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Tertiary agricultural education in Australasia: where to from here?

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Abstract. Agriculture, i.e. the ability to provide food reliably and efficiently for all, will remain the backbone of our economies. Although the relative economic importance of agriculture has diminished over time, its social and political importance has never been questioned. This special status of agriculture as a pillar of our societies means that we need to pay close attention to the way we teach and deliver agricultural curricula at university level. Agriculture is particularly important in Australasia, a region at the edge of SE Asia, where rapid population growth and demographic changes are putting unprecedented pressures on food systems. This paper examines the current state of tertiary agricultural education in Australasia and highlights some of the foreseeable trends that will drive educational policies for the next few decades. We conclude that the two major regional economies, Australia and New Zealand, share a responsibility and a desire to provide modern and forward-looking curricula that will equip graduates with relevant skill sets and make them 'employment ready'. In Australia such graduate attributes have recently been negotiated via a broad, consultative process that resulted in the *Agriculture Learning and Teaching Academic Standards* (AgLTAS). The standards describe the nature and extent of the agricultural discipline as well as a set of Teaching and Learning Outcomes (TLOs) that were identified by potential employers as 'business critical': Knowledge, Understanding, Inquiry and Problem Solving, Communication and Personal and Professional Responsibility. Australia and New Zealand also have the governance and institutional infrastructure that will allow them to act as educational hubs for the region and be responsive to the training and development needs of their nearest neighbours. This should also assist countries such as Fiji and Papua New Guinea to reform their curricula and upskill their accademic workforce. Continuous and rapid changes in information technology requires constant curriculum review and renewal. Concepts such as on-line delivery, blended learning and flipped classrooms need to be part of curriculum delivery. A greater emphasis on pre-degree delivery and a greater responsiveness to articulated business needs is required to meet industry demand for a well-educated and skilled workforce. Satisfying market demands in the pre-degree space can create pathways for a future university education. The role of universities in providing tertiary education in agriculture that is aligned with market needs will require flexibility from administrators, staff, curriculum developers, industry and students.

Keywords. Tertiary agricultural education – Curriculum reform – Agriculture Learning & Teaching Academic Standards (AgLTAS) – Australasia.

L'éducation tertiaire agricole en Australasie : Où allons-nous à partir de là ?

Résumé. *L'agriculture, c.-à-d. le fait de pouvoir nourrir toutes les personnes de façon sûre et efficiente, sera toujours le pivot central de notre économie. Bien que l'importance économique relative de l'agriculture ait diminué au fil du temps, son importance sociale et politique n'a jamais été remise en question. Ce statut spécial de l'agriculture en tant que pilier de nos sociétés signifie qu'il est nécessaire d'accorder une attention spéciale à notre manière d'enseigner et de délivrer les programmes d'études en agriculture au niveau universitaire. L'agriculture est particulièrement importante en Australasie, une région située à partir de la pointe de l'Asie du*

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Sud-Est, où une croissance rapide de la population ainsi que des mutations démographiques provoquent une pression sans précédent sur les systèmes alimentaires. Cet article fait l'état des lieux de l'enseignement agricole tertiaire en Australasie et met en relief certaines des tendances prévisibles qui configureront les politiques éducationnelles sur les décennies à venir. Notre conclusion est que les deux grandes économies régionales, l'Australie et la Nouvelle-Zélande, partagent la responsabilité et le désir d'offrir des programmes d'études modernes et tournés vers l'avenir permettant aux diplômés d'acquérir un ensemble d'aptitudes essentielles et les rendant aptes à occuper un emploi. En Australie, ces attributs que doivent posséder les diplômés ont récemment été définis à travers un vaste processus consultatif qui a débouché sur les normes AgLTAS (Agriculture Learning and Teaching Academic Standards). Ces normes décrivent la nature et l'étendue de la discipline Agriculture ainsi qu'un ensemble de Résultats d'Enseignement et d'Apprentissage (Teaching and Learning Outcomes – TLOs) qui ont été identifiés par les employeurs potentiels comme cruciaux dans le monde des affaires : Savoir, Compréhension, Investigation et Résolution de Problèmes, Communication et Responsabilité Personnelle et Professionnelle. L'Australie et la Nouvelle-Zélande possèdent également la gouvernance et l'infrastructure institutionnelle qui leur permettront d'agir en tant que pôles éducationnels pour la région et de répondre aux besoins de formation et de développement de leurs plus proches voisins. Ceci devrait également être d'utilité à des pays tels que les îles Fidji, la Papouasie et la Nouvelle-Guinée, pour réformer leurs plans d'études et remettre à niveau leur personnel académique. Les changements continus et rapides de la technologie de l'information exigent une révision constante et une rénovation des plans d'études. Des concepts tels que formation en ligne, formation semi-présentielle et classes inversées devront faire partie des programmes d'études délivrés. Il sera nécessaire d'insister davantage sur la formation pré-universitaire et sur une plus forte réponse aux besoins exprimés par le monde des affaires pour satisfaire la demande de l'industrie dans le sens d'une force de travail mieux formée et plus compétente. Satisfaire les demandes du marché dans l'espace pré-universitaire peut créer des parcours pour un futur enseignement universitaire. Le rôle des universités en vue d'apporter un enseignement tertiaire pour une agriculture qui s'aligne sur les besoins des marchés nécessitera une flexibilité de la part des administrateurs, du personnel, des développeurs de programmes d'études, de l'industrie et des étudiants.

Mots-clés. *Enseignement tertiaire agricole – Réforme des programmes d'études – Enseignement et Apprentissage de l'Agriculture – Normes Académiques AgLTAS – Australasie.*

I – Introduction

1. Geo-political context

Australasia is the largest sub-region of Oceania (>10,000 km^2) and comprises the four countries with the highest populations in the region: Australia (23.0 M), Papua New Guinea (7.3 M), New Zealand (4.5 M) and Fiji (0.9 M), plus several small island states. The countries' economic development and prosperity have strong foundations in their agricultural sector (Table 1). Economically, Australia and NZ dominate in the region, having highly developed agricultural sectors and agri-businesses, in contrast to PNG and Fiji, where agriculture is still largely subsistence and small scale.

2. Background

The development of agriculture over 10,000 years ago has resulted in a transformational shift in human behaviour, thereby creating the basis for our civilisations. The efficiencies created by agriculture – the ability to reliably feed growing populations with fewer and fewer farmers – meant that no society has ever turned away from it (Leith and Meinke, 2013). Agriculture provided the foundation on which other sectors of the economy could develop and grow. As a consequence, the contribution of agriculture to large, highly developed economies today is only about 1-3% of GDP (Table 1). This demonstrates the incredible efficiencies created by modern agriculture.

However, the proportionally low farm gate contribution of agriculture to developed economies' GDPs does not diminish the strategic importance of the sector. As a direct result of the efficiencies cre-

Table 1. Percent of agriculture as a contributor to GDP based on farm-gate value as well as current population numbers for a range of countries; Australasian countries discussed in more detail in this paper are highlighted in red (World Bank, 2015)

Country	% of GDP	Population (million)	as of
UK	0.7%	64	2013
Germany	0.9%	81	2013
Japan	1.2%	127	2012
USA	1.3%	316	2012
France	1.7%	66	2013
Netherlands	2.0%	17	2013
Australia	2.5%	23	2013
Brazil	5.7%	200	2013
New Zealand	7.2%	4	2010
China	10.0%	1,357	2013
Fiji	12.2%	>1	2013
Indonesia	14.4%	250	2013
India	18.2%	1,252	2013
Vietnam	18.4%	90	2013
Papua New Guinea	36.3%	7	2012

ated by agriculture, the global population has grown exponentially and is projected to exceed nine billion people by 2050. This is equivalent to an annual increase of approximately 60 million, roughly the population of modern Italy. Furthermore, when accounting for the value-adding processes that food and fibre go through once they leave the farm, along with the value of all the economic activities that support farm production through farm inputs, food manufacturing, transport and logistics, wholesaling and retailing and the food service sector, agriculture's contribution to Australia's GDP increases to around 12% or $155 billion (National Farmers Federation, 2015).

For the first time in history, more than half the global population now live in cities rather than rural communities. Increasing urbanisation means that more people will directly compete with agriculture for access to resources such as land, water, capital, labour and infrastructure, particularly across Asia where over half of the world's population now live. As a result of these demographic changes, the increase in the demand for agricultural produce is projected to rapidly exceed the increase in supply, putting additional pressure on the environment and the global food system.

The potential social consequences of these pressures were well captured by English Parliamentarian Lord Cameron of Dillington who, in relation to Britain's food security concerns in the early 2000s, quipped, "we are all only nine meals away from anarchy". As we have recently seen, social orders break down quickly when food supplies are disrupted (Breisinger *et al.,* 2011). A recent report by DAFF (2012) points out that most Australian households hold sufficient food for only 2-4 days (i.e. the 'nine meals' referred to by Lord Dillington).

In other words: while the relative economic importance of agriculture has diminished over time, its social and political importance has never been questioned. It is this special status of agriculture as a pillar of our society that requires a strong and on-going focus on tertiary agricultural education.

Modern agriculture has become a knowledge-intensive sector of considerable societal relevance as evident by the increasing global concern about food security. For instance, Australia's agriculture currently feeds an estimated 60,000,000 people worldwide (National Farmers Federation, 2015). It has been estimated that an upper limit of Australia's capacity to supply food with current technologies will be a 3-fold increase over current production volume. This means that Australia's

maximum capacity is feeding approximately 3% of the world's population – an important contribution, but hardly the 'food bowl' proclaimed by some (ANZ, 2012; DAFF, 2013). Yet, the ANZ report highlights that Australia and New Zealand combined could more than double their real value of annual agricultural exports by 2050. This would result in an additional, combined US $500 billion of revenues over the next four decades.

For such sectoral expansion to eventuate requires a strong focus on agricultural education. Hence, we must overcome an ingrained image problem that has plagued the sector for several decades: this image problem is epitomised by the widely-held misconception that to study agriculture means to study farming. This fails to recognise that agriculture is an economic sector that spans the entire value chain from farmer to consumer. The bumper sticker "Agriculture – without us you are dead" says it all. It is no accident that the issue of food security has begun to dominate some political agendas. In a recent report "Building the Lucky Country", Deloitte (2014b) labelled 'Agribusiness' as 'Australia's forgotten hero', a sector ideally placed to capitalise on a world-wide leap in demand for higher-value food products.

In terms of tertiary education we need to accept that agriculture is not a discipline with neatly defined boundaries. It cannot be taught the way we teach mathematics, chemistry or computing. To study agriculture means to study all of the natural sciences plus a lot more, such as engineering, economics, business and law. This is increasingly recognised and reflected in the design of modern agricultural curricula.

II – Overview of Tertiary Agricultural Education in Australasia

Australia and New Zealand are the two major providers of agricultural research and education in the region. Their agricultural sectors are characterised by the use of modern technology, a high degree of mechanisation (a direct consequence of high labour costs), scale efficiencies and a strong research – teaching – industry nexus.

Australia has 43 universities (Australian Government, 2015a). In 2007, those universities that offered a degree course in agriculture or related areas formed the Australian Council of Deans of Agriculture (ACDA) as the peak body for higher education in agriculture. Fifteen Australian universities offering agricultural education and research programs are current members of the ACDA. Member universities are spread across every Australian State and in both metropolitan and rural locations and are listed on the ACDA website. Their course offerings are wide and varied.

New Zealand has eight universities spread across its two main islands. Two of those, Lincoln University in Canterbury (near Christchurch) and Massey University, with campuses in Palmerston North, Albany (in Auckland), and Wellington have strong agricultural offerings (Universities New Zealand, 2015). Having its origin as a School of Agricultural Science formed in 1878, Lincoln is the only university in the Austral-Pacific region that fundamentally has agricultural roots.

The University of the South Pacific (USP) has its main campus in Fiji (Laucala) with smaller campuses in twelve other Pacific Island nations. They offer two three-year degrees: a Bachelor of Agriculture with two streams in Agribusiness and Applied Science at the Alafura campus in Samoa and a Bachelor of Commerce (Agricultural Economics and Agribusiness) at the Laucala campus in Fiji. Employment opportunities for graduates outside the public sector are scarce as a consequence of the small-scale, subsistence-style agricultural systems that are further impeded by prohibitively high transport costs due to the island's remote location and small size.

Only three of PNG's six universities offer degree-level agriculture. Similarly to Fiji, career prospects outside the public sector are scarce. Anecdotal evidence indicates that all institutions suffer from low funding levels and poor maintenance. The Australian Overseas Development Assistance

(ODA) program through the Department of Foreign Affairs and Trade (DFAT), as well as the New Zealand ODA program, offer several higher degree by research scholarships that are effectively training future scientists and research managers.

III – Australia, a case of "lies, damn lies and statistics"

Over 10 years ago Australian agribusinesses began to complain seriously about a shortage of agricultural graduates. A closer look quickly demonstrated that the perception of the value of an agricultural education amongst policy makers, the general public and career advisors bore little resemblance to reality. While policy makers – on the basis of erroneous data – assumed that there was an oversupply of agricultural graduates, the general public and career advisors had a "muddy boots" and "rusty tractor" view of agriculture.

Although the report by McColl *et al.* (1991) into agricultural and related education had highlighted a looming shortage of agricultural graduates, very little was done to redress this and graduate numbers continued their decline until 2012. In 2007, sixteen years after the McColl Report was published, a colloquium was held in Adelaide to consider the paucity of agricultural graduates entering the workforce. Universities were blamed for the lack of graduates yet industry itself had done little to promote careers in the sector. One outcome of that meeting was the formation of the ACDA. This allowed the universities involved in agriculture to speak with one voice on matters regarding agricultural higher education and research. The ACDA accepted the challenge to do what it could to analyse the issue and facilitate an evidence-based debate.

Discussions with the then Federal Minister for Primary Industries revealed that the official position of government was that there were plenty of agriculture graduates and insufficient jobs, diametrically opposed to the views being expressed by industry. The ACDA resolved to collect their own statistics based on their members' graduate data (Pratley, 2008; Pratley and Copeland, 2008; Pratley, 2012). The data clearly showed a decline from nearly 900 graduates in 2003 to less than 450 graduates in 2012. Yet, the employment market was buoyant with up to six jobs for every graduate, although this has softened somewhat in 2014.

Why were official data not identifying the shortage of graduates and why were career advisers under the impression that there were no jobs in agriculture? A more thorough analysis of the official data did provide the explanation. As part of their reporting responsibilities to government, universities provide student data according to categories called 'Fields of Education' (FoE). There are 12 broad FoEs, with 'agriculture, environmental and related studies' being one of them (FoE 05) (Australian Bureau of Statistics, 2001). Although these broad 'two digit codes' are broken down into five so-called 'four digit codes' (e.g. agriculture = 0501, forestry = 0505 and environmental studies = 0509), graduate data are not reported at that greater level of granularity. Hence, a simple question about the number of graduates in agriculture generates a 2-digit response unless otherwise requested. This matters, because graduates in environmental science (FoE 0509) outnumber agricultural graduates (FoE 0501) considerably. For instance, in 2010 about 2200 students graduated in FoE 05; only 413 of those were actual agricultural graduates (Table 2; see Pratley, 2015a,b for more details).

Table 2. Decline in graduate completions for Field of Education 05 (agriculture, environmental and related studies) and for agriculture from 2001 to 2010 (Pratley, 2015a, b)

Source	2001	2010	% decline
Undergraduate completions, FoE05	2991	2207	26
Undergraduate agriculture completions	886	413	53

This scenario repeats itself in relation to salary and employment status. New graduates were surveyed several months after graduation by Graduate Careers Australia, an agency of government. Responses received are classified according to FoE at the 2-digit code. Hence, agriculture is represented by both agriculture graduates and environmental graduates. The latter vastly outnumber agriculture graduates in response and so the combined data are more representative of environmental graduates than of agricultural graduates. This would not matter if the outcomes were similar for both cohorts but that is not the case: agricultural graduates report what is regarded as 'full employment' (>90%), whereas environmental graduates hover between 60 and 70% fulltime employment. When combined, the data show around 70% employment creating a wrong perception of underemployment amongst agricultural graduates (Pratley, 2015b).

These findings generated considerable political and media interest. Numerous enquiries and reviews followed and highlighted the lack of a positive image for agriculture, the perception that agriculture related only to farming, the negativity towards agriculture in the schools and the complacency in the education system and the community about food security. Pratley (2013) noted that students were actively discouraged from choosing agriculture as a career by school career advisors who perceived there were to be no jobs or career prospects. Careers in agriculture were being portrayed as unattractive and unrewarding with low student enrolments consequently threatening the viability of many agricultural degrees throughout Australia. Decades of low enrolment numbers have, of course, taken a toll on a system that relies heavily on student numbers for funding.

Today, agribusinesses have become increasingly vocal about this skills crisis, resulting in intense competition for agricultural graduates. This, in turn, has led to ongoing discussions between employers of agricultural graduates, the Vocational Education and Training (VET) sector (Australian Government, 2015a,b) and universities about pathways, curriculum structure, learning outcomes and desirable skills attributes of graduates.

All sectors responded:

1. Industry and Government realised that the lack of graduates was real, generating concern about its capacity going forward and the impact on future opportunities; issues such as social licence became important;

2. Communities began to wonder about their own food security as the global food security issue was highlighted;

3. The importance of educating children at all levels about food and agriculture was elevated and the significance of organisations such as the Primary Industries Education Foundation Australia (PIEFA) became apparent;

4. The impact on universities of lower enrolments is now a national concern.

Self-appointed industry advisory groups formed to provide universities with proactive feedback about their needs and career opportunities; they articulated a general willingness to assist. Universities across Australia, including some who had previously suspended their courses due to a lack of student intakes, invested in promotion of their degrees (e.g. Australian Broadcasting Corporation, 2012). All these efforts are beginning to show results. Over the last few years, there has been a general increase in enrolment numbers of between 10% and 40%, differing by degree and university. New Zealand is reporting a similar trend and current indications are that this is likely to continue. Students are rediscovering the value of a tertiary education in agriculture. It is now up to universities, in partnership with industry, to ensure that this trend is sustained by an ongoing, continuous curriculum reform process that is responsive to a rapidly changing external environment and new career opportunities for agricultural graduates.

This episode has been a wake-up call for all. There has been an increased urgency towards professionalising the industry – a focus on education and training, a desire to improve the image of the sector, a move towards social licence and greater engagement with future opportunities, challenges and needs. Universities have been an integral part of this increasingly professional approach as the issue of quality in higher education is considered. Learning and Teaching Academic Standard (LTAS) Statements across several disciplines have been published, and are listed as reference points in the national standards framework developed by the Higher Education Standards Panel (Australian Government, 2012).

The increased levels of communication and interaction between industry and universities has led to a new, consultative approach to curriculum development, including the development of national tertiary-level education standards for agriculture to align the expectations of graduates, employers and universities. The standards define the nature and extent of agriculture and outline the key threshold learning outcomes (TLOs). They now inform course development and quality assurance in Australian universities that teach agriculture.

The Agriculture Learning and Teaching Academic Standards (AgLTAS) were developed through national engagement with industry, graduates and academics, including 19 consultation workshops, which were supplemented by an online survey that was available via the AgLTAS project website (Botwright Acuna *et al.*, 2014a). A reference group and project team used Bloom's Taxonomy of Cognition to provide a conceptual framework that guided the analysis and structure of the draft AgLTAS statement (Bloom *et al.*, 1956).

The resultant AgLTAS statement includes a description of the nature and extent of the discipline as well as a set of TLOs that closely reference those for the Science discipline: Knowledge, Understanding, Inquiry and Problem Solving, Communication and Personal and Professional Responsibility. Together these represent what a pass-level graduate in agriculture should know, understand and be able to do upon graduation. Although agriculture fits within science, it also includes core components of business and social constructs not typically captured in the science TLOs.

Industry input was vital in developing the Australian standards to ensure that agriculture graduates leave university with the relevant skills and knowledge. In particular, industry stakeholders highlighted the need for students to demonstrate highly-developed problem solving and communication skills whereas industry/farming specific (vocational) knowledge could largely be gained through on-the-job training both during and after graduation (Botwright Acuna *et al.*, 2014b).

Providers of tertiary-level education in agriculture and related disciplines are encouraged to build on the standards as they design and deliver programs that reflect their particular strengths and priorities. If implemented as a reference point, the standards should support collaborative approaches across the tertiary sector and safeguard each higher education provider's autonomy, diversity and reputation.

This is a crucially important point at a time when major changes to the way we teach and deliver content to students of all ages and backgrounds is underway: these TLOs are not a straight jacket or an attempt at standardising what is rightfully a highly diverse curriculum. Instead they are there as a reminder of what many of us have agreed should be achieved, regardless of the approach or specific content of the curriculum.

Agricultural research and teaching relies on strong links with industry. Without these links, sustainable and profitable practice change in agricultural systems cannot be achieved. Industry representatives considered vocational knowledge of lesser importance to the need for students to attain highly developed problem solving and communication skills that can generate new opportunities and innovation in agriculture. Industry-specific (vocational) knowledge was generally regarded as attainable during on-the-job training after graduation.

IV – New Zealand, big enough to matter, small enough to manage

With only two major providers of tertiary agricultural education and an economy that relies disproportionally on agriculture as a sector (Table 1), New Zealand has several advantages when compared with Australia. These advantages are largely a consequence of New Zealand's much smaller size (this reduces issues related to the "tyranny of distance", which is omnipresent in Australia) and an ability to focus a curriculum on an issue important to most New Zealanders: agriculture. As a consequence of rapid expansion over the last few decades in commodities such as wine, horticulture and dairy, New Zealand's two agricultural universities, Lincoln and Massey, have seen strong increases in student numbers since 2012. For instance, student numbers in the Bachelor of Agricultural Science degree at Lincoln have increased from 146 EFTs in 2012 to 223 EFTs in 2015 and new enrolments over the same period from 52 EFTS to 87 EFTS. Bachelor of Agriculture numbers have stayed about the same, averaging 80 EFTS over the same time frame.

Opportunities for graduates are many and varied with recent graduates finding employment in a range of industries including: family farms, agri-technology companies, agricultural support companies, crown research institutes, the dairy industry, red meat industry, arable research and many more. As in Australia, a recent survey of final year students suggested that most had found employment prior to graduation. Opportunities in the dairy industry are substantial with the industry estimating a shortage of at least 1000 trained staff per year.

At Lincoln University, the Bachelor of Agriculture and Bachelor of Agricultural Science have recently been reviewed and updated. Major changes include the introduction of University wide courses in problem solving that ensure graduates can work closely with commerce, marketing, tourism and environmental management students. New courses were introduced in precision agriculture and farm systems modelling to ensure all agriculture students are up to date with modern technologies.

Massey University offers a Bachelor of AgriScience with specialisations in Agriculture, Equine and Horticulture, along with a Bachelor of AgriCommerce and 4-year Bachelor of Science (Agriculture). For example, the AgriScience degree aims to produce graduates with the ability to integrate and apply science, technology and business principles to current and emerging issues in land-based and related sectors.

Both Lincoln and Massey University have developed research hubs with private agribusiness and crown research institutes with plans for further expansion. For example, the Lincoln Hub will include AgResearch, Landcare Research, Plant and Food Research and DairyNZ, resulting in one of the largest congregations of agricultural scientists in the southern hemisphere with over 900 scientists on site. This will create much greater capacity for supervising post-graduate students at both masters and PhD level.

V – Papua New Guinea (PNG)

Three of PNG's six universities offer specific degree-level agriculture, although the University of PNG has a School of Natural and Physical Sciences teaching Environmental Sciences and Geography, Earth Sciences and the Pacific Adventist University has a Bachelor of Science (Environmental Science). Total enrolments in agriculture and fisheries in 2010 were 751 (447 males and 304 females) whilst 176 graduated in that year. This represents about 6.4% of all Higher Education enrolments (Department of Education, 2011).

PNG University of Technology (Unitech) in Lae

The Department of Agriculture is regarded as being the leading provider of agricultural science education in PNG. It has about twelve academic staff across the major disciplines, 150-200 students enrolled in its four year degree program and a small number of postgraduate students. The Department was established in 1971 in Port Moresby at the University of Papua New Guinea but was moved in 1985 to Unitech in Lae because of the close proximity of 39 ha of developed land (Taraka Campus) for teaching, research and demonstration and the constraints of operating in Port Moresby. The farm encompasses facilities for livestock (poultry, pigs, goats), crops (both perennial and annual) and agricultural engineering (Unitech, 2013).

Papua New Guinea University of Natural Resources and Environment

This institution was formerly known as the University of Vudal (prior to that Vudal Agricultural College) and has incorporated campuses at Vudal, Popondetta, the Sepik and the National Fisheries College in Kavieng, New Ireland Province. Courses range from diplomas and undergraduate degrees in tropical agriculture and fisheries and marine resources to a graduate certificate and master's degree in management.

University of Goroka

This university is the third largest of the six universities in PNG and is by far the largest teacher education institution. The teacher's college was upgraded after the UPNG Council decided to unify teacher education programs in Goroka as a result of the National Education Reform and PNG's Higher Education Plan 1992. It has four schools and teaches agriculture as part of its School of Science. From its early days as a teacher's college, it trained agricultural teachers for high schools throughout PNG. In 2007, the university formerly incorporated an agricultural extension program with a four year degree for in-service extension officers by topping up two year agricultural diplomas after a minimum of two years field experience, conferring a Bachelor of Agriculture Extension (University of Goroka, 2010a,b).

Agricultural Vocational Education and Training (VET)

Specific agricultural VET courses appear to be only delivered in West New Britain where there were 16 enrolments in 2013 (Department of Education, 2014). Bonney *et al.* (2012) noted that given the importance of agriculture as a foundational step for development and PNG's reliance on agriculture for food security and employment, the lack of a widely available agricultural education program at the VET level appeared to be a significant constraint to development.

Status of resources and funding

A recent independent PNG and Australian Government report (Garnaut & Namaliu, 2010) found that PNG's Higher Education system faces major challenges, particularly in the areas of governance, funding mechanisms, performance quality, staff practices and a culture of research. For agriculture, land for the universities delivering agriculture was found to be constraining delivery quality and requires significant expansion or, in the case of Unitech at Lae, re-location away from urban expansion to enable full utilisation and exploit higher land prices that could subsidise operations. The report further recommended that constraints on the full use of the profits from commercial activities on these farms be removed.

Despite commitments from the subsequent bi-lateral Government planning (Department of Education, 2011), anecdotal evidence indicates that most institutions continue to suffer from a lack of funding, inadequate resources and poor maintenance.

Hence, the capability of the system to deliver the quality of education and training required to make a significant contribution to PNG's development may be severely constrained. Australia provides kina for kina support in key areas and overall provided about $65 million in 2014-2015 (Department of Foreign Affairs and Trade, 2015). Further, the Australian Overseas Development Assistance (ODA) program through the Department of Foreign Affairs and Trade (DFAT) as well as the New Zealand ODA program offer higher degree by research scholarships that are effective in training future scientists and research managers.

VI – University of the South Pacific (USP)

At the undergraduate level, the University of the South Pacific offers a Certificate in Agriculture, a Diploma in Agriculture and a Bachelor of Agriculture with a stream in Agribusiness and a second stream in Applied Science at its Alafura campus in Samoa. At the Laucala campus in Fiji, the Faculty of Business and Economics offer a Bachelor of Commerce (Agricultural Economics and Agribusiness). While the BAgr students have a good foundation in the agricultural sciences, these are seriously deficient in the BCom program. Conversely, for the BAgr program, instruction in macroeconomics and trade policy is notably absent. A recent review of the USP programs (Batt, 2014) recommended that the current offers be combined and revised to ensure that graduates have a sufficient understanding of both the applied agricultural sciences and the necessary business skills to effectively manage or to advise an agricultural enterprise.

Due to the size, isolation and the quasi-subsistence nature of agriculture across the Pacific Islands, there are very few job opportunities for agricultural graduates in the private sector. While most graduates have found work within the public sector, there has recently been a downturn in demand. To overcome the declining demand for graduates in the public sector, it has been proposed that a unit on entrepreneurship be introduced with the objective of encouraging graduates to become employers rather than employees. A more international, market-oriented, value chain perspective is desirable to facilitate exports and the growth of the agribusiness sector. However, neither course currently provides any instruction in postharvest technology or a basic food technology/food processing unit. Furthermore, graduates should have an appreciation of the need to promote and encourage more sustainable agriculture practices in response to climate change.

Across the twelve Pacific Island nations that USP currently services, while it may be possible to deliver some units in an on-line mode, the laboratory based units will continue to struggle to deliver the desired outcomes without the use of intensive residential periods of instruction. Yet, in spite of these difficulties, enrolment numbers at USP have been steadily increasing since 2011 (Table 3).

Table 3. Enrolment numbers at USP across all pre- and undergraduate agricultural programs from 2010 to 2014

	2010	2011	2012	2013	2014
Male	131	148	185	200	253
Female	91	102	122	149	203

VII – Conclusions

The Australasian region is located at the edge of Southeast Asia, a region undergoing transformational change as rapid population increases, urbanisation and the emergences of a more wealthy and discerning middle class. This has resulted in an increased awareness about issues such as food security and safety. The implications for the Australasian region as a provider of food and ter-

tiary education are in the process of being recognised with some changes in public perception of agriculture and policies related to education evident. There are now early signs that this is actually translating into higher numbers of students enrolling in agricultural courses and degrees.

Agriculture remains an important part of the regional economies, including Australia and New Zealand. These two countries have the capacity and the natural resources to increase agricultural production and to satisfy some of the foreseeable increases in demand for skilled graduates. They also have the governance and institutional infrastructure that will allow them to act as educational hubs for the region. To capitalise on these opportunities will require communication, strategic partnerships, innovation and continous curriculum reform.

We now live in an age where on-line delivery, blended learning[1] and flipped classrooms[2] have become mainstream. As our external environment changes, so will our responses. For instance, many employers have highlighted the need for a generally better educated workforce, but not necessarily to degree level. In many industries there is a shortage of staff with practical, technical skills that are required to perform in modern and often high-tech workplaces. In addition to industry-specific skills, required competencies includes computer skills, core STEM skills, knowledge and appreciation of OHS standards and procedures, a better understanding of legal and financial issues, as well as marketing (Deloitte, 2014b). Many workplaces have now embraced the concept of life-long learning and are keen for their staff to upgrade their skills and qualifications regularly. This ranges from short, one-day courses to intensive and highly specialised programs. The Vocational Education and Training (VET) sector (Government, 2015a) needs to be better integrated with the curriculum of universities. Satisfying market demands in the pre-degree space might also create pathways for a future university education. We have now moved to a situation where the role of a university in providing tertiary education in agriculture has become multifaceted demanding maximum flexibility from staff, curriculum developers, industry and students. Universities can raise to this challenge if they are willing to cooperate and show agility in the way they engage with each other and with their communities in order to address the issue of highest societal importance: how to feed a growing population sustainably, efficiently and effectively.

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[1] Units where a portion of the traditional face-to-face instruction is replaced by web-based online learning.
[2] A pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

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