CENTRE FOR POLICY DEVELOPMENT

discussion paper

From vicious to virtuous cycles: a sustainable future for Australian agriculture

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Front cover image: *'Lana', Uralla, NSW. Image courtesy of Tim Wright.*

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The success and vision of farmers who have embraced regenerative land management practices highlights vast potential for a more productive and sustainable future for Australian agriculture.

The July 2015 *Agricultural Competitiveness White Paper* (the White Paper) makes it clear that the competitiveness and sustainability of Australia's agricultural sector will be pivotal to our future growth and wellbeing.

Agriculture is becoming ever more important as the mining boom recedes and as transformational change in Asia creates a new wave of opportunities for our rural commodities and communities.

> ***The underlying resource base of Australian agriculture has been gripped in a cycle of decline for decades.***

An agricultural sector that prioritises value over volume can make a lasting contribution to Australia's growth and prosperity. This would offer a new and sustainable competitive edge for Australia's food and fibre products, while entrenching Australia's farmers as effective and trusted stewards of Australia's treasured landscapes, natural resources and ecosystems.

There is disconnect between these exciting opportunities and the environmental, social and economic trends evident in past and present performance. The starting point for this discussion paper is a harsh reality: the underlying natural resource base of Australian agriculture has been gripped in a cycle of decline for decades.

The commodity markets in which Australian agriculture competes reward firms that deliver high-volume, low-cost produce to consumers, but are largely blind to the condition of the vital soil, water and other ecological resources that underpin agricultural production. The illusion of abundance masks a self-reinforcing long-term decline in the very natural resources upon which the sustainability of agriculture depends.

To make ends meet in a period of volatile prices, variable output and weakening resource condition, many farmers are compelled to adopt or persist with practices and technologies that maximise near-term production at the expense of further depletion of natural resources. We describe this as the 'vicious cycle'.

The operation of this cycle over several decades has meant that individually rational and well-intentioned producer, supply chain and consumer decisions have added up to collective outcomes that unwittingly, but systemically erode the environmental, human and social resources needed to sustain a thriving agricultural sector.

This discussion paper envisions another way: a strategic future for Australian agriculture that embraces a virtuous cycle.

By opening up markets for agricultural goods and practices that maintain or increase primary resource condition, Australia can reverse a negative cycle of declining resource condition while safeguarding competitiveness and productivity.

This is not a task solely for Australia's farmers. It is a challenge they share with processors, investors, retailers, financial services suppliers, policy makers and ultimately consumers, all of whom have a role to play to support the market-driven mainstreaming of sustainable products and supply chains.

This discussion paper envisions another way: a strategic future for Australian agriculture that embraces a virtuous cycle.

Market forces that can generate value-driven competitiveness and virtuous cycles in agriculture are already emerging.

On the demand side, global firms attuned to societal trends and capable of leading transformational change have shown a determination and capacity to promote sustainability. Major brands including Unilever, Puma and Patagonia are striving to include environmental and conservation attributes in their sourcing of agricultural products, creating exciting opportunities for sustainable producers.

On the supply side, leading-edge farmers in Australia and elsewhere are demonstrating that healthy, biologically-diverse native ecosystems can be utilised to produce conventional agricultural commodities sustainably and profitably.

These 'first practice' techniques show immense early promise for delivering a range of private and public benefits, including increased soil health and biodiversity with minimal reliance on inputs.

If these approaches can be substantiated, supported and scaled up – and the development of new sustainability-focused innovations can be systematically encouraged – these leading-edge farmers and those that follow can support major positive change towards a more sustainable agricultural sector.

While the potential is clear, more needs to be done to build on the early success of first practice. This discussion paper suggests **three key policy priorities:**

Building the evidence base. Research to validate and characterise the productivity and sustainability potential of 'first practice' techniques is consistent with the Government's research and development priorities and would provide a strong platform for wider adoption and standard setting.

Leveraging the leaders. Government can support the adoption of first-practice techniques by 'fast followers' by providing contestable funding pools for emerging projects and partnerships between first-practice entrepreneurs and ecologically-minded firms, and connecting networks of farmers, retailers and stakeholders.

Measuring what matters. Developing accounting standards and national accounts frameworks that accurately reflect the value of natural resources, together with indices to track resource condition, will strengthen the information and incentives needed for better market-led outcomes.

CPD presents these recommendations as guideposts for a broader shift in Australian agriculture towards techniques offering stronger and more sustainable environmental and economic outcomes. Such a shift would capitalise on exciting opportunities to improve Australia's competitiveness and international standing as a leader in agriculture.

The time for seizing the potential of the virtuous cycle has arrived.

Introduction

The Australian Government's *White Paper on Agricultural Competitiveness* (the White Paper) emphasises the major opportunities that projected growth in global food demand will create for Australian agriculture, provided that Australia can maintain competitiveness and productivity.[1] But these opportunities are arising at a time when pressures from land degradation, loss of crop and ecological diversity, the energy intensity of agriculture, competition for natural resources and broader threats such as climate change place increasing pressure on agricultural productivity in Australia and globally. In the longer term, maintaining a competitive position and supporting further productivity growth in agriculture depends on Australia's ability to manage the natural resources that are the basis of those production systems. The Australian agricultural sector will have to transition from a vicious to a virtuous cycle. This discussion paper aims to accelerate that trajectory.

Agriculture directly contributes about 2 per cent of Australia's GDP, but its impact and reach extends well beyond its direct contribution to national production and wealth creation.

Agriculture accounts for 53 per cent of Australia's land mass – a total of 406 million hectares – and uses 65 per cent of consumed water.[2] A wide range of Australian businesses that operate far beyond the farm gate are dependent on agriculture. These include the farm-input sector (comprising industries that supply chemicals, transport, storage, wholesale trade and business services) and the farm-output sector (food retailing, accommodation, cafes and restaurants, food and clothing manufacturers). Collectively, the farm-input sector comprised about 1 per cent of Australia's GDP in 2005 and the farm-output sector about 8 per cent.[3] Australia's four largest banks have combined exposure to farming over $100 billion,[4] while agriculture has a major presence in the portfolios of a range of investment and hedge funds. Agriculture is also integral to Australia's trade and global economic standing, making up almost 15 per cent of Australia's total merchandise exports.[5]

These deep connections mean that flow-on impacts from farm productivity, earnings volatility and resource condition have significant economic, financial and cultural implications. A strong, prosperous agricultural industry is deeply embedded in the national psyche as well as the national economy.

Value versus volume

Agriculture has much to offer as Australia's economy transitions towards a more stable and sustainable footing after the volatility associated with mineral resources-driven growth in recent years.

In the medium term, the economic development and urbanisation in Asia that underpinned rapid increases in demand for Australia's mineral resources will support sustained growth in incomes and consumption. This will create large new markets for high-value agricultural products and manufactured goods and services.

Despite its economic significance, the Australian agriculture sector is never going to be large enough to pick up the economic slack as the mining boom recedes. Nor will it be large enough to feed the growing middle class in Asia.

> ***A thriving modern agricultural sector that leverages Australia's position as a producer of premium agricultural produce could be a major source of strength.***

A thriving, modern agricultural sector that leverages Australia's position as a producer of premium agricultural produce could be a major source of strength, provided we are able to respond to new opportunities and remedy far-reaching trends that threaten the viability of farming practices globally.

To achieve this, our focus needs to be on value, not volume. Growth in global food demand is expected to expand significantly. But compositional changes in the type and quality of produce sought, and the ability of the global agricultural sector to meet these growing and changing patterns of demand sustainably, will be equally crucial drivers of the future of agricultural trade.

On some estimates, there is almost 20 per cent more food available per person now than there was three decades ago, nearly 30 per cent more calories per person per day than necessary, and as much as one third of food produced globally (1.3 billion tonnes) is lost or wasted each year.[6] Emphasising value and sustainability is a logical approach in a sector where value-based positioning will be a growing source of competitiveness and where constraints from natural resource degradation will be increasingly binding.

This paper does not suggest value and volume are binary trade-offs. Developing the technologies, innovations and expertise to increase the productive capacity of land where it is feasible and sustainable to do so is a key part of the challenge, domestically and abroad. On the other hand, simply striving to maximise near-term output in a manner that overlooks major opportunities in value-driven market segments and undermines the

productive capacity of the resource base is a recipe for long-term erosion of Australia's competitive edge.

A 'dining boom' that is based around agricultural production methods that do not match the rate of regeneration of resources to the rate of harvest of produce would ultimately be as extractive and unsustainable as mining.

A more sustainable future

Reversing the long-term decline in the natural resources that support agricultural production will not be easy. As the White Paper notes, the extremely slow rate at which soil forms and regenerates means it is "essentially a non-renewable resource".[7] Natural water, ecosystem and biodiversity resources are also highly vulnerable to long-lasting damage or permanent destruction. Historical and contemporary land management practices, driven by markets that do not adequately value the underlying resource base, have contributed to erosion, high salinity and other forms of degradation that fundamentally compromise sustainability. This adds to existing challenges stemming from the relatively nutrient-poor nature of Australia's weathered soils, our highly-variable climate, and our particular exposures to the longer-term impacts of climate change.

However, Australia is at the threshold of a better way.

Our growing understanding of the limits of historical land management practices, and their detrimental on- and off-farm impacts, is coinciding with increased awareness of the benefits of preserving or enhancing the operation of natural ecosystems and regenerative cycles within land management practices. This is happening at a time when local and international markets for high-value and sustainably farmed produce are growing, and the opportunities associated with the re-generative potential of agriculture are becoming more widely understood.

The challenges this presents are threefold. First, to demonstrate and verify the performance of innovative farmers who constitute the vanguard of sustainable practices. Next, to encourage and channel incipient demand for these products by supporting better information and price signals. Finally, to help these forces to converge through the development and penetration of high-value supply chains to redirect Australian agriculture on a sustainable path through the 21st century.

About this discussion paper

Innovative Australian firms and farmers are responding to the pressure of resource depletion and the opportunity of value-focused, sustainability-conscious markets. These firms and farmers are adopting innovative, ecologically intense production models that place natural resource productivity and sustainability at the core of their business. As in any market or sector, the successes and failures of these cutting-edge visionaries and early adaptors will play a key role in defining new product classes and techniques as markets for sustainably produced agricultural production grow.

The nature of first practice means these farmers are somewhat removed from mainstream practice and policy. While other publications such as the White Paper rightly address the issues being faced by the majority of producers and agribusinesses, this discussion paper focuses on some of the opportunities emerging among the visionaries of agriculture and business. It is informed by the view that disconnection of social networks, low levels of industry knowledge about the value of ecosystems in agriculture, impediments in the supply chain and the lack of financial capital to prove, characterise and develop markets for first practice concepts are significant barriers for firms and farmers at the forefront of these emerging trends.

From vicious to virtuous cycles strives to highlight the exciting opportunities that exist for first practice approaches and how they might be mainstreamed. Above all, it seeks to prompt discussion about the policy alternatives that might support the development of innovative agricultural business models and supply chains that place natural resource condition and sustainability at the forefront of contemporary and future practice.

Agriculture is in the grip of a vicious cycle

The continued degradation of soils and vegetation is a major threat to production and sustainability in Australian agriculture.

Amidst the goodwill towards Australia's productive landscapes, clever farmers and strong agricultural research sector, there is often a lack of recognition that the underlying resource base of soils and biodiversity has been gripped in a cycle of decline for decades (Box 1). This cycle must be corrected if we are to maintain international competitiveness and take advantage of the opportunities on our doorstep in the decades ahead.

Box 1: Signs of declining resource condition in Australia

- 35 per cent of Australian agricultural land is degraded due to over-grazing and cultivation.
- Soil is being lost at thousands of times the rate at which it is created.
- Over the last 20 years the amount of land in production has declined at a rate of 9 per cent per year due to urban encroachment, land use change to mining or conservation and abandonment of land.
- Sub-soil acidification is already threatening productivity in large areas of important cropping soils and is regarded as too economically inefficient to reverse.
- Only 6 per cent of Australian landscapes are suitable for cultivated crops and pastures, and there is significant competition for use of this land for energy production, creating tensions between food, fibre and energy.

Sources: Australian State of the Environment Report (2011), ABS (2014) and Von Braun et al (2013).

Agricultural commodities are produced by transforming sunlight, rain and reserves of soil-water and nutrients into crops and fibre for sale or pastures to produce livestock. The structure of soil and the quantity and quality of soil-water and nutrient reserves affect growth, health and survival rates of crops and livestock, as well as influencing their ability to withstand disturbance by pests, diseases and bad weather.

Productivity and profitability are affected not only by yields, but by the ability of the landscape to capture and retain these resources. Landscapes with primary resources in good condition are more reliable at capturing, retaining

and cycling vital resources such as water and nutrients and producing reliable forage and feed for livestock.[8] This means they can produce more with fewer inputs, making them more profitable and resilient, especially in difficult conditions such as drought.

Alternatively, a low capacity to capture and retain water increases farmers' relative reliance on regular rainfall and purchased inputs. Reduced soil health and biodiversity also narrow the range of rainfall and temperature that crops and livestock can thrive in. Without these buffers, income and operating expenses are significantly exposed to uncontrollable environmental factors, especially as input prices increase. Without healthy soils and reliable grasslands, farmers struggle to put enough aside in good years to be able to withstand droughts and replenish the resource base (for example, by using inputs like lime to reverse soil acidification).

Maintaining output growth despite resource decline

Productivity in Australia's rural sector has significantly outperformed the market-sector average since the beginning of the 1990s, despite pressure from declining resource condition, and year-to-year fluctuations due to drought and other factors. This has been supported by major economy-wide reforms and deregulation of agricultural policy that encouraged competition, greater efficiency in resource use and decision-making that is more responsive to market forces.[9]

> ***Measures that can sustainably improve both productivity and ecological outcomes will be crucial to meeting the opportunities for Australian agriculture in the Asian Century.***

Coupled with new technologies and farming practices, these changes have allowed the agricultural sector to maintain strong (although slowing) rates of productivity growth despite the declining condition of underlying resources. The White Paper estimates that almost two-thirds of the value of broadacre agricultural production in recent years can be attributed to productivity improvements – with almost two-thirds of that productivity growth underpinned by public investment in research, development and extension.[10] Ingenuity in developments related to intensification, logistics, fertilisers, crop and animal genetics, herbicides and pesticides in Australia and globally has enabled steady decreases in price and increases in availability of produce.[11]

Measures that can sustainably improve both productivity and ecological outcomes will be crucial to meeting the opportunities for Australian agriculture in the Asian Century. Improving output and yields where it is sustainable to do so will be an important part of servicing these markets. But to deliver on this promise, we will need to overcome the cumulative impacts

of decades of degradation – including degradation that has stemmed directly from practices designed to temporarily overcome the impact of declining resource condition on farm productivity. Many of these practices – including increased fertiliser use, legume rotations, and annual pastures – actually make the underlying problem worse through negative side effects such as increased subsoil acidity, soil erosion, salinity, and biodiversity loss above and below ground.[12] Where degradation (e.g. soil acidification and structure decline) can be compensated for by soil additives and where the purchase price of the additives is low, output and economic returns can increase – albeit unsustainably – even while the resource base declines. As we have seen, these short-term remedies contribute to a misleading picture of the real sustainability of Australia's agricultural sector.

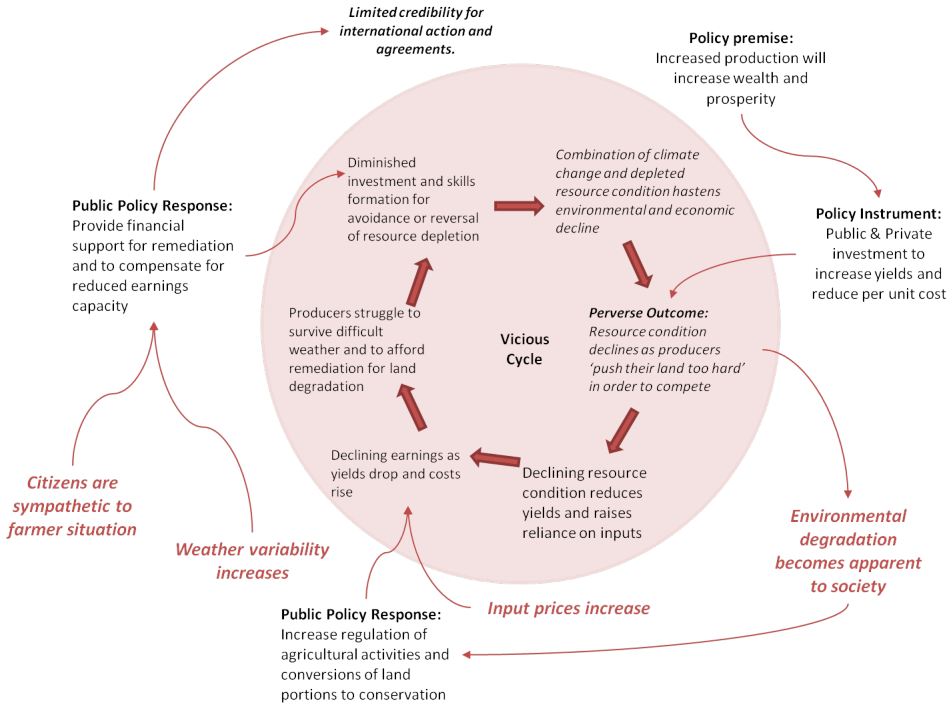
> ***Where price and availability are the dominant means of competition, and resource condition is invisible, participants in global commodity markets have no incentive to address fundamental issues of resource decline.***

Characterising the vicious cycle

Australia's historic strengths and relatively strong recent productivity performance in agriculture are illusory as a guide to the sector's future prospects. The harsh truth is that agriculture is, and has been for some time, in a global vicious cycle which threatens to undermine its contribution to Australia's growth and prosperity and to the stewardship of Australia's landscapes and natural resources.

The diagram below highlights the causal links that make up this vicious cycle.

Figure 1: The vicious cycle



The vicious cycle gripping agriculture is well-known to ecological economists as a phenomenon of commodity markets that rely on natural systems. Market prices in commodity systems are a reflection of production and distribution costs, variability of demand, intensity of competition and availability of substitutes. The vicious cycle arises because the condition of the primary resources that enable agricultural production are not adequately valued in the global commodity markets in which Australian agriculture competes. Where price and availability are the dominant means of competition, and resource condition is invisible, participants in global commodity markets have no incentive to address fundamental issues of resource decline. In fact, they have an imperative to keep increasing volume due to price reductions and to cut back on investment in resource replenishment to maintain earnings. They are compelled to do this to stay afloat, even if the primary resources that underpin production demonstrate decline.

The invisibility of resource condition in agricultural commodity markets – combined with the vast and deep supply chains for agricultural produce – means that individually rational and well-intentioned decisions by producers, other actors in the supply chain and consumers are adding up to collective behaviour that systemically erodes environmental, human and social resources.[13] This problem is not unique to agricultural markets, but is particularly visible in a sector that is at the front line of natural resource management in Australia.

Compensatory financial schemes are relatively inefficient ways of translating citizens' sympathy for farmers into long-term solutions.

In practice, the vicious cycle manifests on the production side of the market as causal linkages between downward pressure on agricultural commodity prices, resource depletion and lower and more volatile economic returns. These impede innovation and replenishment of the resource base. At Commonwealth and State level, Australian governments have responded to this by offering financial services such as farm management deposits or concessional loans to compensate for earnings volatility. These schemes have some merit, but are observed to have the perverse outcome of enabling uncompetitive producers to persist rather than inducing innovation and change.[14] Where producers can survive in part through being insulated from the effects of depletion of their private resources, patterns of management do not change and resource depletion continues, perpetuating unsustainable land management practices and financial pressures. As such, compensatory financial schemes are relatively inefficient ways of translating citizens' sympathy for farmers into long-term solutions.

Continued degradation of productive agricultural landscapes is a by-product of attempts to boost income in the current period. This is a consistent and quite rational pattern under the current market structure. Like any business, farmers continually face tensions between maximising current earnings and preserving or investing in capital or resources that can be used to support future incomes. In the case of agriculture, attempts to protect current earnings and manage financial pressures may come at the expense of resource degradation that compromises the productive capacity of farmland into the future.

The pronounced year-to-year volatility of yields, costs and earnings – heavily influenced by the high variability of Australia's climate – exacerbates the short-term financial challenges faced by famers (Box 2). The Australian Farm Institute estimates that over the past four decades, agricultural output has been almost two and a half times more volatile than the economy-wide average, with Australian farmers experiencing greater volatility in yield and price than most other farmers in the world.[15]

This volatility is itself exacerbated by declining resource condition, and is likely to become even more pronounced as the impacts of climate change intensify. To illustrate: grasslands and pastures that change from being dominated by perennial grass to being dominated by annual grasses become more dependent on favourable weather conditions, causing yields to fluctuate. Soils with declining levels of organic matter, beneficial soil organisms and pest-predators show greater volatility of crop yields and more frequent crop failures. And degraded soil with less water-holding capacity results in farming systems that are much more dependent on the timing and volume of rainfall.

Pressure to maintain competitiveness in international markets reinforces the operation of the vicious cycle. Australian agriculture competes against countries with naturally younger and more fertile soils, including some that use extensive deforestation to convert highly fertile areas to agriculture. Australian farmers who rely on increasingly expensive energy-intensive chemicals and additives to overcome deficiencies in soil and biodiversity face a competitive disadvantage. This is now being seen in declining terms of trade for farmers whose prices received have been in a long term decline relative to the cost of inputs,[16] and reductions in Australia's share of global markets.[17]

Box 2: Financial pressure and earnings volatility on Australian farms

- Volatility in yearly output in agriculture over the last 3 decades was more than 2.5 times the average for all other industries.
- Droughts reduced agricultural output by 25 per cent, productivity by 17 per cent and real agricultural incomes by 50 per cent.
- There has been downward pressure on agricultural commodity prices over 40 years.
- Agricultural debt has grown from 22 per cent of annual production in 1980 to 91 per cent in 2013 (after peaking at 113 per cent in 2009).
- The proportion of cash income used to repay loans increased from 6 per cent in 2000-2001 to 11 per cent in 2006-2007, before easing to 9 per cent in 2011-2012.
- The last three droughts reduced Australia's GDP and employment growth by 1 per cent and negatively affected multifactor productivity growth (MFP) by 1 per cent, around half of the market sector MFP growth.

Sources: Productivity Commission 2005 and 2014

In the longer term, these trends represent a potential threat to the attractiveness of Australian agriculture as an investment opportunity, as well as a material risk to existing lenders and investors in agriculture. Australian agriculture is already perceived by some investors to be at relatively high (and increasing) risk due to climate change. Land degradation on top of climate impacts increases investment risk and makes the prospects of regeneration of land condition more uncertain.

As this vicious cycle continues, positive appearances such as abundant agricultural output and declines in the per unit price of produce are apt to mislead consumers, citizens and policymakers about the state and performance of the underlying resources base. Far from indicating a sustainable basis for current production methods, these are being delivered through technological innovations that overcome limitations imposed by the declining resource base and near-term financial pressures (Box 3). These positive appearances also rely on increased market concentration that maintains earnings through the realisation of economies of scale. Meanwhile, resource degradation contributes to the earnings volatility that undermines the ability of farmers to invest in skills, innovations and techniques to avoid or reverse resource depletion and enhance sustainability over time.

Box 3: Confined animal feedlot operations

Increasingly, farmers have been overcoming these challenges by adopting confined animal feeding operations (CAFOs). Developments in technologies for animal housing, feed preparations and livestock genetics to enable CAFOs have enabled farmers to use stored feed (from grain production) to reliably and cost-effectively produce a consistent product at an attractive profit margin. By being able to supply a consistent product all year round and reduce labour intensity, they improve their ability to supply Australia's major supermarkets and exporters. In this way, CAFOs make a significant positive impact on the economic performance of the supply chain.

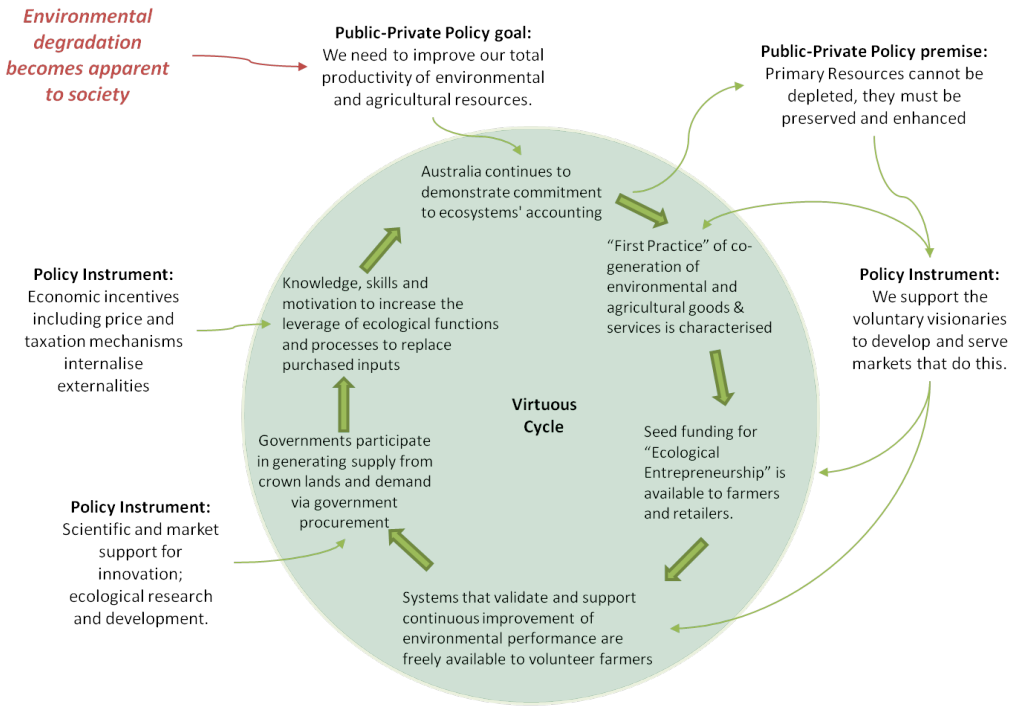
However, because CAFOs are reliant on annual crops for feedstock, their increasing use without a corresponding transformation of grain production practices may have the unintended and undesirable consequence of accelerating the loss of soil health and biodiversity. There may be human health impacts as well. Studies of changes to nutrient characteristics of meat produced in CAFOs compared to that produced on diverse perennial grasses, indicate that these production methods change the characteristics of important nutrients such as fatty acids to create a less healthy food. (See for e.g. Picket (2012) and Ponnampalam et al (2006).)

A virtuous cycle is emerging – Australia must step into it

Australia should help the visionaries amongst our brands, processors, investors and farmers to develop and serve markets for agricultural goods that maintain or increase primary resource condition. This would put Australia's agricultural resources into a virtuous cycle. 'Ecological intensification' in agriculture – that is, transition to systems that use land, water, biodiversity and nutrients in an efficient and regenerative way[18] – would help to improve Australian agriculture's competitiveness and enhance the condition of the resource base. This is necessary and achievable and would be a pragmatic recognition of the opportunities emerging from better knowledge of the private and public value of natural resources and the risks of depleting them.

The diagram below outlines the main features of the virtuous cycle that Australian farmers and stakeholders can and indeed must be part of. The virtuous cycle highlights the pivotal role for our leading farmers who are trailblazers. If their vision, capabilities and aspirations can be translated across the sector, with support from governments, investors and other stakeholders, then Australian agriculture can ride an enduring wave of prosperity.

Figure 2: The virtuous cycle



The markets of the virtuous cycle are already developing

Increasing global awareness of social and environmental sustainability challenges is supporting the development of sustainability-conscious markets. These are providing new opportunities and advantages for enterprises that deliver improved environmental and social performance as part of their goods and services.

Support may be particularly strong in Asia, which is likely to be a major source of increased demand for Australian agricultural goods as population and income growth fundamentally changes the region's demand for quality agricultural products. Consumer surveys show that in China, which could become the single largest middle-class market in the world by 2020,[19] there has been a sharp rise in demand for responsible product offerings across many industries, with agriculture topping the list.[20] Broader surveys suggest the Asia-Pacific region leads the world in terms of consumer willingness to pay more for socially and environmentally responsible goods, with demand for eco-friendly products particularly high among young consumers.[21] Even if Australia can capitalise on a fraction of the rapidly increasing demand for sustainably and ethically produced food and fibre, especially in our region, we will be immeasurably better off.

> ***Surveys suggest the Asia-Pacific region leads the world in terms of consumer willingness to pay more for socially and environmentally responsible goods.***

As these trends take hold, private sector sustainability policies will become more exacting, creating exciting new opportunities for producers to form partnerships with progressive companies and brands. Companies are becoming more adept at thinking about sustainability in broader contexts. Many are moving from addressing single issues such as toxicity or pollution to more complex and holistic concepts such as corporate social responsibility, shared value and natural capital. Advances in communications and information technology mean practices that sustain the agricultural supply chains of leading companies are becoming more visible to their customers – including in a literal sense through the advent of satellite imagery and drone technology. This presents the very real prospect that customers and investors can see for themselves whether their suppliers are restoring landscapes. The use of social media means dissatisfied customers can spread the word rapidly and widely. These two factors are combining to generate conditions where the markets will only be satisfied by genuine results.

Leading brands recognise and act on the aspirations and motivations of influential customers. Young people have always been an important market segment for brands because loyalty created early in life can be persistent

and influential. With the most to lose from the consequences of resource depletion, they are putting increased pressure on firms to reverse environmental and social damage. So too are discerning consumers across the age spectrum. The 'sustainability filter' is becoming pervasive. Firms who are attuned to societal trends and capable of leading transformational change are showing increased determination and capability to address sustainability,[22] particular in the food and beverage sectors.[23]

Some companies are becoming more proactive in instilling sustainability considerations into the 'psyche' or automatic expectations of customers. For example, Proctor & Gamble has reset its sustainability goals and increased its marketing effort to communicate the reasons why the consumer should choose higher sustainability products.[24] Some of the world's top public relations companies have ruled out working with companies that deny the existence of climate change.[25]

Major brands, including Unilever, Puma and Patagonia, are building marketing momentum on the back of their sophisticated assessments of primary resource condition and valuation in their sourcing of agricultural products. Puma has gained significant credibility by estimating publicly that the leather it sourced from Australia created an environmental loss of €11.5M in the 2010 financial year.[26] Puma appeals to its consumer base by promoting its own efforts to develop more sustainable alternatives, such as by reducing its use of leather, wool and cotton in preference to textiles created from recycled plastic. McDonalds has shown determination to act on climate change by identifying that two-thirds of its carbon foot print is from its supply chain, with livestock the biggest emitter.[27] McDonalds is supporting the actions of the Global Round Table on Sustainable Beef to reduce livestock emissions and address other sustainability problems.[28]

Financial institutions, investment houses and the broader services industries have become increasingly involved at all points of the agri-food system.[29] In recent years, hundreds of investment entities have been established for the purpose of investing in farmland throughout the world.[30] The condition of natural resources is increasingly recognised as a material issue for the private sector, not only for agriculture and primary processing, but for much of the services industries as well.[31] The financial industry recognises its influence in natural resource condition and has formed a global institutional commitment to making that influence a positive one.[32] In Australia, the National Australia Bank (NAB) has taken a leadership role in this area, including through moves to take environmental management into

account when making credit assessments in the agriculture sector. Internationally, groups such as the Natural Capital Coalition are advocating prominently for a positive role for business in enhancing natural capital, including by developing new methods for natural capital valuation and accounting methods.

With increasing risks in other investment categories, a lower risk and reliable agricultural investment is becoming an important part of the portfolio of pension and superannuation funds and other forms of long-term capital, including sovereign investment for future food security. Sustainable Land Management Partners (SLM Partners), an asset manager that acquires and manages rural land on behalf of institutional investors, is one example of an organisation capitalising on opportunities to make long-term investments that enhance both profitability and sustainability. By increasing the ecological resilience of its landscapes and matching production to carrying capacity, SLM Partners is able to significantly reduce volatility of earnings from agricultural investments.

Intensification of ecological functions can deliver immense benefits to farmers and society.

Similarly, brand-building that differentiates according to sustainability attributes is emerging in the food market. Many commentators on sustainable food production and purchasing are already recommending significant reductions in meat production and consumption (especially grain-fed beef) because of the negative environmental and health effects of intensive grain production and COFAs.[33] Livestock production can be a significant contributor to a 're-greening world'[34] as well as supplying a healthy and popular food category, but only if it regenerates and maintains natural resources such as grasslands, savannahs and grassy woodlands. The path it takes depends on the signals from the markets.

Pressure on governments and the private sector to support accelerated transformations towards sustainable agriculture is likely to increase, not subside.[35] Wise companies get on board early to influence change, gain time to adapt and access leading edge knowledge and support programs.[36]

Significant win-win opportunities exist

Improved primary resource condition can deliver both public and private benefits. With recent local and international advances in the fields of ecology and ecosystem services, it is apparent that intensification of ecological functions can deliver immense benefits to farmers and society.[37] Improved soil health, biodiversity and quality of land management can significantly reduce the reliance on expensive inputs and vulnerability to

unfavourable weather, pests and diseases.[38] This reduces operational cost, risk and the volatility of earnings, which is particularly crucial for farmers who have borrowed to purchase land or other assets. These factors are also important to investment funds that have to meet commitments to investors.

A growing number of studies from around the world demonstrate the economic benefits of ecological intensification to agricultural productivity and profitability, even in current conditions of relatively cheap fuel and more moderate initial impacts of climate change.[39] This suggests the benefits of ecologically intensive agriculture are likely to increase in time as the impacts of climate change intensify.

Improved soil health and biodiversity also provide a range of public benefits[40] including positive effects on human health,[41] improved water resources and improved landscape amenity, including for tourism. Soil health and biodiversity are also important elements of a healthy, adaptive resource base for future novel forms of agricultural production such as biofuels[42] or using plants for remediation of polluted sites or the remnants of mining and minerals exploration.[43]

Australia already has leading capabilities

Australia can be a global leader in sustainable agriculture. As recognised in various reports and case studies including the *Communities in Landscapes* report under Caring for Our Country, leading Australian farmers have demonstrated they can produce very healthy, biologically diverse native ecosystems and use them to sustainably and profitably produce conventional agricultural commodities.[44]

Some Australian farmers have played a leading role in developing and demonstrating dryland management that increasingly substitutes ecological functions for anthropogenic inputs. These farmers, though relatively few at this point, are poised for rapid ecological intensification should the market turn towards this. A growing number of graziers from the high rainfall to the semi-arid zones have been altering grazing management practices to increase perennial grass density, size and species richness and encourage natural regeneration of widely spaced paddock trees.

Case studies in first practice

Case studies of the effect on economic performance of farmers who have adopted first practice techniques show that when nature does more of the work for free, farm profits improve.

> ***First practice techniques show that when nature does more of the work for free, farm profits improve.***

Tim and Karen Wright near Uralla in NSW made a deliberate decision to invest in ecological capital by changing livestock grazing in order to increase the quality, size and density of perennial grasses and the native plant component of the paddocks. This has increased their stock numbers and improved calving and lambing percentages whilst reducing the need for supplementary feeding and veterinary medicines. The changes to grazing management have made the Wrights' animals calmer and easier to work with. The combination of these small-scale reforms has dramatically improved the farm's labour efficiency. In addition to dramatic reductions in operating costs, concurrent increases in wool yields and quality have resulted in a gross profit per hectare for the enterprise. Importantly, the Wrights' profits are consistently and significantly higher than published benchmark figures for the region.[45]

Gilgai farms and Winona in the Central West of NSW changed cropping practices to increase recruitment and development of perennial grasses whilst continuing to produce crops when conditions were suitable. This reduced farm expenses by more than 50 per cent for a net improvement in gross margin per hectare of 30 per cent.[46] Similar results have been confirmed in the northern savannahs, where researchers have empirical evidence that sustainable grazing management that maintains landscapes in top condition is essential for optimizing medium to long-term profit.[47]

By supplying beautifully crafted woollen garments, **Woolerina and Glenwood Merino** give consumers the opportunity to support the virtuous cycle. Glenwood Merino near Wellington are recognised in the Communities in Landscapes project[48] and the 'Target 100' sustainable agriculture program[49] for demonstrating that farms can combine high conservation values, economic productivity and exemplary animal welfare. Woolerina supports the virtuous cycle by exclusively selecting wool of high quality that is produced from land in good condition.

Key actors in the financial sector are also taking a more active role in funding a stable and sustainable global economy. In Australia, NAB aims to reward farmers who have better environmental practices with better credit ratings for financial products. By introducing better prices for lending to managers

who improve land condition, NAB has made an important step into the virtuous cycle.

Confirmation that improved environmental performance can improve economic results is a necessary but insufficient condition to shift Australian agriculture to a virtuous cycle. It can only be truly established when the entire supply chain shares responsibility for maintaining or improving resource condition (Box 4).

Box 4: First practice farmers, retailers and financial services

First practice farmers:

- Use fertilisers more efficiently because they have better soil fertility
- Have less soil acidity and salinity
- Have softer soils that provide favourable conditions for infiltration of rainfall and better plant growth
- Have higher biodiversity and more native plants and animals in their landscapes
- Use exemplary animal welfare and management practices to achieve high levels of productivity
- Have lower operating costs and lower variability in yields
- Are highly economically efficient

First practice retailers:

- Supply food and garments from first practice farmers
- Pay a fair price for the primary goods so that the farmer can afford a lifestyle comparable to that enjoyed by the customers.
- Inform citizens of the advantages generated by improved condition of agricultural resources for them and their descendants
- Provide opportunities for citizens to 'vote with their wallets' and stimulate the virtuous cycle

First practice financial services:

- Assess whether the natural capital – the underlying agricultural resource base – can support the economic returns required by the business
- Identify financial risks associated with environmental degradation
- Can detect and avoid situations where meeting economic obligations in the current period would degrade agricultural resources in future periods
- Enable financing of long-term ecological infrastructure investments to create productive ecosystems that generate flows of goods and services

Box 5: Additional case studies: first practices in Australian agriculture

First practice livestock management and cropping techniques include low cost methods to increase the presence of actively-growing perennial grasses. This increases regenerative capacity and reduces earnings volatility and financial risk.

Near Mudgee, NSW: A technique called Pasture Cropping, developed by Colin Seis and Darryl Cluff, reduces fertiliser use and increases soil fertility for mixed cropping and grazing operations. It also improves livestock performance, particularly the quality and clean yield of wool. The value of this has been conservatively estimated as improving profitability by 27 per cent (UNCTAD 2013). Pasture Cropping and related techniques known as Cover Cropping are used widely through the sheep-wheat zones of Australia and internationally. Mr Seis was recently recognised in the Bob Hawke Landcare Awards for the significant regeneration of biodiversity and native vegetation on Winona.

Near Alice Springs, NT: "It is common knowledge that most stations in central Australia can only produce fat cattle in good seasons, however finished cattle are turned off Woodgreen every year." When Bob Purvis took over Woodgreen station, it was "a desert". He used first practice techniques of landscape rehabilitation and livestock management to reverse soil erosion and desertification. These have resulted in increased quality and diversity of native perennial grasses and shrubs, increased animal biodiversity, and improved live-weight gain and carcase quality of the cattle he produces (Walsh 2009).

Near Theodore, QLD: Shane Joyce's use of first practice grazing techniques has increased native grasses and legumes and reduced the proportion of Buffel grass, which is an introduced grass feared to be invasive. Mr Joyce has virtually eliminated soil erosion and significantly increased biodiversity by regenerating tree cover and habitat for native wildlife. This has translated into better business performance. Within five years of adopting the techniques, beef production more than doubled from 54.5 to 137 kg/ha and cost of production dropped by 20 per cent (Joyce 2000).

In the rangelands of Northern Australia: Studies of first practice techniques that match livestock numbers to the amount of grass available found that these systems were better ecologically and financially in the medium to long term than systems that maintained high numbers of livestock regardless of available grass. This can be attributed to avoidance of natural resource depletion during drought. Graziers who maintained high livestock numbers depleted their landscape resources so significantly during the drought years that their productivity failed to recover within the study period (Hunt et al 2014).

In the Grassy Gum Woodlands of Australia: Australia's Grassy Gum Woodlands are unique, beautiful and highly significant to our native biodiversity. They are found along the east coast of Australia as well as in the South West but are currently regarded as threatened by agricultural practices. A study funded by the Australian government's 'Caring for our Country' program discovered a community of first practice farmers in Australia's iconic Box Gum Grassy Woodlands who produce consistently healthier landscapes, higher biodiversity and better productivity than their neighbours (Ampt et al, 2011). It is also expected that these farmers have much greater adaptive capacity to climate change as a result of their regeneration of these highly functional and productive woodlands (Lavorel et al, 2015).

Policy approaches to scale up the benefits of 'first practice'

These leading examples of first practice suggest that such approaches, while at an early stage of development, have considerable potential. There is scope for the sector as a whole to leverage the vision, capabilities and expertise these leaders have developed, and to learn from their successes and failures. As the evidence-base builds and workable models are extrapolated from the evidence, prospects for more widespread change will open up. Though there are structural barriers to reform, there is already an appetite amongst farmers to use innovative, sustainable practices, which will grow in strength when an appropriate market or policy signals are in place. This section considers some of the important drivers and possible impediments to change. It also raises a number of policy priorities that can unlock the potential of the virtuous cycle.

> ***There is already an appetite amongst farmers to use innovative, sustainable practices.***

Barriers and complexities

There are major opportunities for propagating a more sustainable approach to Australian agricultural supply chains. However, for policy interventions and reforms to be effective, they must respond to known barriers and impediments to change.

Currently, the viability and benefits of sustainable supply chains are poorly understood. In part, this reflects the multifaceted nature of the benefits involved, which accrue both on farm (from more efficient and sustainable production) and off farm (more sustainable food, fibre and finance markets and better ecological outcomes with less negative spill-overs). Benefits also flow to government from more effective and efficient allocation of scarce public resources, with reduced emphasis on subsidies that support unsustainable farming practices.

There is also great variability in ecological drivers between different properties and geographies. These drivers are overlaid with transforming land management practices, ownership and climactic conditions, which increases the difficulty of defining prescriptive practices or methods of measuring ecological condition. The high costs of gathering, interpreting and disseminating data and evidence on these issues is further complicated by the difficulties and costs of co-ordinating efforts and establishing communication across newly-forming supply chains.

There are a broad range of economic, institutional and cultural factors that will influence the interaction of practice and policy as efforts to improve sustainability intensify. These include macroeconomic factors that influence the competitiveness of Australia's agricultural sector as well as microeconomic reform (including further deregulation, trade liberalisation and competition policy reform) that will continue to exert a strong influence on the sector. As the vicious cycle diagram depicts, shareholder expectations, debt burdens and earnings volatility can create near term barriers and risks to innovation and sustainability adaptation, while fiscal constraints across public and community sector agencies may limit investment in incentives and programs to support change. Overlaid with this is the diversity of normative beliefs and cultural values at the level of individual farmers and producers, in peak farming organisations, and across other institutions that have a major influence on land management practices.

These challenging factors mean taking concerted moves towards a virtuous cycle in Australian agriculture will be a task replete with complexity.

The role of government and regulation

Another key challenge is defining an appropriate role for government. This is an important question, given the limited historical success of pursuing top-down changes to agricultural practices and the demonstrated ineffectiveness of regulatory approaches targeted at improved resource condition.

Regulating or legislating for particular agricultural practices has major drawbacks and can cause perverse outcomes. For example, enforcement of regulations to prevent clearing of native vegetation, lease conditions that allow pastoral leases to be compulsorily destocked to prevent soil erosion, or lease conditions that require closure of artificial watering points in rangelands have, in effect, created significant and sometimes tragic policy resistance.[50] Other measures have had similar shortcomings. Support for farmers and community members to excise pieces of land (e.g. riparian areas, native vegetation) and convert them to conservation is ultimately an inefficient way of responding to public concern about land quality because it fails to address the condition of the productive areas.

At present, attempts to regulate the majority of our farmers for minimum resource condition on privately owned land as an attempt to halt the vicious cycle would be resisted justifiably on the grounds of the significant risk to their businesses and to our national competitiveness. Quite apart from

these risks, auditing and enforcing sector-wide condition standards – let alone helping the majority of farmers to achieve them – is beyond our current capabilities.

Payments for ecosystem services in agriculture are increasingly being explored as an incentive-based mechanism for encouraging farmers to deliver public benefits. Examples of incentivised ecosystem services include increasing the storage of carbon in soil, increasing biodiversity,[51] payments for increased ground-cover, supply of fencing to protect riparian areas and assistance to establish tree-belts.[52] These have been somewhat effective at improving land condition, but can be inefficient and highly vulnerable to changing funding priorities of governments.[53]

As with other interventions, those stakeholders seeking to develop an ecosystems-services approach would benefit from greater clarity and information on the effectiveness of different land and resource management strategies. This again reinforces the importance of developing the evidence base for first practices approaches that have been at the forefront of harnessing ecosystem services to improve sustainability and productivity.[54]

Policy roadmap: priorities for broadening first practice

We believe the early entrants into the supply chains that form the virtuous cycle are highly significant. The practices that they use open up the possibility of a new source of improved competitiveness and productivity growth as part of a more sustainable and innovative agricultural sector.

Despite the barriers and complexities discussed above, momentum for change has the potential to be self-reinforcing. This will only occur if the right evidence, institutional supports and market signals are in place. New practices and approaches which can demonstrate financial and ecological benefits are likely to be adopted more widely throughout the supply chain. The success of today's sustainability pioneers prompts further innovation and continual improvement, as the frontier of first practice continues to expand.

Against this background, we argue for a three-pronged policy approach to build on the progress made by today's first practice farmers. This includes: building the evidence base for sustainable practices; leveraging the leaders by connecting sustainable supply chains; and developing the broader set of metrics and techniques that can support measurement and channel price signals for sustainability as supply-side and demand-side momentum grows.

> ***'The future success of Australian agriculture depends on smarter farming practices.'***
>
> White Paper 2015

1. Building the evidence case and sustainability standards

Establishing a strong evidence base for the benefits of first practice approaches is the crucial starting point.

Emerging evidence already indicates that 'first practice' approaches are both environmentally and economically superior to the industry average, based on a solid base of early innovators.[55] So far, first practice farmers have largely been self-funded and unsupported in developing the techniques, experience and knowledge that is now being recognised as having great potential for delivering stronger financial outcomes and improved resource condition.

To take first practice to the next level, **the government should provide targeted financial support for programs to research and verify first practice approaches.** There is a strong case for targeted government support for verification programs and research that can track and demonstrate the financial and ecological potential of first-practice supply chains and financial services. Under recent research priorities, however, this area has been under-researched due to lack of returns for private sector

research and development, and the significant paradigm shift this represents for current agronomic and agricultural science.[56]

The potential of first practice and revised research priorities requires Australia to invest purposively in scientific research, modelling and marketing plans for the following purposes. First, to use 'double-loop learning' to characterise, validate and raise the summit already set by the leading farmers. Second, to assist the private sector to identify company characteristics, business and marketing models that generate competitive advantage by investing in improved natural resource condition. The key is to equip people with the environmental and institutional supports for innovation, as well as the practical knowledge, that are growing around increasing demand for sustainable products. This is needed on farms and throughout the supply chains.

Funding programs to build the first practice evidence base can contribute to three broader priorities: (i) facilitating greater awareness of the benefits and success stories, thus encouraging greater adoption of sustainable approaches throughout the supply chain; (ii) supporting the development of more effective voluntary industry standards and laying a longer-term platform for effective regulatory approaches; and (iii) guiding the design of other tools, policies and programs (including those discussed below) to facilitate stronger market signals for maintaining natural resource condition over time.

This funding priority **is consistent with the 'farming smarter' agenda outlined in the 2015 White Paper.** The White Paper highlights the importance of improving farming practices to support productivity, competitiveness and sustainability, and highlights the strong returns from government and industry investment in research, development and extension (RD&E).[57] It also announced four key overarching RD&E priorities: (1) advanced technology (to enhance innovation in products, processes and practices) (2) biosecurity (3) soil, water and managing natural resources and (4) R&D adoption.

Targeted support for RD&E into first practice approaches would be consistent with each of these funding priorities. It is particularly relevant to the emphasis on managing soil health, improving water use efficiency and improving resilience to climate events and impacts.[58] It would also be consistent with the White Paper's emphasis on equipping farmers with the information, knowledge and techniques they need to respond to

contemporary challenges and drive better productivity and land management outcomes.

Better evidence and understanding of first practice can also aid the development of **realistic targets and standards for resource condition and land management** that are ecologically sustainable and economically profitable. As the Wentworth Group of Concerned Scientists recently argued, standards and verification schemes are crucial for making sure that information on sustainability is deployed in a way that allows consumers to make more effective purchasing decisions and ensures farmers receive a financial reward for managing their land sustainably.[59] Targeted research of the kind we argue for is crucial to ensure that standards and verification processes are streamlined to guide the longer-term development of more sustainable agricultural practices and supply chains.

As the White Paper notes, consumer concerns around sustainability and a desire to differentiate premium products have contributed to a proliferation of labelling and certification schemes. The variability of ecological literacy amongst company directors and contested stakeholder interests is causing a range of alternative environmental standards to be defined amongst the private sector and non-government organisations. The multiplicity of standards increases compliance costs without necessarily generating the best environmental or sustainability outcomes on farm, or providing the accurate information needed for the marketplaces to function effectively.

A stronger evidence base from first practice can contribute to the development of more streamlined and effective voluntary industry standards that can be implemented and verified at low cost and have the confidence of producers, supply-chains and consumers. Government support for the development of these certification standards should be augmented by efforts to engage with and influence the development of international sustainability standards and measurement techniques (Box 6).

In the longer term, as the information, skills and political capital required builds, this evidence and experience could inform the development of regulatory approaches to support and reinforce improved land management practices.

Box 6: Staying ahead of the game – trade and sustainability

Being at the cutting edge of new sustainability standards, metrics and measurement techniques will be vital for Australia's access to global agricultural supply chains.

The volume of global farm trade now exceeds $1 trillion. As agricultural trade continues to grow, the policy questions and priorities for trade in agricultural goods are evolving. Traditional questions of market access for agricultural goods continue to feature prominently (and problematically) in negotiations for major trade agreements. But as Pascal Lamy, the former Director-General of the World Trade Organisation, has observed, reduction of trade barriers is no longer the main game (FFA, 2014). The future of trade agreements arguably lies less in reforming tariffs and subsidies and much more in international regulatory convergence. As Lamy argues, the emphasis will increasingly be on "quantity, quality, availability and sustainability".

As this shift takes hold, non-tariff measures to preserve national capital and ensure sustainability will add to trade cost for those countries that are late adopters. Australia should strive to be at the front of the pack in developing the domestic expertise and capabilities it needs to influence the development of international sustainability standards – and to live up to them.

Contributing to the development of international standards that are "consistent with the biophysical nature of food and fibre production in Australia" (Wentworth Group of Concerned Scientists, 2015) will protect Australia's competitiveness and strengthen our existing reputation as a provider of high quality food and fibre.

2. Moving from first practice to fast followers

As the evidence case and business models of leading edge farmers and supply chains builds up, a key measure of success will be how new practices are broadened out from first practice to 'fast followers'.

In part, we will be able to rely on natural momentum as the productivity and sustainability case for new land management practices and business models becomes clear and well-known.

However, there are barriers to change that could slow or stall progress even as the potential of first practice innovations become more established. These include entrenched attitudes, rigid business models, limited financial resources for investing in novel approaches, the financial risk associated with changing operational practices, and difficulties connecting smaller producers with large brands and retailers looking to create more sustainable supply chains.

We argue that to supplement initiatives to build evidence on first practice, government should adopt policy options to fast-track the development of first practice models and supply chains. Such options include:

- **Contestable funding pools for supply-chain innovations**: The creation of contestable funding pools could play a vital role in supporting emerging projects and partnerships between farmers and brand leaders seeking to meet rising demand for ecologically sustainable products. Such funding could be aimed at potential fast adaptors and early diffusion, sitting between first-mover advantage and the final stage of standardised practice. A fund administered by a Board comprising experts in the field, industry groups and government representatives could call for participants to tender for practices that can demonstrate achievement of first practice metrics or guidelines as the first practice evidence base builds. Evaluations of successful projects will help to substantiate first practice approaches, while support for early adopters can help to support further innovations to supply chains, goods and services that would increase the amplitude of the virtuous cycle.
- **Government as a broker:** Governments arguably have a role to play as 'brokers' – bringing together networks of farmers, retailers and other stakeholders to share information, and jointly develop practical solutions to resource condition issues. The recently announced Industry

Growth Centres program is a possible model for the role of the Australian government in supporting ecological entrepreneurship in the initiation of the virtuous cycle. Beyond this, governments can assist in identifying and targeting potential customers, including overseas, where information gaps and transaction costs are prohibitive. This would help to uncover the existence of 'win-win' opportunities, where profitable, ecologically sustainable agricultural producers can meet the needs of sustainability-conscious brands.

3. Sending the right signals: metrics and measurement to widen market entry

Demand for sustainable products that are delivered reliably and competitively will be a key long-term driver of improved land management practices and resource condition. The development of standards and metrics that support informed decision making by consumers and provide financial incentives for supply chains and land managers that deliver verified sustainability performance will be crucial to enduring market-led change.

Building on the discussion of voluntary and regulatory land management standards above, the following policy priorities focus on the adoption of a broader array of accounting and measurement techniques that can support better market-led outcomes.

- **Adapting accounting standards to include privately-owned resources**: Privately-owned natural resources such as soil, grasslands and biodiversity are not currently recognised explicitly as assets of private enterprises. Now that we know they have significant impact on revenues and expenses of agriculture, their biophysical characteristics and current fair value should be included on balance sheets in an appropriate manner. Mechanisms to do this are under development.[60]
- **Establishing an assurance capability to record and communicate the condition and trends in privately-owned natural resources**: As the market matures and economic incentives and disincentives become more powerful, it will be important to have capacity to audit resource condition and provide citizens and investors with information about resource condition. This should include the development of indices of land condition that allow consumers to judge the quality of management and the viability and sustainability of agricultural enterprises.

- **Supporting the development of National Ecosystems Accounts**: The United Nations (UN) and World Bank (WB) are developing methods to include natural resources in the national accounts of countries. The System of Environmental-Economic Accounting-Experimental Ecosystem Accounting (SEEA) is a multi-purpose, conceptual framework that describes the interactions between the economy and environment, and the stocks and fluctuations of environmental assets. Australians working for the UN and the WB have been prominent in this initiative, especially in developing water and carbon accounting at local government, state, federal and global levels. These approaches should be amplified and extended to other vital natural resources, especially to soil. This would be a strong source of information about the condition and trends of the natural resource base and its impact on the economy.

  As these accounting standards develop, in addition to standard economic information such as GDP forecasts and other financial data, Australian governments will be able to provide publicly complementary data on alternative measures of wealth, incorporating resource condition, when making major policy statements. Australian participation in the development of these global initiatives, through demonstrated world leadership of ecological intensification of agriculture, will improve our ability to influence global economic development.

- **Encouraging participation in internationally recognised environmental improvement systems**: Environmental management systems such as ISO14000 can support voluntary continuous improvement as well as validation and assurance of contracted resource goals. The experience of the quality management movement in using internationally recognised, auditable processes (ISO) to generate continuous quality improvement and improved efficiency of sourcing provides a possible model. The ISO processes have been adapted to environmental management systems to provide users with a platform to develop improvement goals and strategies and to track and report progress. The success of ISO standards programs in generating significant voluntary improvement in a range of industries suggests that they would also be effective in this context.

Conclusion and discussion

For a country that has built its largess from the land, it is deeply concerning that Australian agriculture is trapped in a vicious cycle. The situation becomes more alarming when we consider how this impacts sustainability over the long term, together with the wellbeing of future generations. So long as the condition of our natural assets remains largely invisible, incentives to ignore or run down our precious natural endowment remain in place.

As this discussion paper proposes, better alternatives are at hand. Leading farmers, retailers and financial services providers are working to show the potential of new production techniques, sourcing and lending policies. An ever-growing cohort of sustainability-conscious consumers, support them. Concerted effort and creativity is now required to ensure the relatively small-scale activities of these farmers become the norm across the sector.

This paper has identified the magnitude of the challenges and opportunities confronting Australian agriculture, and suggested policy priorities for supporting a shift from vicious to virtuous cycles. This requires a shift in emphasis from volume to value. Securing an injection of capital to initiate the virtuous cycle, identifying the best policy interventions, roles and measurements for different sectors, and encouraging the buy-in of key stakeholders is our next challenge.

Endnotes

[1] Australian Government, *Agriculture Competitiveness White Paper*, 2015 (White Paper, 2015).

[2] White Paper, 2015

[3] Productivity Commission, *Trends in Australian Agriculture*, 2005, Canberra.

[4] Australian Financial Review, 'Big four farming debt $107 billion', 10 November 2014.

[5] White Paper, 2015.

[6] See 'Food wastage footprint: impacts on natural resources', *Report of the Food and Agricultural Organisation of the United Nations (FAO)*, 2013, pp. 6, 11-14; http://www.unep.org/wed/2013/quickfacts/; http://www.mercycorps.org/articles/quick-facts-what-you-need-know-about-global-hunger; http://reliefweb.int/report/world/fao-statistical-yearbook-2013-world-food-and-agriculture.

[7] Gray, E., M. Oss-Emer, and Y. Sheng, 'Australian agricultural productivity growth: Past reforms and future opportunities', *Research Report 14.2*, 2014, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

[8] Tongway, D.J. and N.L. Hindley, *Landscape Function Analysis: Procedures for monitoring and assessing landscapes*, 2004, Canberra: CSIRO Sustainable Ecosystems.

[9] Gray et al, 2014.

[10] White Paper, 2015.

[11] Pingali, P.L. *Green Revolution: Impacts, limits, and the path ahead,* 2013, Proceedings National Academy of Science USA, 109.

[12] Gretton, P. and U. Salma, *Land Degradation and the Australian Agricultural Industry*, 1996, Productivity Commission: Canberra Australia.

[13] See: Barbier, E.B., *'Wealth accounting, ecological capital and ecosystem services', Environmental and Development Economics*, 2013, 18, p. 133-161; Dasgupta, P., 'Nature in Economics', *Environmental and Resource Economics*, 2008, 39(1), p. 1-7; Farley, J., 'The Role of Prices in Conserving Critical Natural Capital', *Conservation Biology*, 2008, 22(6), p. 1399-1408; Rees, W.E., 'FORUM: Consuming the earth: the biophysics of sustainability', *Ecological Economics*, 1999, 29(1) p. 23-27; Sawin, B., et al., *Commodity system challenges: Moving sustainability into the mainstream of natural resource economies*, 2003, The Sustainability Institute, Hartland, Vermont, USA.

[14] Productivity Commission, *Submission to the Agricultural Competitiveness Taskforce*, 2014, Australian Government: Canberra.

[15] Australian Farm Institute (AFI), 'Managing uncertainty in the world's riskiest business', *Farm Policy Journal,* 2012, *9:1*, Autumn quarter, Australian Farm Institute, Surry Hills

[16] Productivity Commission, 2014.

[17] See McKinsey Australia, *Compete to Prosper: Improving Australia's global competitiveness*, 2014 and Port Jackson Partners, *Greener Pastures: The Global Soft Commodity Opportunity for Australia and New Zealand*, 2013, in *ANZ Insight*.

[18] FAO, *Glossary of terms on ecosystem services in agriculture*, 2013.

[19] Kharas, H. and G. Gertz, *The New Global Middle Class: A Cross-Over from West to East*, 2010, Brookings Institute: Washington DC.

[20] Gilbert-Jones, R, 'Should supply or demand drive sustainable products?', *Greenbiz,* 2 June 2015.

[21] Nielsen, 'Global consumers are willing to put their money where their heart is when it comes to goods and services from companies committed to social responsibility', 7 June 2014.

[22] KPMG International, *A New Vision of Value: Connecting corporate and societal value creation*, 2014.

[23] Moffat, A., '3 ways food and beverage companies can lead on sustainability', *GreenBiz*, 30 July 2014.

[24] Makower, J., 'Why Procter & Gamble is resetting its sustainability goals', *Greenbiz,* 13 October 2014.

[25] Goldenberg, S. and Karim, N., 'World's top PR companies rule out working with climate deniers', *The Guardian*, 4 August 2014.

[26] PPR, *Puma's Environmental Profit and Loss Account for the year ended 31 December 2010*.

[27] Kashmanian, R.M. and Moore, J.R., 'Building Greater Sustainability in Supply Chains', 2014, *Environmental Quality Management*, 2014, 23(4), p. 13-37.

[28] Global Roundtable on Sustainable Beef, *Draft Principles and Criteria for Global Sustainable Beef*, 2014.

[29] KPMG, 2014.

[30] *Burch, D. and Lawrence, G.,* 'Towards a third food regime: behind the transformation', *Agriculture and Human Values*, 2009, 26(4), p. 267-279.

[31] ACCA, FFI, and KPMG, *Is Natural Capital a Material Issue? An evaluation of the relevance of biodiversity and ecosystem services to accountancy professionals and the private sector,* 2012.

[32] United Nations Environment Programme, *Natural Capital Declaration*, 2011.

[33] See for e.g. Barendse, W., 'Should animal fats be back on the table? A critical review of the human health effects of animal fat', *Animal Production Science*, 2014, 54(7): p. 831-855; Decker, E., and Park, Y., 'Healthier meat products as functional foods', *Meat Science*, 2010, 86: p. 49-55; Howe, P. et al., 'Dietary intake of long-chain omega-3 polyunsaturated fatty acids: contribution of meat sources', *Nutrition*, 2006, 22(1): p. 47-53.

[34] See Janzen, H.H., 'What place for livestock on a re-greening earth?', *Animal Feed Science and Technology*, 2001, 166–167: p. 783-796; Glover, J.D., et al., 'Harvested perennial grasslands provide ecological benchmarks for agricultural sustainability', *Agriculture, Ecosystems and Environment*, 2010, 137: p. 3-12. Wang, K.M. and R.B. Hacker, 'Sustainability of Rangeland Pastoralism—ACase Study from the West Australian Arid Zone using Stochastic Optimal Control Theory', *Journal of Environmental Management*, 1997, 50(2): p. 147-170.

[35] Dobermann, A. and R. Nelson, *Solutions for Sustainable Agriculture and Food Systems*, Sustainable Development Solutions Network, 2013.

[36] KPMG, 2014.

[37] Bommarco, R., D. Kleijn, and S.G. Potts, 'Ecological intensification: harnessing ecosystem services for food security', *Trends in Ecology & Evolution*, 2013, 28(4): p. 230-238; Garnett, T., et al., 'Sustainable Intensification in Agriculture: Premises and Policies', *Science*, 2013, 341(6141): p. 33-34.

[38] See Walsh, D., 'A maximum sustainable stocking rate system in central Australia: Woodgreen Station', *The Central Australian Grazing Strategies project Working Paper Series*, 2009, Working Paper 54: Alice Springs; Ampt, P. and S. Doornbos, *Communities in Landscapes project Benchmark Study of Innovators*, 2011, Landcare NSW: Wyong; Bommarco et al 2013; Culman, S.W., Dupont, S. T., Glover, J. D., Buckley, D. H., Fick, G. W., Ferris H., Crews T. E., 'Long-term impacts of high input annual cropping and unfertilzed perennial grass production on soil properties and belowground food webs in Kansas, *USA', Journal of Agricultural Economics*, 2009; Davis, A.S., et al., 'Increasing cropping system diversity balances productivity, profitability and environmental health', *PLoS One*, 2012, 7(10): p. e47149; Kremen, C. and A. Miles, 'Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities, and Trade-Offs', *Ecology and Society*, 2012, 17(4); Landis, D.A., S.D. Wratten, and G.M. Gurr, 'Habitat Management to Conserve Natural Enemies of Arthropod Pests in Agriculture', *Annual Review of Entomology*, 2000, 45(1): p. 175-201; O'Reagain, P.J. and J.C. Scanlan, 'Sustainable management for rangelands in a variable climate: evidence and insights from northern Australia', *Animal*,

2013, 7(Supplements1): p. 68-78; Sandhu, H.S., et al., 'The future of farming: The value of ecosystem services in conventional and organic arable land. An experimental approach', *Ecological Economics*, 2008, 64(4): p. 835-848; Teague, W.R., et al., 'Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie', *Agriculture, Ecosystems and Environment*, 2011, 141: p. 310-322; Tozer, P.R. and J.R. Stokes, 'Investing in Perennial Pasture Improvement: A Real Options Analysis', *Applied Economic Perspectives and Policy*, 2009, 31(1): p. 88-102; Wang, L., Wang, D., He, Z., Liu, G., Hodgkinson, K. C., 'Mechanisms linking plant species richness to foraging of a large herbivore', *Journal of Applied Ecology*, 2010, 47: p. 868-875. Lavorel, S., et al., 'Ecological mechanisms underpinning climate adaptation services', *Global Change Biology*, 2014, 21: p. 12-31.

[39] See for example UNCTAD, *Wake up before it is too late: Make agriculture truly sustainable now for food security in a changing climate*, 2013; Culman, S.W., et al., 'Long-term impacts of high-input annual cropping and unfertilised perennial grass production on soil properties and belowground food webs in Kansas, USA,' *Agriculture, Ecosystems and Environment*, 2010, 137: p. 13-24; Economics of Land Degradation Initiative, *The rewards of investing in sustainable land management. Interim Report for the Economics of Land Degradation Initiative: A global strategy for sustainable land management*, 2013, Bonn, Germany; Glover, J.D., Culman, S. W., DuPont, T. S. Broussard, W., Young, L., 'Harvested perennial grasslands provide ecological benchmarks for agricultural Sustainability', *Agriculture, Ecosystems and Environment*, 2010, 137: p. 3-12; Jarchow, M.E., et al., 'The future of agriculture and society in Iowa: four scenarios', *International Journal of Agricultural Sustainability*, 2012, 10(1): p. 76-92; Teague, W.R., et al., 'An ecological economic simulation model for assessing fire and grazing management effects on mesquite rangelands in Texas', *Ecological Economics*, 2008, 64(3): p. 611-624; Millar, G.D. and W.B. Badgery, 'Pasture cropping: a new approach to integrate crop and livestock farming systems' *Animal Production Science*, 2009, 49: p. 777-787.

[40] Cork, S., et al., *Discussion Paper on Ecosystem Services for the Department of Agriculture, Fisheries and Forestry. Final Report*, 2012, Australia 21: Canberra, ACT.

[41] Lal, R., 'Soil degradation as a reason for inadequate human nutrition', *Food Security*, 2009, 1(1): p. 45-57.

[42] Tilman, D., J. Hill, and C. Lehman, 'Carbon-negative biofuels from low-input high-diversity grassland biomass', *Science*, 2006, 314: p. 1598 – 1600.

[43] See Gomes, P., et al., 'Metal Uptake by Native Plants and Revegetation Potential of Mining Sulfide-Rich Waste-Dumps', *International Journal of Phytoremediation*, 2013, 16(11): p. 1087-1103; Lintern, M., et al., 'Natural gold particles in Eucalyptus leaves and their relevance to exploration for buried gold deposits', *Nature Communications*, 2013, 4: p. 2614; van der Hoek, B.G., S.M. Hill, and R.C. Dart, 'Calcrete and plant inter-relationships for the expression of concealed mineralization at the Tunkillia gold prospect, central Gawler Craton, Australia', *Geochemistry: Exploration, Environment, Analysis*, 2012, 12(4): p. 361-372.

[44] See Walsh, 2009; Ampt et al. 2011; O'Reagain et al. 2013 and Hunt, L.P., et al., 'Principles and guidelines for managing cattle grazing in the grazing lands of northern Australia: stocking rates, pasture resting, prescribed fire, paddock size and water points – a review', *The Rangeland Journal*, 2014, 36(2): p. 105-119.

[45] Wright, T., K. Wright, and N. Reid, *Case Study: Wool production & biodiversity working together for Tim & Karen Wright - 'Lana'*, 2005, Armidale, NSW Australia.

[46] Central West Catchment Management Authority, *Case Study: Pasture Cropping for soil health benefits*, in *The economic benefits of well-managed perennial pastures*, 2007; Seis, C. and N. Seis, *"Pasture Cropping" a profitable & sustainable approach for mixed farming systems*, 2003, CWCMA: Mudgee, NSW Australia.

[47] O'Reagain, P.J., *Testing and developing principles and management guidelines for the sustainable management of the seasonably variable tropical savannas,* 2006, Sydney, Australia.

[48] Ampt, 2011.

[49] Meat and Livestock Australia, *Target 100*, 2015.

[50] See for example Curry, P.J. et al., *An inventory and condition survey of the Murchison River catchment, Western Australia*, 1994, Western Australia Department of Agriculture and Food; and Waddell, P.A., Thomas, P. W. E., and P.A. Findlater, *A report on the Gascoyne River catchment following the 2010/11 flood events*, 2012, Western Australia Department of Agriculture and Food.

[51] Kemkes, R.J., J. Farley, and C.J. Koliba, 'Determining when payments are an effective policy approach to ecosystem service provision', *Ecological Economics*, 2010, 69(11): p. 2069-2074; Farley, J. and R. Costanza, 'Payments for ecosystem services: from local to global', *Ecological Economics*, 2010, 69(11): p. 2060-2068; Jack, B.K., C. Kousky, and K.R. Sims, 'Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms', *Proceedings of the National Academy of Sciences*, 2008, 105(28): p. 9465-70.

[52] Jack et al., 2008; Ash, A.J., et al., 'Grazing Management in Tropical Savannas: Utilization and Rest Strategies to Manipulate Rangeland Condition', *Rangeland Ecology & Management*, 2011, 64(3): p. 223-239.

[53] Jack et al., 2008.

[54] See, for example, Thorn et al., 'How effective are on-farm conservation land management strategies for preserving ecosystem services in developing countries? A systematic map protocol', *Environmental Evidence*, 2015, 4, pp. 11-23.

[55] See Hunt et al., 2014; Ampt et al., 2011; Tongway and Hindley, 2004;, Ash, A.J., et al., 2011; Kemp, D.R. and D.L. Michalk, 'Towards sustainable grassland and livestock management', *The Journal of Agricultural Science*, 2007, 145(6): p. 543; McIntyre, S., J.G. McIvor, and K.M. Hear, *Managing & Conserving Grassy Woodlands*, 2002, Canberra: CSIRO Publishing.

[56] López, R., 'Under-investing in public goods: evidence, causes, and consequences for agricultural development, equity, and the environment', *Agricultural Economics*, 2005, 32: p. 211-224; Van Der Ploeg, J.D., et al., 'Dealing with novelties: a grassland experiment reconsidered', *Journal of Environmental Policy and Planning*, 2006, 8(3): p. 199-218; Vanloqueren, G. and P.V. Baret, 'How agricultural research systems shape a technological regime that develops genetic engineering but locks out agroecological innovations', *Research Policy*, 2009 38(6): p. 971-983.

[57] White Paper, 2015, p.12.

[58] White Paper, 2015, p.98.

[59] Wentworth Group of Concerned Scientists, *Blueprint Paper 1: Using Markets to Conserve Natural Capital*, 2015

[60] Ogilvy, S, 'Developing the ecological balance sheet for agricultural sustainability', *Sustainability Accounting, Management and Policy Journal*, 2015.

References

ABS, 4627.0 - *Land Management and Farming in Australia, 2012-13: Land use on farms*, 2014, Canberra, Australia: Australian Bureau of Statistics

ACCA, FFI and KPMG, *Is Natural Capital a Material Issue? An evaluation of the relevance of biodiversity and ecosystem services to accountancy professionals and the private sector*, 2012. Available from: http://www.accaglobal.com/content/dam/acca/global/PDF-technical/environmental-publications/natural-capital.pdf.

Australian Government, *Agricultural Competitiveness White Paper*, 2015.

Australian Farm Institute (AFI), 'Managing uncertainty in the world's riskiest business', *Farm Policy Journal*, 2012, 9:1, Autumn quarter, Surry Hills.

Ampt, P. and Doornbos, S., 'Communities in Landscapes project Benchmark Study of Innovators', 2011, Landcare NSW, Wyong.

Andrews, E., 'This just in: Millennials love organic eggplant, hate Gucci, *GRIST*, 2014.

Ash, A. J.; Corfield, J. P.; McIvor, J. G. and Ksiksi, T.S., 'Grazing Management in Tropical Savannas: Utilization and Rest Strategies to Manipulate Rangeland Condition', *Rangeland Ecology & Management*, 2011, 64:3, p. 223-239.

Cranston, M., 'Big four farming debt $107 billion', *Australian Financial Review*, 10 November 2014.

Australian Government, *Industry Growth Centres*, 2015. Available from: http://www.business.gov.au/advice-and-support/IndustryGrowthCentres/Pages/default.aspx.

Barbier, E. B.,' Wealth accounting, ecological capital and ecosystem services', *Environmental and Development Economics*, 2013, 18:2, p. 133-161.

Barendse, W., 'Should animal fats be back on the table? A critical review of the human health effects of animal fat', *Animal Production Science*, 2014, 54:7, p. 831-855.

Bommarco, R.; Kleijn, D. and Potts, S. G., 'Ecological intensification: harnessing ecosystem services for food security', *Trends in Ecology & Evolution*, 2013, 28:4, p. 230-238.

Burch, D. and Lawrence, G., 'Towards a third food regime: behind the transformation', *Agriculture and Human Values*, 2009, 26:4, p. 267-279.

Central West Catchment Management Authority, 'Case Study: Pasture Cropping for soil health benefits', *The economic benefits of well-managed perennial pastures*, 2007, Central West Catchment Management Authority, Wellington.

Cork, S.; Gorrie, G.; Ampt, P.; Maynard, S. and Rowland, P., 'Discussion Paper on Ecosystem Services for the Department of Agriculture, Fisheries and Forestry: Final Report', 2012, Australia 21, Canberra, ACT.

Culman, S. W.; DuPont, S.T.; Glover, J.D.; Buckley, D. H.; Fick, G.W.; Ferris, H. and Crews T. E., 'Long-term impacts of high input annual cropping and unfertilzed perennial grass production on soil properties and belowground food webs in Kansas, USA', *Journal of Agricultural Economics*, 2009, 137, p. 13-24.

Curry, P.J.; Payne, A.L.; Leighton, K.A.; Kennig, P. and Blood D.A., 'An inventory and condition survey of the Murchison River catchment, Western Australia', W.A.D.o. Agriculture, Editor, 1994, Government of West Australia, South Perth, Australia.

Dasgupta, P., 'Nature in Economics', *Environmental and Resource Economics*, 2008. 39:1, p. 1-7.

Davis, A.S.; Hill, J.D.; Chase, C.A.; Johanns, A.M. and Liebman, M., 'Increasing cropping system diversity balances productivity, profitability and environmental health', *PLOS ONE*, 2012, 7:10, p. e47149.

Decker, E. and Park, Y., 'Healthier meat products as functional foods', *Meat Science*, 2010, 86, p. 49-55.

Dobermann, A. and Nelson, R., 'Solutions for Sustainable Agriculture and Food Systems', S.D.S. Network, Editor, 2013, Sustainable Development Solutions Network.

ELDI., 'The rewards of investing in sustainable land management', *Interim Report for the Economics of Land Degradation Initiative: A global strategy for sustainable land management*, 2013, Bonn, Germany.

FAO., 'Glossary of terms on ecosystem services in agriculture', 2013. Available from: http://www.fao.org/fileadmin/templates/agphome/documents/scpi/Deliverable_7_2_LiberationGlossary.pdf.

Farley, J. and Costanza, R., 'Payments for ecosystem services: from local to global', *Ecological Economics*, 2010. 69:11, p. 2060-2068.

Farley, J., 'The Role of Prices in Conserving Critical Natural Capital', *Conservation Biology*, 2008. 22:6, p. 1399-1408.

Forum for the Future of Agriculture (FFA), *7th Forum Conference Report*, 1 April 2014. Available from: http://europolitics.info/sites/default/files/pave300x300/Syngenta_V7.pdf

Garnett, T.; Appleby, M.C.; Balmford, A.; Bateman, I.J.; Benton, T.G.; Bloomer, P.; Burlingame, B.; Dawkins, M.; Dolan, L; Fraser, D.; Herrero, M.; Hoffmann, I.; Smith, P.; Thornton, P.K.; Toulmin, C.; Vermeulen, S.J. and Godfray, H.C.J., 'Sustainable Intensification in Agriculture: Premises and Policies', *Science*, 2013, 341:6141, p. 33-34.

Gilbert-Jones, R., 'Should supply or demand drive sustainable products?', *GreenBiz*, 4 July 2013. Available from: http://www.greenbiz.com/blog/2013/07/04/should-supply-or-demand-drive-sustainable-products.

Global Roundtable for Sustainable Beef, *Draft Principles and Criteria for Global Sustainable Beef*, 15 July 2014]; Available from: http://grsbeef.org/Resources/Documents/GRSB%20Principles%20and%20Criteria%20for%20Global%20Sustainable%20Beef.pdf

Glover, J.D.; Culman, S. W.; DuPont, T. S; Broussard, W. and Young, L., 'Harvested perennial grasslands provide ecological benchmarks for agricultural sustainability', *Agriculture, Ecosystems and Environment*, 2010, 137, p. 3-12.

Goldenberg, S. and Karim, N., 'World's top PR companies rule out working with climate deniers', *The Guardian*, 4 August 2014.

Gomes, P.; Valente, T.; Pamplona, J.; Sequeira Braga, M.A.; Pissarra, J; Gil, J.A.G. and Luisa, de la Torre, M., 'Metal Uptake by Native Plants and Revegetation Potential of Mining Sulfide-Rich Waste-Dumps', *International Journal of Phytoremediation*, 2013, 16:11, p. 1087-1103.

Gray, E.; Oss-Emer, M. and Y. Sheng, 'Australian agricultural productivity growth: Past reforms and future opportunities', *Research Report 14.2*, 2014, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Gretton, P. and Salma, U., *Land Degradation and the Australian Agricultural Industry*, 1996, Productivity Commission: Canberra.

Howe, P.; Meyer, B; Record, S and Baghurst, K., 'Dietary intake of long-chain omega-3 polyunsaturated fatty acids: contribution of meat sources', *Nutrition*, 2006. 22:1, p. 47-53.

Hunt, L.P.; McIvor, J.G.; Grice, A.C. and Bray, S.G., 'Principles and guidelines for managing cattle grazing in the grazing lands of northern Australia: stocking rates, pasture resting, prescribed fire, paddock size and water points – a review', *The Rangeland Journal*, 2014, 36:2, p. 105-119.

Jack, B.K., Kousky, C and Sims K.R., 'Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms', *Proceedings of the National Academy of Science USA*, 2008, 105:28, p. 9465-9470.

Janzen, H.H., 'What place for livestock on a re-greening earth?', *Animal Feed Science and Technology*, 2011, 166–167, p. 783-796.

Jarchow, M.E.; Kubiszewski, I.; Larsen G.L.D.; Zdorskowski, G.; Costanza, Robert; Gailans, S.R.; Ohde, N.; Dietzel, R.; Kaplan, S.; Neal, J.; Petrehn, M.R.; Gunther, T.; D'Adamo, S.N.; McCann, N.; Larson, A.; Damery, P.; Gross, L.; Merriman, M.; Post, J.; Sheradin, M. and Liebman, M, 'The future of agriculture and society in Iowa: four scenarios', *International Journal of Agricultural Sustainability*, 2012, 10:1, p. 76-92.

Joyce, S., 'Change the management and what happens - a producer's perspective', *Tropical Grasslands*, 2000, 34, p. 223-229.

Kashmanian, R.M. and Moore, J.R., 'Building Greater Sustainability in Supply Chains', *Environmental Quality Management*, 2014, 23:4, p. 13-37.

Kemkes, R.J., Farley, J. and Koliba, C.J., 'Determining when payments are an effective policy approach to ecosystem service provision', *Ecological Economics*, 2010, 69:11, p. 2069-2074.

Kemp, D.R. and Michalk, D.L., 'Towards sustainable grassland and livestock management', *The Journal of Agricultural Science*, 2007, 145:6, p. 543.

Kharas, H. and Gertz, G., *The New Global Middle Class: A Cross-Over from West to East*, 2010, Brookings Institute: Washington DC.

KPMG International, *A New Vision of Value: Connecting corporate and societal value creation*, 2014. Available from: http://www.kpmg.com/Global/en/topics/climate-change-sustainability-services/Documents/a-new-vision-of-value-v1.pdf

Kremen, C. and Miles, A., 'Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities, and Trade-Offs', *Ecology and Society*, 2012, 17:4.

Kroeger, T. and Casey, F., 'An assessment of market-based approaches to providing ecosystem services on agricultural lands', *Ecological Economics*, 2007, 64:2, p. 321-332.

Lal, R., 'Soil degradation as a reason for inadequate human nutrition', *Food Security*, 2009, 1:1, p. 45-57.

Landis, D.A., Wratten, S.D. and Gurr, G.M., 'Habitat Management to Conserve Natural Enemies of Arthropod Pests in Agriculture', *Annual Review of Entomology*, 2000, 45:1, p. 175-201.

Lavorel, S.; Colloff, M.J.; Mcintyre, S.; Doherty, M.D.; Murphy, H.T.; Metcalfe, D.J.; Dunlop, Michael; Williams, R.J.; Wise, R.M. and Williams, K.J., 'Ecological mechanisms underpinning climate adaptation services', *Global Change Biology*, 2015, 21:1, p. 12-31.

Lavorel, S., et al., 'Ecological mechanisms underpinning climate adaptation services', *Global Change Biology*, 2014. In press.

Lintern, M.; Anand, R.; Ryan, C. and Paterson, D., 'Natural gold particles in Eucalyptus leaves and their relevance to exploration for buried gold deposits', *Nature Communications*, 2013, 4, p. 2614.

López, R., 'Under-investing in public goods: evidence, causes, and consequences for agricultural development, equity, and the environment', *Agricultural Economics*, 2005, 32, p. 211-224.

Van Der Ploeg, J.D.; Verschuren, P.J.M.; Verhoeven, F.P.M. and Pepels, J.H.M., 'Dealing with novelties: a grassland experiment reconsidered', *Journal of Environmental Policy and Planning*, 2006, 8:3, p. 199-218.

Lourenco, M.; Van Ranst, G.; De Smet, S.; Raes, K and Fievez, V., 'Effect of grazing pastures with different botanical composition by lambs on rumen fatty acid metabolism and fatty acid pattern of longissimus muscle and subcutaneous fat', *Animal*, 2007. 1:4, p. 537-545.

Makower, J., 'Why Procter & Gamble is resetting its sustainability goals', *GreenBiz*, 13 October 2014. Available from: http://www.greenbiz.com/blog/2014/10/13/why-procter-gamble-resetting-its-sustainability-goals

Mann, N., 'Dietary lean red meat and human evolution', *European Journal of Nutrition*, 2000, 39:2, p. 71-79.

McGuire, M.A. and M.K. McGuire, 'Conjugated linoleic acid (CLA) ruminant fatty acid with beneficial effects', *Journal of Animal Science*, 2000, 77, p. 1-8.

McIntyre, S.; McIvor, J.G. and Heard, K.M., *Managing & Conserving Grassy Woodlands*, 2002, Canberra, CSIRO Publishing.

Lydon, J.; Dyer, D. and Bradley, Chris, McKinsey Australia, *Compete to Prosper: Improving Australia's global competitiveness* 2014, Australia.

Meat and Livestock Australia, *Target 100*, 2012, 29 May 2015. Available from: http://www.target100.com.au/Home.

Millar, G.D. and Badgery, W.B., 'Pasture cropping: a new approach to integrate crop and livestock farming systems', *Animal Production Science*, 2009. 49, p. 777-787.

Moffat, A., '3 ways food and beverage companies can lead on sustainability', *GreenBiz*, 30 July 2014. Available from: *http://www.greenbiz.com/blog/2014/07/30/3-ways-food-and-beverage-companies-can-lead-sustainability*.

Nielsen, 'Global consumers are willing to put their money where their heart is when it comes to goods and services from companies committed to social responsibility', 17 June 2014. Available from: http://www.nielsen.com/us/en/press-room/2014/global-consumers-are-willing-to-put-their-money-where-their-heart-is.html.

Ogilvy, S., 'Developing the ecological balance sheet for agricultural sustainability' *Sustainability Accounting, Management and Policy Journal*, 2015, 6:2, p. 110-137.

O'Reagain, P.J. and Scanlan, J.C., 'Sustainable management for rangelands in a variable climate: evidence and insights from northern Australia', *Animal*, 2013, 7 (Supplements1), p. 68-78.

O'Reagain, P.J., 'Testing and developing principles and management guidelines for the sustainable management of the seasonably variable tropical savannas', 2006, Meat & Livestock Australia Limited, Sydney, Australia.

Panea, B.; Carrasco, S.; Ripoll, G. and Joy, M., 'Diversification of feeding systems for light lambs: sensory characteristics and chemical composition of meat', *Spanish Journal of Agricultural Research*, 2011, 9:1, p. 74-85.

Pickett, H., 'Nutritional benefits of higher welfare animal products', 2012, Surrey: Compassion in *World Farming*.

Pingali, P.L., 'Green Revolution: Impacts, limits, and the path ahead', *Proceedings National Academy of Science USA*, 2013, 109:31, p. 12302-12308

Ponnampalam, E.N., Mann, N.J. and Sinclair, A.J., 'Effect of feeding systems on omega-3 fatty acids, conjugated linoleic acid and trans fatty acids in Australian beef cuts: potential impact on human health', *Asia Pacific Journal of Clinical Nutrition*, 2006, 15:1, p. 21-29.

Port Jackson Partners, 'Greener Pastures: The Global Soft Commodity Opportunity for Australia and New Zealand', *ANZ Insight*, 2013, ANZ.

PPR, *Puma's Environmental Profit and Loss Account for the year ended 31 December 2010*, 2010.

Productivity Commission, *Submission to the Agricultural Competitiveness Taskforce. 2014*, Australian Government, Canberra.

Productivity Commission, *Trends in Australian Agriculture*, 2005, Australian Government, Canberra.

Rees, W.E., 'FORUM: Consuming the earth: the biophysics of sustainability', *Ecological Economics*, 1999, 29:1, p. 23-27.

Sandhu, H.S.; Wrattan, S.D.; Cullen, R. and Case, B., 'The future of farming: The value of ecosystem services in conventional and organic arable land. An experimental approach', *Ecological Economics*, 2008, 64:4, p. 835-848.

Sawin, B., et al., *Commodity system challenges: Moving sustainability into the mainstream of natural resource economies*, 2003, The Sustainability Institute, Hartland, Vermont, USA.

Seis, C. and Seis, N., '"Pasture Cropping" a profitable & sustainable approach for mixed farming systems', 2003, CWCMA: Mudgee, NSW Australia.

Simopoulos, A.P., 'Evolutionary aspects of diet, the omega-6/omega-3 ratio and genetic variation: nutritional implications for chronic diseases', *Biomed Pharmacotherapy*, 2006, 60:9, p. 502-507.

Smith, N. and Smith, P., *Glenwood Merinos*, 29 May 2015, Available from: http://www.glenwoodmerinos.com.au/our-story/.

Swinton, S.M.; Lupi, F.; Robertson, G.P. and Hamilton, S.K., 'Ecosystem services and agriculture: Cultivating agricultural ecosystems for diverse benefits', *Ecological Economics*, 2007, 64:2, p. 245-252.

Teague, W.R.; Grant, W.E.; Kreuter, U.P.; Diaz-Solis, H.; Dube, S; Kothmann, M.M.; Pinchak, W.E. and Ansley, R.J., 'An ecological economic simulation model for assessing fire and grazing management effects on mesquite rangelands in Texas', *Ecological Economics*, 2008, 64:3, p. 611-624.

Teague, W.R.; Dowhower, S.L.; Baker, S.A.; Haile, N.; DeLaune, P.B. and Conover, D.M., 'Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie', *Agriculture, Ecosystems and Environment*, 2011, 141, p. 310-322.

TEEB, *The Natural Capital Coalition*, 2014. Available from: http://naturalcapitalcoalition.org/.

Thorn, J., Snaddon, J., Waldron, A., Kok, K., Wen, Z., Bhagwat, S., WIlis, K. and Petrokofsy, G., 'How effective are on-farm conservation land management strategies for preserving ecosystems services in developing countries? A systemic map protocol', *Environmental Evidence,* 2015, 4, pp. 11-23.

Tilman, D., Hill, J. and Lehman, C., 'Carbon-negative biofuels from low-input high-diversity grassland biomass', *Science*, 2006, 314, p. 1598 - 1600.

Tongway, D.J. and Hindley, N.L., 'Landscape Function Analysis: Procedures for monitoring and assessing landscapes', 2004, Canberra, CSIRO Sustainable Ecosystems.

Tozer, P.R. and Stokes, J.R., 'Investing in Perennial Pasture Improvement: A Real Options Analysis', *Applied Economic Perspectives and Policy*, 2009, 31:1, p. 88-102.

Tsiplakou, E.; Kominakis, A. and Zervas, G., 'The interaction between breed and diet on CLA and fatty acids content of milk fat of four sheep breeds kept indoors or at grass', *Small Ruminant Research*, 2008, 74:1-3, p. 179-187.

UNCTAD, 'Wake up before it is too late: Make agriculture truly sustainable now for food security in a changing climate', *United Nations Conference on Trade and Development*, 2013.

UNEP, *Natural Capital Declaration*, 2011. Available from: *http://www.naturalcapitaldeclaration.org/*.

UNEP, *Food Waste Facts*, 2013. Available from: http://www.unep.org/wed/2013/quickfacts/

van der Hoek, B.G.; Hill, S.M. and Dart, R.C., 'Calcrete and plant inter-relationships for the expression of concealed mineralization at the Tunkillia gold prospect, central Gawler Craton, Australia', *Geochemistry: Exploration, Environment, Analysis*, 2012, 12:4, p. 361-372.

Vanloqueren, G. and Baret, P.V., 'How agricultural research systems shape a technological regime that develops genetic engineering but locks out agroecological innovations, *Research Policy*, 2009, 38:6, p. 971-983.

Waddell, P.A.; Thomas, P. W. E., and P.A. Findlater, *A report on the Gascoyne River catchment following the 2010/11 flood events*, 2012, Perth.

Walsh, D., 'A maximum sustainable stocking rate system in central Australia: Woodgreen Station, NT', *The Central Australian Grazing Strategies project Working Paper Series*, DKCRC Working Paper 54, 2009, Alice Springs.

Wang, K.M. and Hacker, R.B., 'Sustainability of Rangeland Pastoralism—a Case Study from the West Australian Arid Zone using Stochastic Optimal Control Theory', *Journal of Environmental Management*, 1997, 50:2, p. 147-170.

Wang, L.; Wang, D.; He, Z.; Liu, G. and Hodgkinson, K. C., 'Mechanisms linking plant species richness to foraging of a large herbivore', *Journal of Applied Ecology*, 2010, 47, p. 868-875.

Wentworth Group of Concerned Scientists, *Blueprint Paper 1: Using Markets to Conserve Natural Capital*, 2015. Available from: http://wentworthgroup.org/2015/06/blueprint-paper-1-using-markets-to-conserve-natural-capital/2015/

Woolerina. *Woolerina: soft Australian Merino*. 29 May 2015; Available from: http://www.woolerina.com.au/pages/about-us.

Wright, T.; Wright, K. and Reid, N, 'Case Study: Wool production & biodiversity working together for Tim & Karen Wright - 'Lana'', 2005, Armidale, NSW Australia.

Zhang, W.; Xiao, S.; Samaraweera, H.; Lee, E.J. and Ahn, D.U., 'Improving functional value of meat products', *Meat Science*, 2010, 86, p. 15-31.

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