1 Sustainable Agriculture

Agriculture is central to the character of the Avon River Basin. The Avon Arc was one of the first areas of Western Australia settled by Europeans and the Central, Southern and Eastern sub-regions were being farmed early in the 20th century.

Today agricultural production contributes 50% ($3.1 billion per annum) of the Avon region's GDP and is the dominant land use in all sub-regions with the exception of the Great Western Woodlands, covering approximately 50% (6.6 million ha) of the entire region and accounting for 87.5% of the combined land area of the Avon Arc, Central, Eastern and Southern sub-regions.

Table 1. Area of Agricultural Land Use

	Avon Arc	*Central*	*Eastern*	*Southern*	*GWW*
Area of Agriculture (ha)	1,235,008	2,548,403	1,509,057	1,306,225	-
Proportion of sub-region	90%	94%	87%	76%	-

Agricultural production within the ARB is dominated by crop production and in particular wheat (refer Table 2). Over recent decades the trend has been toward full cropping and away from mixed farming operations (livestock and grains), particularly in the eastern part of the region.

Table 2. Value of Gross Agricultural Production for the Wheatbelt Region 2004 and 2011. (WRC 2006, WRC 2011)

	2004 ($billion)	**2011 ($billion)**	**2011 (%)**
Crops	2.40	2.49	79%
Livestock Meat	0.35	0.41	13%
Livestock products	0.28	0.25	8%
Total	3.03	3.15	

1.1 Background

Agriculture continues to have negative effects on natural resources within the region, including:

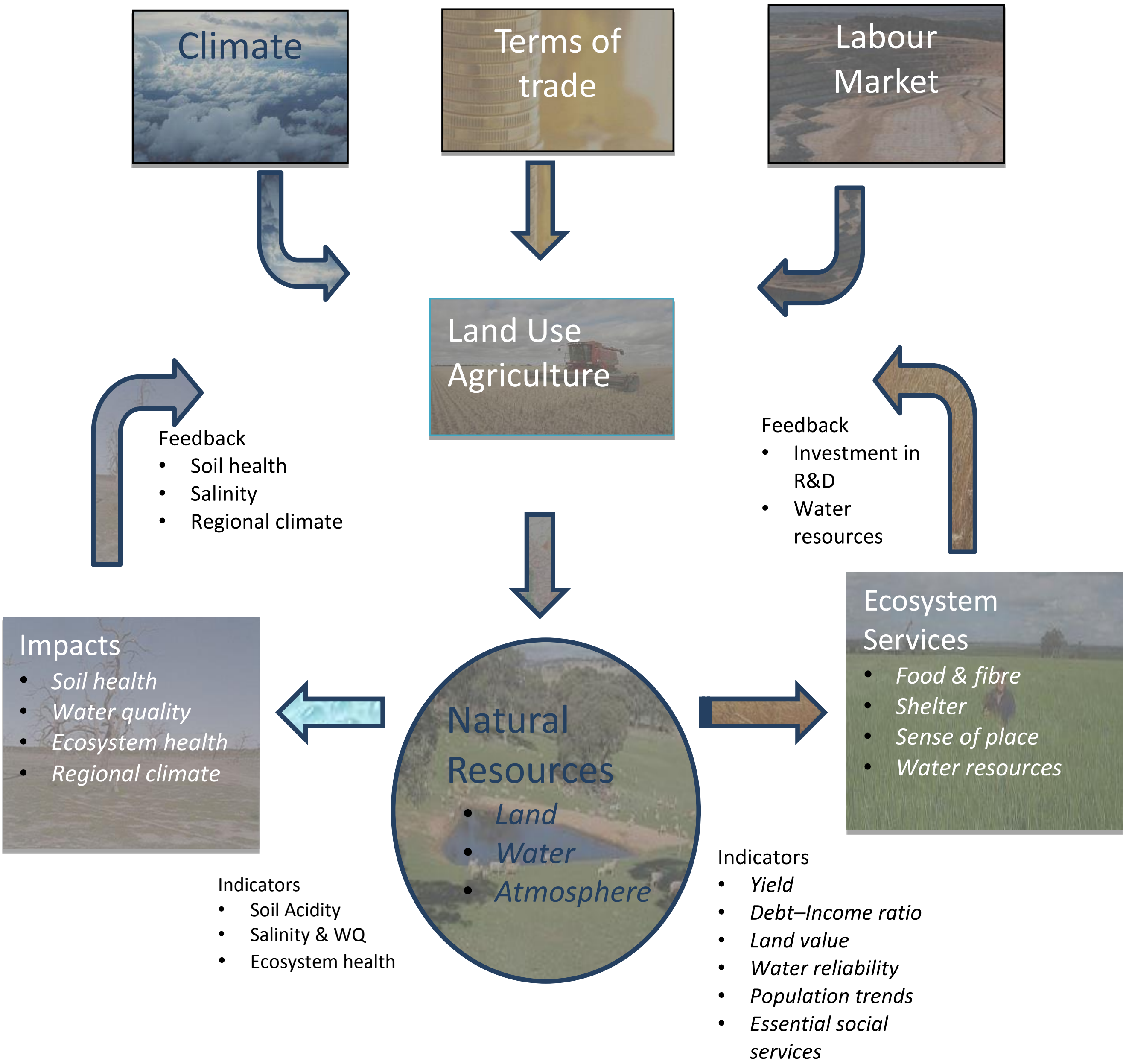
- Landscape fragmentation due to extensive clearing of native vegetation.
- Soil degradation including soil acidification, and loss of soil physical properties and soil biology.
- Reduced water quality, including eutrophication of water bodies and impacts associated with saline acid groundwater discharge from drains.
- Weed infestations.
- Grazing by domestic stock.
- Changes to natural fire regimes.
- Potential cumulative impacts associated with agricultural chemicals.

In considering industry-related natural resource impacts it is important to consider the value of ecosystem services derived from those natural resources, and recognise that ecosystem services are derived through a range of land use practices. Where ecosystem service demands are not being met, industry will often respond though a change in land management practice. For example, during the 1980s and 1990s declining terms of trade meant that landholders found it more difficult to derive sufficient economic returns from mixed farming. They responded by increasing grain production and reducing less profitable livestock production. This precipitated a range of other developments, including wide-scale adoption of no-till farming, resulting in reduced soil erosion. But it also resulted in reduced runoff, the development of herbicide resistance, increased incidence of soil-water repellence and acceleration of soil acidification.

The objective of agricultural land use is to derive economic benefits from food and fibre production, and management of water resources. As agriculture forms the mainstay of the regional economy, flow-on effects throughout the regional economy impact on urban and peri-urban land use alike. Although economic ecosystem services are important, agriculture is also central to the character of the ARB and those involved in the industry have an extremely well-developed sense of place within the region. This sense of place underpins much of the European heritage values of the region.

An ecosystem services model for agriculture within the ARB is presented in Figure 1, highlighting the ecosystem services derived from the natural resources of the region, potential impacts to natural resources, indicators and feedback loops. Figure 1 also highlights that agriculture is directly impacted by external stressors, including impacts of climate change, terms of trade and other market influences.

Figure 1. Ecosystem Services Model for Agriculture



1.2 Indicators (Ecosystem Services)

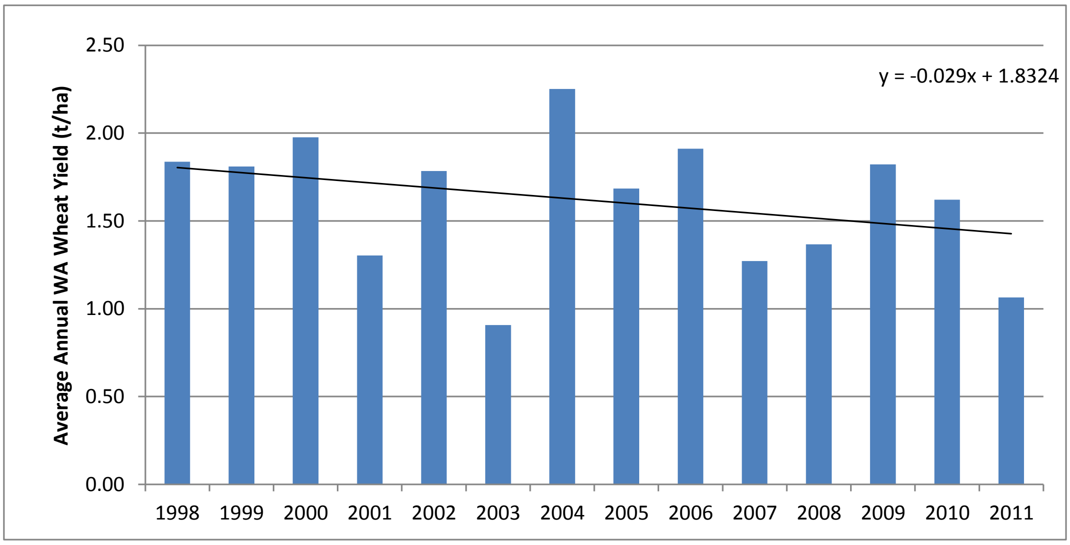
Indicators are used to assess the quality of ecosystem services derived from natural resources. Effective indicators are measurable, reflective of ecosystem services derived from natural resources, and ideally have a threshold indicating where current land management practice and natural resources fail to deliver the ecosystem services demanded of the system. Where ecosystem services are not being effectively derived from the system, then changes in land management practice are inevitable, potentially placing natural resources under increased pressure, but also representing an opportunity to improve management practice and reduce impacts on underlying natural resources.

1.2.1 Crop Yield

Crop yield is a strong indicator of the industry's capacity to derive effective economic returns from agriculture because 80% of the region's agricultural income is derived from grain production.

Average wheat yields in Western Australian peaked in 2000; the subsequent decline is due a series of poor rainfall years. Interviews with landholders during the NRM strategy development indicated that the break-even point for wheat production within the region is approximately 1.6 t/ha (although some landholders remain profitable at lower yields through reduced inputs). The trend analysis presented in Figure 2 indicates that average crop yields within the region crossed the threshold for productivity in about 2005. Falling yields and negative returns means debt has been increasing across the industry.

Figure 2. Average Annual Western Australian Wheat Yield (t/ha) 1998 – 2011 (source: ABARES 2012)



1.2.2 Debt to Income Ratio

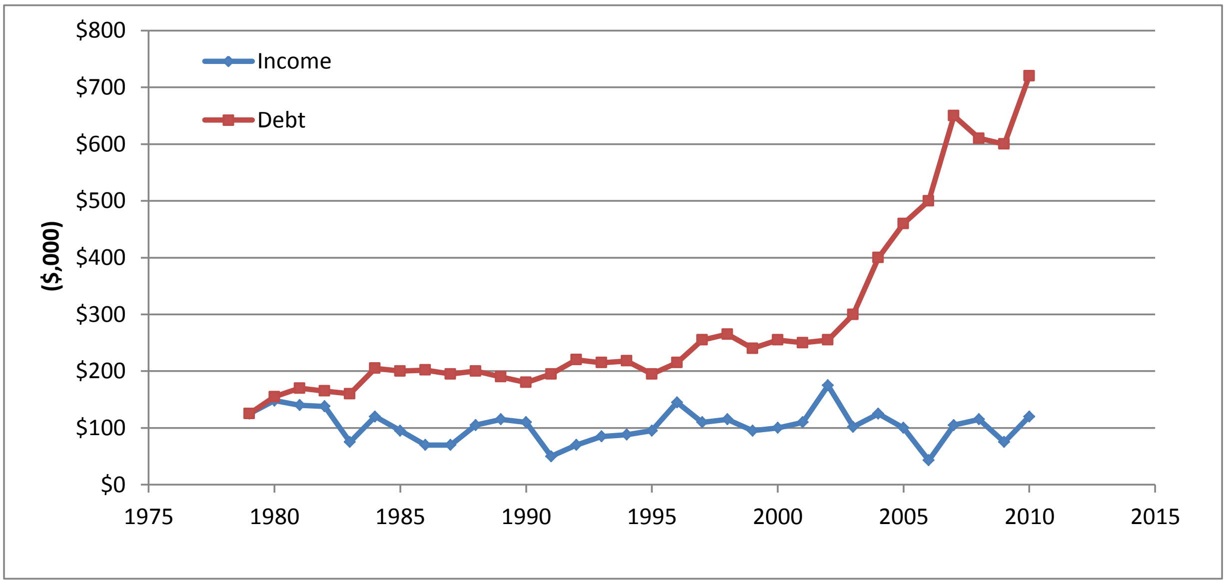
Whilst it is recognised that debt to income ratio is not always a reliable indicator of the economic position of an agriculture enterprise, it does provide useful insight into the financial performance of the agricultural industry within the region. Debt–income ratio also provides a simple mechanism for determining the farm sector's viability, particularly when compared to alternative indicators such as liquidity and solvency measures or equity to asset ratios, and data for debt–income ratios are readily available.

Throughout the 1980s and 1990s good farm incomes for cropping combined with lower interest rates led to an increase in expenditure on plant and machinery and land for farm expansion. However, this increase in investment also led to a dramatic increase in farm debt. Average farm debt within the grains industry increased by 130–160% over the last decade (ABARES 2011, Planfarm 2011). As a result of increasing debt and static income, the debt–income ratio within the agricultural industry has increased substantially since the 1980s (refer Figure 3) (ABARE 2003).

It is estimated that approximately 30% of farmers in the Western Australian wheatbelt went into the 2012 season with extremely high debt levels, and that the debt per hectare ratio increased from $170 per hectare in 1998 to approximately $600 per hectare in 2010. Declining incomes across many broadacre farms have caused an alarming spike in the debt to income ratio (Bettles 2011).

Declining land prices as supply of land outstrips demand will exacerbate the mounting debt crisis within the industry.

Figure 3. Capital Expenditure, Debt and Farm Cash Income, Grains Industry, Australia-wide (Adapted from ABARE 2003, ABARES 2011)



The data presented in Figure 3 are estimates of the average income and debt of broadacre grain enterprises Australia-wide, but provides a strong indication of the debt to income ration of landholders within the ARB. The size of debt relative to income has a powerful influence on land management decisions, and in particular the capacity of landholders to trial and adopt alternative or innovative farming practices. Anecdotal evidence collected during interviews for the development of the NRM strategy suggests that current debt levels are also impacting existing land management practices, such as liming for acidity.

1.2.3 Reliability of Water Resources

Access to reliable water resources is essential to agricultural production and all life within the region. A formal assessment of the current state of water resources in the ARB and the potential impacts of climate change on the security of water supplies within the region is yet to be undertaken. However, anecdotal evidence suggests that water resources within the region are currently stretched and predicted to be increasingly so. Monitoring of the security of the ARB's water resources is limited, but water shortages have been experienced in isolated parts in recent years (Martin Revel, Department of Water, pers. comm.).

It is estimated that average annual stream flow in the Avon River has declined by 65% compared with pre 1970 flows, with the most recent decline occurring since 2000 (ACC 2008, Giraudo 2013). It is also estimated that a 10% reduction in rainfall in the ARB will result in a 30% reduction in flow in the Avon River (ACC 2008).

Average dam reliability will fall from the current 93% to 70% as a result of a predicted 10% reduction in rainfall (ACC 2008). A 10% reduction in rainfall is well within the predicted range due to the impact of climate change within the region by 2030 (IOCI 2012).

1.2.4 Population Trends

Population density varies significantly across the sub-regions of the ARB, from less than 0.05 individuals/km^2 in the GWW, to more than 1.0 individuals/km^2 in other sub-regions. The Eastern and Southern sub-regions have population densities of 0.05–0.1 individuals/km^2 and the central sub-region 0.1–0.2 individuals/km^2 (ABS 2011).

Changes in population density within the region over the period 2001–2010 have been dramatic, with reductions of approximately 25% in some shires within the Eastern sub-region and 5 to 15% throughout much of the Southern and Central Sub-regions. Shires in the Avon Arc Sub-region have experienced increases in population of between 10 and 15% over the period 2001–2010 (ABS 2011).

Interviews with community during the development of the strategy indicate that the community is extremely concerned about the nature of population decline throughout much of the region.

1.2.5 Access to Essential Social Services

Access to the following services was used to assess the community's access to essential social services:

- *Health services (local doctor)*
- *Hospital*
- *District high school*
- *Police station*
- *Football club.*

A detailed assessment of this issue is presented in the "Access to Social Services" chapter. However, the undying trend appears to indicate that where town population falls below a threshold of 500 residents, then the risk of loss of services in greatly increased.

Many towns within the region have populations of 500–1000 residents, and several towns have been identified as approaching the threshold of 500 residents and are considered at risk of losing access to social services, with potential widespread impacts on the hinterland that rely on these services (refer Table 3).

Table 3. Towns Considered at Risk

Town	*Residents*
Goomalling	500
Lake Grace	503
Kondinin	556
Quairading	594
Dalwallinu	595

1.3 Resource Impacts

In delivering ecosystem services, agricultural management practice influences the capacity of the underlying resource base through impacts to soil health, water resources and regional climate. This in turn results in direct and indirect feedback to land management practice.

Agriculture benefits from climate regulation services provided by the surrounding natural environment, but it impacts climate regulation by exporting nutrients, pollutants and sediment, ecosystem modification and greenhouse gas emissions. Agriculture also affects the region's capacity to deliver a range of ecosystem services including climate regulation, genetic resources, water quality, environmental and cultural services and values through direct and off-site impacts on surrounding ecosystems.

For indicators of resource condition to be effective they should:

- *Have a direct link to resource condition*
- *Be measurable*
- *Have historical data to enable effective trend analysis*
- *Be associated with a slow-moving variable so as to provide an indication of trend*
- *Have established and measurable thresholds.*

Presented below is a brief assessment of indicators useful in assessing the resources impacts associated with agricultural land management practice.

1.3.1 Soil Acidity

Indicators of soil health include soil acidity, soil nutrition, subsoil compaction, soil structure decline, water repellence, erosion and salinity. Of these soil health impacts, soil acidity is the most widespread in the ARB, costs the industry the most through lost production, and is the simplest to measure. Soil acidity affects 80% of topsoils and 50% of subsoils in the ARB *(*Andrew & Gazey 2010), and currently costs the industry in the order of $140–$220 million/annum (Herbert 2009).

Soil acidity is the 'low-hanging fruit' of soil health, in that it is generally economically viable to treat and there are no real technical and human capacity constraints in doing so. Managing soil acidity is an essential precursor to achieving other physical and biological soil health outcomes, in that acid soils are more prone to a range of physical degradation processes and low pH soils have poorer capacity to support soil biota. Soil acidity has clearly defined thresholds – a pH value of 5.0 (CaCl) for topsoil and 4.8 (CaCl) for subsoil.

Industry monitors soil acidity through soil testing. Annual lime sales are a strong indicator of industry's effectiveness at managing soil acidity. The agricultural industry currently applies 0.5–1.0 Mt lime/yr, 20–40% of the 2.5 Mt lime/yr required to contain the spread and increase in severity of soil acidity (Gazey, unpublished). Even though liming is economically viable, it is estimated that only about 5% of landholders in the ARB lime according to recommendations.

1.3.2 Soil Organic Carbon

Soil organic matter – and more specifically, soil organic carbon (SOC) –play an important role in maintenance of a range of soil properties, including soil structure, cation exchange capacity, buffering capacity and soil water holding capacity. (Krull et al. 2006).

Total SOC provides a primary basis for understanding the overall health of the so as it is a relatively slow-moving variable, is largely reflective of land management practice and has relatively well-established thresholds. On the down side, SOC is subject to annual fluctuations reflecting rainfall and therefore crop and pasture growth. In addition, the amount of carbon that can be stored in soils is influenced greatly by soil types and different soil types have different thresholds.

There is currently insufficient information to determine the SOC thresholds for the specific soil types of the Wheatbelt, but existing literature indicates that SOC of 2–4.5% is necessary to maintain healthy, structurally sound and fertile soils (Krull et al. 2006, Howard & Howard 1990, Kay & Angers 1999, Greenland et al. 1975). However, these thresholds may not apply directly to many of the sandy soils in lower rainfall areas of the Avon River basin.

1.3.3 Groundcover

Whilst groundcover is not a resource impact per se, low groundcover exposes soil to a range of degradation processes, including water and wind erosion and loss of nutrition. Groundcover is easily measured and has a well-defined threshold of 50%. It is generally accepted that where groundcover falls below 50%, the potential for erosion increases significantly.

Ground cover can be assessed from ground level or in a light aeroplane. However, groundcover is not a slow moving variable and will be influenced by annual climatic conditions, so whilst providing an indication of the risk to erosion it is less effective as an indicator of longer-term trends in the resource condition.

1.3.4 Water Quality

Agriculture has a dramatic impact on water quality in the ARB. It is estimated that 34% and 69% of the total TP and TN load entering the Swan Canning Estuary is generated within the ARB. The Avon River is particularly high in TN, with an estimated 98% of TN generated from agricultural land (DoW 2007, WNRM 2008, GHD 2011, Giraudo 2013).

The defined thresholds for nutrient concentration in surface water within the ARB are 0.06 mg/L for TP and 1.0 mg/L for TN. The Department of Water recently ceased its nutrient monitoring program for the Avon region, previously meaning nutrient concentrations are no longer a usable indicator of water quality.

Re-establishment of the aquatic nutrient monitoring program within the ARB is essential in assessing resource impacts. In addition, eutrophication is one of the primary aquatic health issues for the ARB, and monitoring it provides a direct assessment of aquatic health.

Increasing salinity, particularly throughout the Central, Eastern and Southern sub-regions, present a risk to aquatic environments from declining water quality and changes to hydroperiods (DEC 2008). Agricultural drainage also poses a threat to the health of aquatic ecosystems throughout the region through changes to salinity, pH nutrient and metals (DEC 2009a, DoE unpublished).

Salinity and pH have well-established thresholds and are currently monitored by the Department of Water at strategic points within the ARB. Thresholds are discussed in more detail in the Landscape Water of this strategy.

1.3.5 Vegetation Vigour

Agricultural impacts on ecosystem health are pervasive yet often subtle (with the exception of broad-scale clearing) and often difficult to measure. Impacts may include:

- *Grazing by domestic stock*
- *Spray drift*
- *Weed infestation*
- *Reduced connection through loss of paddock trees*
- *Increased nutrient status of remnant vegetation*
- *Edge effects*
- *Regional climate impacts.*

Direct assessment of vegetation health is often complex and it is also difficult to separate out direct impacts from agriculture from the range of other internal and external stressors impacting native vegetation, including the impacts of exotic predators, climate change, altered fire regimes and grazing pressure by native and exotic browsers. Nevertheless, remote sensing assessment vegetation vigour may serve as an overall indicator of health of the regional biota. Unfortunately, the health and vigour of vegetation is not monitored systematically. Further investigation is required to establish more effective vegetation monitoring programs within the region. This potentially includes the use of remote sensing, like the adaptation of the veg machine product used so effectively for rangeland vegetation vigour monitoring (CSIRO 2013).

1.4 General Resilience Assessment

The resilience of the agricultural industry is the key factor influencing the longer-term capacity of the community to respond to current and emerging challenges and continue to derive the range of ecosystem services demanded from the environment without adversely impacting the underlying resource condition.

In assessing resilience, we first need to consider the key range of stressors impacting agriculture within the region.

1.4.1 Stressors

The agricultural industry faces difficult challenges over the coming decades. The primary stressors influencing the agricultural industry are:

- *Increasing energy and input costs associated with peak oil and peak phosphorus, coinciding with ongoing declining terms of trade*
- *Changing rainfall patterns and increased seasonal variability associated with regional and global climate change*

- *Declining access to human capital, exacerbated by underlying declining regional economic and population trends*
- *Declining public investment in R&D, coinciding with reduced development and uptake of new technologies and increasing complexity of management requirements*
- *Soil and natural resource degradation issues, exacerbated by changes to climate and economic demands*
- *Reduced access to finance and increasing debt.*

Each of these issues is briefly considered below.

1.4.1.1 Increasing Energy Costs and Declining Terms of Trade

Increasing energy and fertiliser, machinery, chemical and finance costs are likely to continue to inflate agricultural production costs. The economic impacts of pricing of greenhouse gas emissions, peak oil and peak phosphorus remain unquantified, but undoubtedly represent upward pressure on input costs for agriculture in the coming decades.

Previous declining terms of trade have been offset by increases in productivity through input substitution, adoption of new technologies, productivity growth, improved production systems, improved management and efficient use of economies of scale (Nossal et al. 2009). However, many of the gains associated with input substitution, new technologies and economies of scale have already been realised, limiting landholder options for overcoming future declining terms of trade. Recent productivity gains have not been sufficient to overcome underlying increases in costs, resulting in increased farm debt (refer Figure 3).

1.4.1.2 Climate Variability

Seasonal rainfall variability remains the primary factor influencing productivity in the grains industry. Predictions for climate change within the region include declining growing season rainfall, increased seasonal variability, longer dry spells and more intense storms (IOCI 2012).

Australia's agricultural sector is projected to be one of the most adversely affected by future global climate trends. ABARE predicted that agricultural production in Australian is likely to decline by approximately 9–10% by 2030 and by 13–19% by 2050,when compared to the no climate change scenario (Gunasekera 2007).

Structural adjustment within marginal and vulnerable agricultural sectors is inevitable, and significant investment in R&D associated with climate change adaption and mitigation technologies will be essential (Gunasekera 2007). Maintaining or enhancing profitability and viability of agriculture in the face of climate change will require (Stephen et al. 2006):

- *A focus on adaptation and resilience*
- *A risk-based management approach*
- *Farmer/industry-driven applied R&D, as opposed to science-driven strategic planning (science must be directed by industry)*
- *Knowledge-based strategy of building on an existing understanding.*

1.4.1.3 Human Capital and Region Population Trends

Declining population trends in agricultural communities coupled with high participation rates and lower unemployment indicate significant skill and labour shortages within the region. In addition, ageing population across the Wheatbelt indicates a declining workforce and increased demands on community services. Migration from the Wheatbelt is likely to be a response to a lack of education, employment and social opportunities, and is adding to the skill shortages within the region in addition to having a range of social ramifications (Donnahue & Price 2010).

Of the 9,500 businesses in the region, 56% are sole traders and a further 27.5% employ between one and four staff. Eighty per cent of businesses within the Wheatbelt region employ less than five staff members. Smaller businesses, particularly those employing less than 10 employees, are more acutely affected by skilled and labour shortages and are impacted by rising cost of wages and high staff turnovers (ABS 2010). This makes businesses in the region vulnerable, and many report difficulty in recruiting new employees (Donnahue & Price 2010).

1.4.1.4 Declining Public Investment in R&D

Australian dryland farming systems have outperformed agricultural sectors in most other countries over the last 30 years. Australian R&D and extension programs have contributed significantly to realising growth in agricultural productivity (Carberry 2001). The close relationship between productivity growth in agriculture and research and development investment is well documented both in Australia and globally. Recent global trends of slowing growth in productivity and reduced R&D funding for agriculture is a significant cause for concern (Alston et al. 2009).

Public investment in agricultural R&D in Australia dropped from a peak of more than 5% of agricultural GDP during the late 1970s to approximately 3% in the 2000s (Keating et al. 2010). Combined with a similar slowdown in investment in R&D in other major agricultural countries, including the United States, Australian agriculture is facing a decline in new technologies that will potentially restrict growth in productivity for several decades (Alston et al. 2009).

There is a strong history of active participation of farmers in R&D effort in Australia and this has been an important aspect of the success of the industry. Continued partnerships between landholders and research institutions and a focus of system based approaches to R&D will be essential for the future success of the industry (Carberry 2001).

1.4.1.5 Access to Finance Spiralling Farm Debt

Farm debt increased dramatically in 2000–2010 (refer Figure 3). Increases in farm debt are principally associated with increases in demand for working capital in addition to ongoing land purchases (ABARES 2011, Planfarm 2011).

Increases in productivity (particularly prior to the mid-1990s) coupled with increasing land value have encouraged landholders to service greater debt and to increase land holdings. Generally increasing land value throughout this period has meant that landholders have been able to maintain equity. However, limited productivity gains coupled with stable land prices will mean that landholders will be unable to continue to increase debt at the levels apparent over the last 10 years. Furthermore, increasing debt levels, in association with tightening financial markets within the region in response to global economic recession, presents a significant challenge to many landholders, particularly within lower-rainfall areas (Bettles 2011).

1.4.1.6 Land Degradation

Key challenges facing agriculture within the region will almost certainly place more pressure on resource condition, and pressure will be exacerbated by the (predicted) more extreme weather conditions. Structural adjustment within the agricultural industry may also increase pressure on natural resources.

Potential land under-utilisation in some areas may also occur, creating weed and fire management problems, but also developing potential for biodiversity, carbon sequestration and/or alternative productive use.

1.5 The Resilience Cycle

The resilience cycle provides fundamental strategic insight into the future of agriculture within the region.

The resilience cycle consists of the following phases:

- *Growth/exploitation phase* – characterised by reorganisation, rapid growth and unpredictable outcomes
- *Conservation phase* – where the system becomes largely stable or predictable
- *Release phase* – characterised by a chaotic release, in which the system succumbs to internal and/or external influences of stressors
- *Reorganisation phase* – period of reorganisation providing new opportunities agriculture.

Western Australian agriculture underwent cycles of release and reorganisation during the 1930s and 1970s. Both periods of release were associated with a combination of adverse world economic conditions and a series of poor rainfall years. The 1930s release was triggered by the Great Depression and a run of poor seasons causing significant agricultural financial stress and farm abandonment. The outbreak of World War II in 1939 extended the period of reorganisation through shortages in labour, fuel and fertilisers, as did a severe drought in 1940. After WWII, agriculture boomed due to world economic recovery, high commodity prices and availability of new machinery and new farming methods (Alison 2003).

The 1970s release and subsequent reorganisation was triggered by a severe drought in 1969, an oversupply of wheat and the introduction of wheat quotas in the early 1970s, followed by severe world inflation from 1973. The situation was further exacerbated by a series of poor rainfall years throughout the 1970s. This crisis was short-lived and was followed by a period of significant growth within the Western Australian grains industry as a result of capitalisation, the introduction of new fertilisers and the adoption of new technologies and economies of scale (Alison 2003, ACF 1983, Burvill 1979).

Current conditions within the agricultural industry in Western Australia reflect those of the 1930s and 1970s, in that difficult economic times coinciding with a run of poor seasons have resulted in extreme debt levels, suggesting the industry may be approaching a release phase.

During the 1930s and 1970s substantial government investment was required, with the introduction of the Farmers in Debt Adjustment Act in the 1930s and low-interest loans provided to farmers through the Rural and Industry Bank during the crisis of the 1970s. Based on historical events, significant external investment in the agricultural industry will be necessary to manage the emerging release phase.

1.6 Resilience Attribute Assessment

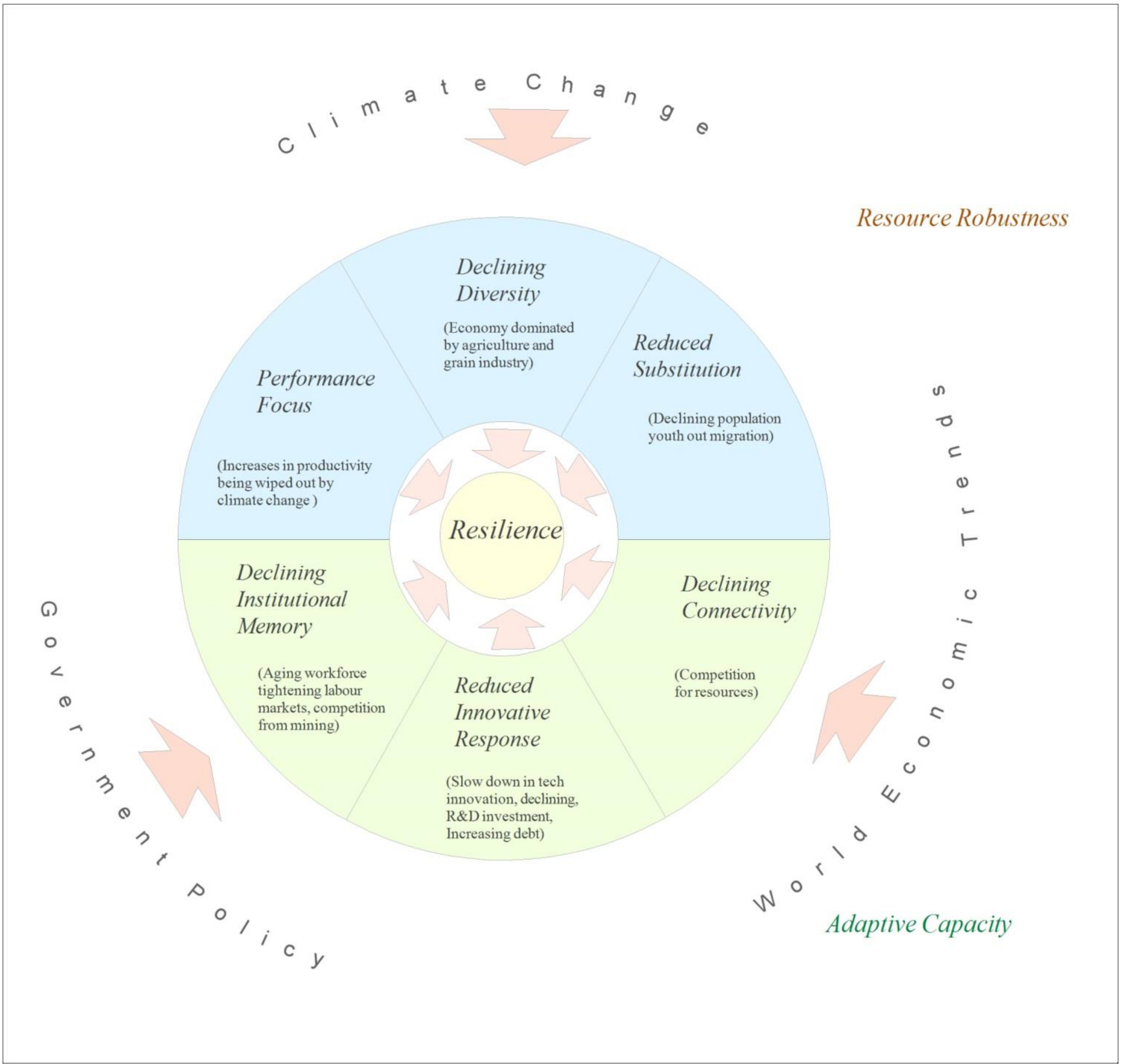
An assessment of the attributes of resilience of a system can provide insight into the resilience of the system as a whole and ways of improving it

The attributes of resilience are:

- ***Resource Robustness*** *– performance, diversity and redundancy*
- ***Adaptive Capacity*** *– institutional memory, adaptive response, connectedness.* (Longstaff et al. 2010).

Figure 4 gives an overview of the impact of various stressors on the resilience of agriculture.

Figure 4. Resilience Attribute Model of Agriculture



A more detailed assessment of the individual attributes of resilience of agriculture is presented below.

1.6.1 Performance

Agriculture in the ARB has experienced no real gains in productivity since the mid-1990s due to a series of underlying constraints including a run of poor seasons, a slowdown in technological advances accompanied by a reduction in R&D, diminishing returns from economies of scale and increasing farm debt (ABARES 2011). At the same time, farmers' input costs have increased due to a decline in terms of trade (Cooks et al. 2010).

The overall performance of agriculture within WA is in decline, reflected in a declining trend in wheat yields over the period 1998–2011. ABARE (2006) reported that the bottom third of broadacre farms in Western Australia had experienced consistent negative rates of return on capital since the early 1990s. The average wheat yield in Western Australia has declined over the last decade from 1.83 t/ha to approximately 1.45 t/ha (refer Figure 2) (ABARES 2012).

Previously, the performance and efficiency of the agricultural sector was its primary strength, but mounting stressors are now reducing the capacity of agriculture to maintain high levels of productivity.

1.6.2 Diversity

Agriculture within the ARB now has a low level of diversity, being dominated by grain production and wheat in particular. Grain production accounts for approximately 80% of the regional agricultural GDP, with the remaining 20% of agricultural production coming from livestock sales and livestock products. Approximately 80% of livestock-related income is derived from sheep sales and wool production (WDC 2006, WCD 2011).

In recent decades the trend has been toward an increase in the area of cropping and a reduction in sheep numbers within the region, which has eroded diversity to achieve increases in production.

1.6.3 Redundancy

Declining populations in the central and eastern Wheatbelt coupled with high participation rates and lower unemployment indicate significant skill and labour shortages and a lack of redundancy within the labour force. The Wheatbelt is characterised by an ageing workforce, particularly in qualified and technical professions, with more than 30% of people involved in agriculture over the age of 55. Skilled positions are often held by older individuals, and when coupled with falling youth participation this indicates a low level of redundancy in Wheatbelt agriculture.

Farm amalgamations have slowed within the agricultural sector over the last decade, indicating that productivity gains associated with structural adjustment are reducing, with landholders less willing or less able to continue to expand their enterprises. This also suggests that redundancy within the agricultural sector is declining (ABARES 2011).

1.6.4 Institutional Memory

Population decline over much of the region has been driven by previous structural adjustment in agriculture. Some shires within the agriculture-dominated Eastern and Southern sub-regions experienced population declines of up to 20% in the period 2001–2011 (ABS 2011). High levels of outmigration contribute to losses in institutional memory.

The Wheatbelt has a significantly lower year 12 equivalent completion rate of 32% (within the workforce) than the West Australian average of 45% (Donnahue & Price 2010). This, combined with falling youth participation and general ageing trends, suggests that skills and knowledge are increasingly contained within a declining and ageing population, and that loss of institutional memory is impending or ongoing.

1.6.5 Innovative Responses

Landholders' capacity for innovation has traditionally been a primary driver for resilience within the region. In recent decades technological advances have enabled the grains industry to benefit from input substitution, with farmers substituting labour for capital (predominantly through increased machinery costs) and more recently for materials and services. The grains industry has also benefited from new technologies, productivity growth, improved production systems, improved management and efficient use of economies of scale (Nossal et al. 2009).

However, a decline in productivity gains since the mid-1990s resulting in diminishing returns coupled with ongoing increases in the cost of inputs has resulted in increasing farm debt (refer Figure 3) (ABARES 2011). High debt levels restrict the industry's capacity to trial and adopt new and innovative practices through a desire to reduce risk and due to tightening capital investment.

This slowdown is mirrored by a decline in public investment in agricultural R&D, discussed in section 1.4.1.4.

1.6.6 Connectedness

The agricultural industry within the region maintains a high degree of connectedness through a network of grower groups and institutional arrangements (including the Grower Group Alliance) that allow for sharing and dissemination of information technology.

More generally, regional development pressures have resulted in local communities competing to attract external capital investment and maintain services (Tonts & McKenzie 2005). The impact of this has been to marginalise communities and to reduce the level of inter-connectedness between rural communities, potentially reducing their resilience.

1.7 Summary

The agricultural industry in Western Australia is underpinned by low resource robustness. The sector's moderate performance is due to limited rainfall, infertile soils and a lack of diversity in production systems.

The resilience of agriculture to previous stressors has been largely driven by a strong capacity for innovation, and good connectedness. Nevertheless, a focus on productivity gains at the expense of other attributes of resilience, including diversity and redundancy (replaceability), and more recently the erosion of the agricultural industry's ability to respond to a changing environment has reduced the resilience of the industry. Similarly, reductions in public investment in R&D and a general slowdown in the development and adoption of new technologies, in addition to declining performance, increasing debt, industry rationalisation, an ageing population, tightening labour markets, competition for limited resources and pressures on institutional memory all indicate a notable reduction in the general resilience of the agricultural industry within the region, particularly over the last two decades.

Improve the resilience within the agricultural sector will require an increase industry production diversity, a reversal of population decline and current labour market trends, encourage youth recruitment within the sector, reduce farm debt and support industry-led R&D.

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