Open University Press.

Kaltoft, P. & Rasmussen, J., (2004). Opening the "Black Box" of Agro-Scientific Expert Knowledge – and Bringing the Perspectives Back into the Agricultural University. *The Journal of Agricultural Education and Extension*, 10(4), pp. 163-170.

Klemmer, C. D., Waliczek, T. M. & Zajicek, J. M., (2005). Growing Minds: The Effect of a School Gardening Program on the Science Achievement of Elementary Students. *HortTechnology*, 15(3), pp. 448-452.

Knobloch, N. A., Ball, A. L. & Allen, C., (2007). The benefits of teaching and learning about agriculture in elementary and junior high schools. *Journal of Agricultural Education*, 48(3), pp. 25-36.

Leech, N. L., Dellinger, A. B., Brannagan, K. B., & Tanaka, H., (2010). Evaluating Mixed Research Studies: a Mixed Methods Approach. *Journal of Mixed Methods Research*, 4(1), pp. 17-31. doi: 10.1177/1558689809345262

Lieblein, G., Francis, C. & King, J., (2000). Conceptual framework for structuring future agricultural colleges and universities in industrial countries. *The Journal of Agricultural Education and Extension*, 6(4), pp. 213-222. doi: 10.1080/13892240085300041.

Lieblein, G., Østergaard, E. & Francis, C., (2004). Becoming an Agroecologist through Action Education. *International Journal of Agricultural Sustainability*, 2(3), pp. 147-153.

Leutton, R. & Jacobsen, N., (2009). *Hurlstone Agricultural High School Inquiry: Review Report, Terms of Reference - Items #4 and #5.* Retrieved from: http://www.hurlstoneinquiry.nsw.gov.au/consult_reps.htm

Lindesay, K., (1988). Agricultural education in Australia - an historical perspective. *The Australian Science Teachers Journal*, 34(2), pp. 95 - 99.

MacRae, R. J., Lynch, D. & Martin, R. C. (2010). Improving Energy Efficiency and GHG Mitigation Potentials in Canadian Organic Farming Systems. *Journal of Sustainable Agriculture*, 34(5), pp.549-580. doi: 10.1080/10440046.2010.484704.

Mollison, B., (1988). *Permaculture: A Designers Manual*. Tyalgum, Australia: Tagari Publications.

Moser, C. A. & Kalton, G. (1971). Questionnaires. In *Survey methods in social investigation,* (pp. 303-349). London: Heineman.

Myers, B.E. & Washburn, S. G., (2008). Integrating science in the agriculture curriculum: Agriculture teacher perceptions of the opportunities, barriers and impact on student enrollment. *Journal of Agricultural Education*, 49(2), pp. 27-37.

National Farmers' Federation, (2008). *2008 Labour Shortage Action Plan*. Retrieved from: http://www.nff.org.au/get/702.pdf

Niggli, U., Fließbach, A., Hepperly, P. and Scialabba, N. (2009). *Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems.* Rome: Natural Resources Management and Environment Department, Food and Agriculture Organisation of the United Nations. Retrieved 3rd October 2010 from: ftp://ftp.fao.org/docrep/fao/010/ai781e/ai781e00.pdf

NSW Department of Education and Training, (2011). *Warrawong High School: School Plan 2011*. Retrieved from: www.warrawong-h.schools.nsw.edu.au/sites/swsRepo/8480/asset/2010/11/19eb9eec2b886e61012c6c96bde504a3.pdf

NSW Farmers Association, (2010). *Educating Our Children About Food & Fibre Production.* Retrieved from: http://www.nswfarmers.org.au/policy_committees/rural_affairs/education

Onwuegbuzie, A. J., Bustamante, R. M., & Nelson, J. A., (2010). Mixed Research as a Tool for Developing Quantitative Instruments. *Journal of Mixed Methods Research*, 4(1), pp. 56-78. doi: 10.1177/1558689809355805

Osborne, E. W. & Dyer, J. E., (2000). Attitudes of Illinois agriscience students and their parents toward agriculture and agricultural education programs. *Journal of Agricultural Education*, 41(3), pp. 50-59. doi: 10.5032/jae.2000.03050

Østergaard, E., Lieblein, G., Breland, T. A. & Francis, C., (2010). Students Learning Agroecology: Phenomenon-Based Education for Responsible Action. *Journal of Agricultural Education and Extension*, 16(1), pp. 23-37. doi: 10.1080/13892240903533053.

Parr. D. M., Trexler, C. J., Khanna, N. R. & Battisti, B. T., (2007). Designing sustainable agriculture education: Academics' suggestions for an undergraduate curriculum at a land grant university. *Agriculture and Human Values*, 24, pp. 523-533. doi: 10.1007/s10460-007-9084-y

Peake, J. B., Duncan, D. W. & Ricketts, J. C., (2007). Identifying Technical Content Training Needs of Georgia Agriculture Teachers. *Journal of Career and Technical Education*, 23(1), pp. 44-54.

Peters, M., (2009). *Hurlstone Inquiry: Report by Mal Peters - October 2009.* Retrieved from http://www.hurlstoneinquiry.nsw.gov.au/index.htm

Pratley, J., (2008). Workforce Planning in Agriculture: Agricultural Education and Capacity building at the Crossroads. *Farm Policy Journal*, 5(3), pp. 27-41.

Pratley, J. & Copeland, L., (2008). Graduate Completions in Agriculture and Related Degrees from Australian Universities, 2001-2006. *Farm Policy Journal*, 5(3), pp. 1-11.

Pretty, J. N., (1995). Sustainable agriculture. In *Regenerating agriculture: Policies and practices for sustainability and self-reliance* (pp. 1-25). London: Earthscan.

Primary Industries Centre for Science Education, (2009). Primary Industries Centre for Science Education - About Us - Overview. Retrieved from: http://www.picse.net/HUB/overview.htm

Primary Industries Education Foundation, (2009). *The origins of Primary Industries Education Foundation*. Retrieved from: http://www.primaryindustrieseducation.com.au/index.html

Primary Industries Education Foundation, (2010a). *Submission to ACARA for the Inclusion of Primary Industries Education in the Australian Curriculum.* Retrieved from: http://www.primaryindustrieseducation.com.au/reports.htm

Primary Industries Education Foundation, (2010b). *Professional Development Day for Teachers of Agriculture in New South Wales. Homebush Bay, Sydney, 26 November 2010. Final Report.* Retrieved from: http://www.primaryindustrieseducation.com.au/reports.htm

Primary Industries Education Foundation, (2011, June). Foundation Newsletter - June 2011. Retrieved from: http://www.nswaat.org.au/resources/PIEF_Newsletter_Winter_2011.pdf

Pritchard, D. & Longnecker, N., (1998). Should agricultural courses at university be targeted at rural students only? In Black, B and Stanley, N. (Eds), *Teaching and Learning in Changing Times,* 274-277. Proceedings of the 7th Annual Teaching and Learning Forum, The University of Western Australia, February 1998. Perth: UWA.

Pritchard, A., (2010). *Ways of Learning: Theories and Learning Styles in the Classroom*. Retrieved from EBook Library.

Randall, D., (2009). *Stage 6 Agriculture syllabus support workshop.* Retrieved from: http://www.curriculumsupport.education.nsw.gov.au/secondary/technology/11_12/agriculture/index.htm

Roberts, T. G. & Ball, A. L., (2009). Secondary agricultural science as content and context for teaching. *Journal of Agricultural Education*, 50(1), pp. 81-91. doi: 10.5032/jae.2009.01081

Russell, D., (2003). From PD to PC. *Professional Educator*, 2(2), pp. 12-13.

Russell, D., Stone, G., & Green, S., (2006). *Scoping Study: The National Primary Industry Centre for Science Education (PICSE). "A strategy to attract young people into careers in primary industry through tertiary science."* Burnie: University of Tasmania.

Salomonsson, L., Nilsson, A., Palmer, S., Roigart, A., & Francis, C., (2008). Farming systems education: Case study of Swedish test pilots. *Renewable Agriculture and Food Systems*, 24(1), pp. 48-59. doi: 10.1017/S1742170508002408.

Saunders, M., Lewis, P. & Thornhill, A., (1997). Analysing qualitative data. In *Research methods for business students*, (pp.338-362). London: Pitman.

Scales, J., Terry, R. Jnr. & Torres, R. M., (2009). Are Teachers Ready to Integrate Science Concepts into Secondary Agriculture Programs? *Journal of Agricultural Education*, 50(2), pp. 100-111. doi: 10.5032/jae.2009.02100

Scarlet Consulting, (2005). *Promotion of Agriculture to Schools: Scoping Report and National Workshop Outcomes.* Available from: http://www.primaryindustrieseducation.com.au/reports.htm

Smith, L. L. & Motsenbocker, C. E., (2005). Impact of Hands-on Science through School Gardening in Louisiana Public Elementary Schools. *HortTechnology*, 15(3), pp. 439-443.

Sriskandarajah, N., Francis, C., Salomonsson, L., Kahiluoto, H., Leiblein, G., Breland, T. A., Geber, U., & Helenius, J., (2006). Education and training in organic agriculture: the Nordic region and the USA. . In P. Kristiansen, A. Taji & J. Reganold (Eds.). *Organic Agriculture A Global Perspective,* pp. 385-406. Collingwood, VIC: CSIRO Publishing.

Steiner Schools in Australia, (2002). *Steiner, Anthroposophy and Education.* Retrieved from: http://www.steiner-australia.org/other/anthrop.html

Stephanie Alexander Kitchen Garden Foundation, (2011a). *About the Program, Stephanie Alexander Kitchen Garden Foundation*. Retrieved from: http://www.kitchengardenfoundation.org.au/about-the-program

Stephanie Alexander Kitchen Garden Foundation, (2011b). *Our Subscription Program*. Retrieved from: http://www.kitchengardenfoundation.org.au/our-subscription-program

Stephens, C. A. & Little, D., (2008). Testimonies from four agricultural education student teachers related to completing an international student teacher experience in New South Wales, Austr. *Journal of Agricultural Education*, 49(3), pp. 46-55. doi: 10.5032/jae.2008.03046

Stephenson, L. G., Warnick, B. K. & Tarpley, R. S., (2008). Collaboration between science and agriculture teachers. *Journal of Agricultural Education*, 49(4), pp. 106-119. doi: 10.5032/jae.2008.04106

Tashakkori, A. & Creswell, J. W., (2007). Editorial: The New Era of Mixed Methods. *Journal of Mixed Methods Research*, 1(1), pp. 3-7. doi: 10.1177/2345678906293042

The Warrawong Community of Schools (2011). *Permaculture Partners Newsletter: Term Two 2010.* Retrieved from: http://www.cringila-p.schools.nsw.edu.au/sws/view/1022383.node

Tisdell, C. (2007). Sustainable Agriculture. In G. Atkinson, S. Dietz, E. Neumayer (eds), *Handbook of sustainable development* (pp.362-375). Cheltenham: Edward Elgar

Thomas, N. R. & Spencer, J. D., (1996). Policy and Quality in Agricultural Education. In, *Rural education: quality provision, quality experience, quality outcomes: Proceedings of the 12th National Conference 1996,* pp. 205-214.

Warner, W. J. & Washburn, S. G., (2009). Issues facing urban agriscience teachers: A Delphi study. *Journal of Agricultural Education*, 50(1), pp. 105-115. doi: 10.5032/jae.2009.01105

Webber, L., (1991). Semi-structured interview protocol. *Kyeamba Participatory Rural Appraisal* (pp. 1-6). Wagga Wagga, NSW.

Wiedenhoeft, M., Simmons, S., Salvador, R., McAndrews, G., Francis, C., King, J. & Hole, D., (2003). Agroecosystems Analysis from the Grass Roots: A Multidimensional Experiential Learning Course. *Journal of Natural Resources and Life Sciences Education*, 32, pp. 73-79.

Williams, D. L. (2000). Students' knowledge of and expected impact from sustainable agriculture. *Journal of Agricultural Education*, 41(2), pp. 19-24. doi: 10.5032/jae.2000.02019

Williams, D. L. & Dollisso, A. D. D., (1998). Rationale for research on including sustainable agriculture in the high school agricultural education curriculum. *Journal of Agricultural Education*, 39(3), pp.51-56. doi: 10.5032/jae.1998.03051

Williams, D. L. & Wise, K. L., (1997). Perceptions of Iowa Secondary School Agricultural Education Teachers and Students Regarding Sustainable Agriculture. *Journal of Agricultural Education*, 38(2), pp. 15-20. doi: 10.5032/jae.1997.02015

Glossary of Terms

ACARA - Australian Curriculum Assessment and Reporting Authority

BFA - Biological Farmers of Australia

DET - Department of Education and Training

GBL - Garden based learning

HSIE - Human Society In its Environment

KLA - Key Learning Area

NAPLAN - National Assessment Program - Literacy And Numeracy

NSWAAT - NSW Association of Agriculture Teachers

OSGP - Organic School Gardens Program

PIEF - Primary Industries Education Foundation

PICSE - Primary Industries Centre for Science Education

SAKG - Stephanie Alexander Kitchen Garden