Submission to the Senate Standing Committee on Rural and Regional Affairs and Transport Inquiry into Climate Change and Australian Agricultural Sector

Queensland Government

March 2008

Executive Summary

The Queensland Government recognises the significance of climate change to the agricultural sector, as demonstrated by the ClimateSmart 2050 Strategy and the ClimateSmart Adaptation Plan which identify actions to assist primary industries to adapt to climate change.

1. Scientific evidence available on the likely future climate of Australia's key agricultural zones, and its implications for current farm enterprises and possible future industries

Warming by 2030 relative to 1990 of 0.7 to 0.9°C in coastal areas and 1.0 to 1.2°C inland has recently been predicted (CSIRO & Bureau of Meteorology (BoM), 2007). There is a large degree of uncertainty attached to the projected changes in rainfall. However a decrease in rainfall is more likely than an increase for most of Australia with the exception of the north which is likely to remain unchanged. A decrease of between two and five percent was projected by CSIRO & BoM (2007). An earlier study projected that average rainfall over most of Queensland would change in the range of -13% to +7% by 2030 compared to the average between 1961 and 1990. The change was expected to occur mainly in winter and spring (Caie et al, 2005).

Climate change projections increase the risk facing the agricultural sector. The Australian agriculture sector has been successful at increasing productivity in a highly variable and warming climate. However, the rapid rate of warming and drying predicted for most of Australia raises the importance of agricultural research, development and extension.

Biosecurity will increase in importance, as the change in climate will enable many agricultural pests, diseases and weeds to flourish. A strategic assessment of the key risks is required so that investment in this area can be prioritised.

Furthermore, government policies to mitigate climate change create risks and opportunities for the sector. The uncertainty relating to how government will address the methane emissions from ruminants is particularly significant to Queensland's economy, as beef cattle generate $4 billion per annum. Heat stress arising from increased temperatures is expected to constrain beef production. The dynamic processes of weed invasion, erosion and salinisation will affect the productivity of the rangelands and hence beef production to varying extents according to climatic events and management practices. The financial benefits to the sector for its role in carbon sequestration will be important in offsetting the additional costs of climate change.

Targets for renewable energy that increase biofuel crop production could reduce the availability of affordable feedstock for intensive livestock production, and compete strongly with other agricultural industries for access to land.

Increased temperature, reduced water supply and elevated CO_2 will interplay to exacerbate known risks and provide some benefits to horticulture and this may even affect the suitability of sites and regions for horticultural production. Rising temperatures are a constraint to moving horticulture north. Pest and disease pressure will change due to rising temperature and elevated CO_2.

Cereal grains, which generate about $490 million per annum, will also be affected by climate change. Elevated CO_2 is expected to reduce wheat quality through heat stress and reduced protein levels.

Improved drought preparedness will be crucial in the changing climate. This will require investment partnerships between Government and industry for regionally specific research, development and extension. Pressure on agricultural land will increase in this harsher climate, and ongoing research into sustainable production systems will be required to protect the resource base.

Recognition of the role of agriculture in carbon sequestration and emission control through financial incentives such as the emission trading scheme will encourage mitigating practices.

2. The need for a national strategy to assist Australian agricultural industries to adapt to climate change

The Queensland Government supports the need for a national strategy to assist Australian agricultural industries to adapt to climate change. The Queensland Government is in the process of implementing its ClimateSmart Adaptation Plan (2007–12), which specifically includes primary industries and supports the National Agriculture and Climate Change Action Plan 2006–2009. A national strategy should enable this national challenge to be addressed more effectively and efficiently.

3. Adequacy of existing drought assistance and exceptional circumstances programs to cope with long-term climatic changes.

The focus of national drought policy is on self reliance and drought preparedness, however it recognises a continuing role for governments in drought assistance programs. The ability to implement this policy focus has been limited in recent years due to continuing drought conditions. Through the Primary Industries Ministerial Council (PIMC), plans are being developed to phase out business assistance during exceptional drought events and replace with financial incentives to ensure producers are better prepared for future drought events. Better risk management practices and a focus on being better prepared for drought is important. Payments for ecosystem services provided by farmers such as carbon sequestration could be a means to assist farmers deal with drought exacerbated by climate change.

Introduction

The Queensland Government is pleased to make this submission to the Senate Standing Committee on Rural and Regional Affairs and Transport Inquiry into Climate Change and Australian Agricultural Sector. Agriculture is an important industry in Queensland, and is the lifeblood of many rural communities. The Queensland Government has traditionally supported farmers to adjust to climate risk primarily through the research and extension services provided by the Department of Primary Industries and Fisheries. Recent alarming projections of temperature rises and rainfall decreases (Intergovernmental Panel on Climate Change (IPCC), 2007) have heightened the importance of a strategic response to climate change.

The Queensland Government has adopted ClimateSmart 2050 Strategy and the ClimateSmart Adaptation Action Plan (the Action Plan) (www.climatechange.qld.gov.au). The Action Plan identifies three strategies including building and sharing knowledge, including climate change in decisions and reducing vulnerability; and increasing resilience. There are seven actions in the Action Plan which relate to agriculture.

1. Scientific evidence available on the likely future climate of Australia's key agricultural zones, and its implications for current farm enterprises and possible future industries.

Present climate trends and expected climate changes

Observed global changes

(extracted from IPCC, November 2007)

At the global scale, warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, melting of snow and ice, and rising global sea level (IPCC, 2007). The temperature increase is widespread over the globe, and is greater at higher northern latitudes. Over the past 50 years, cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent.

There is evidence of an increase in intense tropical cyclone activity in the North Atlantic since about 1970, with limited evidence of increases anywhere else. Precipitation has increased in eastern parts of North and South America, northern Europe and northern and central Asia since 1905. Interestingly, over this same period, precipitation has decreased in the Sahel, the Mediterranean, southern Africa and parts of southern Asia[1].

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[1] Observed changes in climate have been linked to more than 29,000 observational data series from 75 studies showing significant changes in many physical and biological systems (IPCC, November 2007).

Observed trends in Australia

Australian annual average temperatures have increased 0.9°C since 1950, with significant regional variations. The highest increases in annual average temperatures are recorded for eastern Australia, particularly Queensland, north New South Wales (NSW), north east South Australia (SA) and eastern Northern Territory. In Queensland average annual temperatures have increased by between 0.2 to 0.6°C, with the biggest increases in spring and summer (http://www.bom.gov.au/cgi-bin/silo/reg/cli_chg/trendmaps.cgi). The number of days with maximum temperatures over 40°C and duration of hot spells increased in general over most of Queensland over the last 50 years.

Since 1950, most of eastern and south-western Australia has experienced substantial rainfall declines (30–50mm), particularly along the eastern coast from southern NSW to about Cairns in Queensland (http://www.bom.gov.au/cgi-bin/silo/reg/cli_chg/trendmaps.cgi). With the exception of the Cape York Peninsula, most of Queensland observed reductions in rainfall range from 5 to 50mm. Over the last 50 years, the trend in the number of very heavy rain days and amount of daily rainfall decreased in Queensland, particularly along the eastern coast (http://www.bom.gov.au/cgi-bin/silo/reg/cli_chg/extreme_trendmaps.cgi).

Climate change projections for Australia

Regardless of future emissions, there is general scientific consensus that atmospheric levels of greenhouse gases have already reached the point where further climate change is inevitable. Warming by 2030 relative to 1990 of .7 to .9 °C in coastal areas and 1 to 1.2°C inland has recently been predicted (CSIRO & BoM, 2007).

Rainfall in the north is not expected to change much by 2030, and a decrease of 2 to 5% is expected elsewhere in Australia. The range of projections in change to rainfall by various models is large. For example the predicted change in summer and autumn rainfall across Australia is from -15% to +10% (CSIRO, 2007, p.10). This information is produced by global circulation models, which tends to be broad scaled (e.g. 200–400 km^2). Further work is required to 'downscale' this information, in time (i.e. seasonal, monthly or weekly) and in space (region to basin to catchment).

The Queensland Climate Change Centre of Excellence is downscaling modelling research in partnership with CSIRO, while the Queensland Government is investing in a downscaling project as part of the SEQ Urban Water Alliance program. However further support to improve the accuracy of downscaled modelling is essential to confidently determine the implications on farm enterprises and future industries.

More specific projections for climate change in Queensland were made in 2005 by CSIRO (Cai et al, 2005), however the models at that time would not be as refined as in the 2007 report. The resulting projections were more wide ranging than in the later CSIRO and BoM report. For example, the change to annual average rainfall ranged from −13% to +7% by 2030. The change was expected to occur mainly in winter and spring (Appendix 1).

Overview of Queensland's agricultural industries and zones

Queensland's major agricultural industries are beef, lifestyle horticulture (including flowers and turf), fruit and nuts, vegetables, winter cereals, sugar, sorghum and forestry (Table 1).

Table 1: Gross value of production at farm gate of major primary industries in Queensland

Item	Gross Value of Production at Farm gate Year ended 2007 $m
Sugar cane	1,075
Cotton	120
Cereal grains	490
Fruit and nuts	975
Vegetables	810
Lifestyle Horticulture	1,220
Other crops	260
TOTAL CROPS	4,950
Cattle and calves	3,625
Other livestock	505
TOTAL LIVESTOCK	4,130
Milk, wool and eggs	410
Fisheries	275
Forestry	720
Total primary industries	10,485

Queensland's key agricultural zones can be described as:

- Low rainfall rangelands in the western half of the State, used for extensive grazing
- The high rainfall coastal strip used for horticulture, intensive livestock production and forestry plantations
- Dryland cropping and less extensive grazing areas (Figure 1).

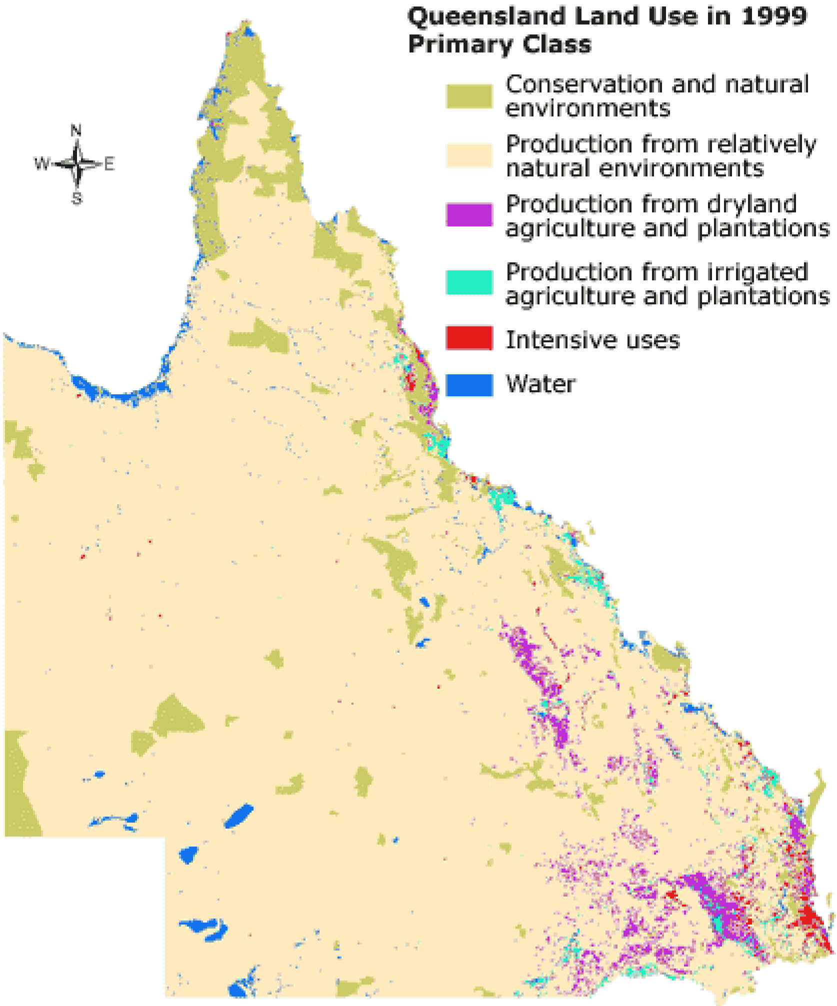


Figure 1: Primary land use in Queensland in 1999 (www.nrw.gov.au).

Implications for current farm enterprises and future industries

Increasing temperatures and declining rainfall will pose significant challenges to current land management practices and agriculture in Queensland. However, Queensland producers are well used to meeting the challenge of climate risk, and responding through the use of improved practices. The Queensland Department of Primary Industries and Fisheries research and extension services focussing on climate risk management and drought preparedness will become increasingly important to economic development as climate change progresses.

Pests and diseases possess attributes that will allow them to respond rapidly to a changing climate. Aurambout et al. (2006) reported that “A pole-ward shift in the geographical range of some pests and pathogens has been observed during the last century.” The formation of new or novel climates in areas is likely to provide opportunities for species that have the potential to become new pests. Climate change will reduce the impacts and/or range of some pest species and there is likely to be increased opportunities to better manage some species due to less favourable climatic conditions (e.g. reduced rainfall, drought). Increased temperatures could facilitate southern and higher altitude expansion of frost-intolerant weed species such as rubber vine and Siam weed. There will be an increased risk from ‘sleeper’ weeds as the potential area of suitable habitat may increase. Extreme weather events creating environmental disturbance will provide opportunities for weeds to establish in new areas. For some weeds and pest animals that are near the northern extreme of their distribution in southern Queensland, climate change may decrease their impact in the state – for example rabbits and blackberries.

The world is facing an unprecedented impact from emerging and re-emerging animal diseases that have a major impact on production and trade (e.g. nipah virus, foot and mouth disease, tuberculosis). Climate change can affect many processes that influence animal diseases including the pathogen or parasite, the host, the vector and the behaviour of the disease (epidemiology). Warmer temperatures and more extreme rainfall events will produce conditions that are more favourable to many livestock diseases. Insect vectors of disease such as mosquitoes and midges are likely to expand their range increasing the risk of disease spread to new areas. The increased atmospheric levels of CO_2 and its effect on climate are likely to increase the impacts of plant diseases such as rust diseases which are caused by fungi. Climate change is likely to increase the severity of plant pests and diseases of agriculture in Queensland.

Government policies in response to climate change will also impact on current farm enterprises and future industries. The design of the emission trading scheme could affect the methane emitting animal production, the adoption of farming practices and land-use believed to sequester carbon and the use of energy. There is an expectation that there will be some financial benefit to farmers from the carbon they sequester in vegetation or in the soil, and carbon-trading schemes are currently being promoted to farmers. The value to farmers of carbon sequestration is highly speculative until the design of the trading scheme is resolved, and a means of verifying sequestration is determined. An understanding of the 'carbon footprint' of agricultural industries is important to prioritise actions to mitigate greenhouse gases. Mitigation could be achieved through best management practice programs and market based mechanisms.

Targets for renewable energy will also have an impact on biofuel crop production and will reduce the availability of affordable feedstock for intensive livestock production. It is important that the impact on primary industries is considered in developing emission mitigation policies. Industry should receive market and other signals that both discourage greenhouse gas emissions and reward emission reduction and carbon sequestration.

Another factor that will affect farm enterprises and future primary industries is the response of investors to the additional business risk posed by climate change and the ensuing policies. Investors, including private and corporate farmers and their commercial lenders have always had to consider climate risk, however it is reasonable to believe that the current drought and publicity of climate change would increase the consideration of climate risk when making investment decisions. It is important that government policies and programs are designed promptly and are clear in their application, so that they do not exacerbate risk.

The provision of infrastructure to support primary industries suitable for a changing climate will impact on the viability of existing industries and the development of new industries. Transport infrastructure may need to be upgraded or redesigned to avoid damage from the predicted more severe cyclones.

The Australian Bureau of Agricultural and Resource Economics (ABARE) has modelled the impact on primary industry sectors at a national scale, and predicted that production of wheat, beef and sugar could decline by 9 to 10 percent by 2030 (ABARE 2007, p.657). Although some modelling has been done on the impact of climate change on mixed grain and grazing businesses in Queensland, very little modelling has been done in other agricultural enterprises at a regional scale. The reliability of predictions of the impact of climate change on farm enterprises and future industries is constrained by not only the uncertainty of the predicted change in rainfall, but also the unknown Government policy and industry investment response.

Future scenarios of land use type and distribution need to be thoroughly tested using modelling techniques for extensive and intensive agricultural land uses. Such modelling experiments need to consider both on-site effects (productivity, hydrology, fertility, acidification), as well as off-site impacts. The risk of degradation of the resource base due to drought also needs to be considered and managed.

Extensive livestock

Extensive beef production is one of Queensland's major industries and is compatible with other land-uses including mining, carbon sequestration, biodiversity conservation and water harvesting. It is undertaken in the rangelands of western Queensland which have low rainfall and infertile soils.

There is likely to be an increase in the potential distribution and abundance of exotic weeds, e.g., *Acacia nilotica* and *Cryptostegia grandiflora* (Kriticos et al, 2003a and b) and native woody species, e.g., *A. aneura* (Moore et al, 2001). This is likely to increase competition with pasture grasses, reducing livestock productivity. However, the same CO_2 and climate changes are likely to provide increased opportunities for woody weed control through increased burning opportunities (Howden et al, 2001). The dynamics of erosion and salinisation will be affected by the changing climate and this will affect the productivity of the resource base.

Heat stress already affects livestock in many Australian regions, reducing production and reproductive performance and enhancing mortality. Increased thermal stress on animals is very likely (Howden et al, 1999b). Impacts of the cattle tick (*Boophilus microplus*) in Queensland are likely to increase and move southwards (White et al, 2003).

The importance of reducing methane emissions is acknowledged. The means by which this is achieved could have significant impacts on the extensive livestock (beef and sheep) industry. The uncertainty over the means to reduce emissions from livestock is a business risk which must be currently impacting on investment in this industry.

Modelling suggests some productivity benefits may arise from increased levels of CO_2, however this could be offset by the projected reduced rainfall (Box 1).

Box 1

A rise in CO_2 concentration is likely to increase pasture growth, particularly in the water-limited environments in Australia and specifically Queensland (Ghannoum et al, 2000; Ash et al, 2006). However, if rainfall is reduced by 10%, this CO_2 benefit is likely to be offset (Howden et al, 1999b; Crimp et al., 2002). A 20% reduction in rainfall is likely to reduce pasture productivity by an average of 15% and live weight gain in cattle by 12%, substantially increasing variability in stocking rates and reducing farm income (Crimp et al., 2002). Elevated concentrations of CO_2 significantly decrease leaf nitrogen content and increase non-structural carbohydrate, but cause little changes in digestibility (Lilley et al, 2001). In farming systems with high nitrogen forage (e.g., temperate pastures), these effects are likely to increase energy availability, nitrogen processing in the rumen and productivity. In contrast, where nitrogen is deficient (e.g., Queensland's extensive rangelands), higher temperatures are likely to exacerbate existing problems by decreasing non-structural carbohydrate concentrations and digestibility, particularly in tropical C4 grasses. Doubling of CO_2 concentrations and warming are likely to result in only limited changes in the distributions of native C3 (more productive) and C4 (less productive) grasses (Howden et al, 1999b).

The state's stock route network (SRN) will increase in importance to the pastoral industry due to more frequent and severe drought events. The network is used both for moving stock, and for short term drought relief. Queensland is committed to strategically maintaining and managing the SRN assets for a changing role in whatever climate change scenario emerges.

Grains and mixed grain and graze industries

The grain industry is not only important in its own right, but is also an important input to the beef industry. Elevated CO_2 reduces grain quality, firstly by limiting protein levels. Significant increases in nitrogenous fertiliser application or increased use of pasture legume rotations would be needed to maintain protein levels (Howden et al, 2003). Secondly, there is an expectation of a substantial increase in heat shock in northern Australia which will reduce the dough-making qualities of grain (Howden et al, 1999a, p.5). The limited modelling done on the regional impact of climate change shows the high level of uncertainty (Box 2).

Box 2

The potential impacts of climate change on wheat vary regionally, according to limited simulation work by Howden and Jones (2004). These show that at Dalby (Darling Downs, Queensland) in the year 2070, there is an 82% likelihood of increases in yield with these being up to 35% higher than historical values. Nevertheless, there is 18% chance of lower yields with reductions up to 42% compared with historical yields. Median yields were 12% higher than the historical baseline. However, simulation results from one location in Queensland should not be extrapolated to produce whole of Queensland impact assessments for wheat. Important climatic differences exist throughout Queensland cropping regions, eg, from Emerald in Central Queensland to Goondiwindi in Southern Queensland (Rodriguez and Sadras, 2007; Sadras and Rodriguez, 2007).

More recent results of a 716 parts per million CO_2 modelled scenario for 2070 showed a 22 % and 18 % reduction in median wheat and sorghum yields, respectively, for a cropping rotation at Brigalow (50km north of Dalby) (Crimp and deVoil, 2007, personal communication).

Horticulture

Horticulture is a $3 billion industry in Queensland. Important management factors are crop and cultivar selection to match the climate, pest and disease control and water supply. Increased temperature, reduced water supply and elevated CO_2 will interplay to exacerbate known risks and provide some benefits to horticulture.

The suitability of current sites and regions for horticultural production may change for some crops. Queensland temperate fruits and some vegetable crops which require winter chilling or vernalisation are likely to be negatively affected by warmer conditions. An expansion could occur in areas for growing tropical and sub-tropical crops. Similarly changes will occur in regions producing vegetable crops, as changes to the length and the timing of the growing season are likely to occur, together with the adverse effects of increased sunburn, changes in the timing of crop stages, bolting (premature flowering), pollination timing and failure, and other quality and yield issues. Frost risks may remain, as changes to planting times (facilitated by shorter winters) allow growers to plant earlier, exposing crops to the adverse effects of late frosts. It is important to note that rising temperatures are a constraint to moving horticulture north.

For tropical and subtropical crops such as avocadoes, mangoes and bananas, increasing temperatures will provide opportunities for production to occur in regions which are currently too cold for economic yields and quality. Increasing temperatures will reduce the development time for all crops (i.e. reduce the time from planting to harvest of all vegetable crops, and reduce the time from flowering to harvest in perennial crops).

Cultivar selection is used to better match the crop with climate. This will become an increasingly important adaptation strategy in horticulture, under a changing climate, where more adaptable vegetable cultivars will be required in the future.

Water demand will increase for most crops growing under warmer conditions. However, rainfall and, more importantly, runoff reduction will impact on irrigation water supply. Reduced river flow can be expected to affect the competition between natural flows, irrigation and town water supplies and hence increase the cost of water and constrain agricultural production. Horticultural crops, which are almost exclusively reliant on irrigation, are likely to be threatened where irrigation water availability is reduced. Increasing water use efficiency practices will be critical adaptation strategies. (IPCC, 2007).

Pest and disease pressure will change. The increase in CO_2 concentration may increase the growth and reproductive capability of some fungal diseases. However, decreasing rainfall may reduce fungal pressure, depending on the timing. Flooding due to extreme rainfall events could benefit the wider spread of some soil borne pathogens.

Higher temperatures will increase the activity of pests and diseases, and perhaps have a negative impact on the effectiveness of parasites and beneficial organisms. Cold season suppression of some pest species may be reduced. Examples of this potential are demonstrated in a recent modelling analysis which indicated that if citrus canker had become established in Queensland, the geographical range of the pathogen, *Xanthomonas axonopodis pv. citri*, was predicted to extend further south with a 1–5ºC temperature increase (Aurambout et al, 2006) and a predicted increase in winter temperatures may prolong the survival of weed hosts through winter increasing the ability of Silverleaf Whitefly to over-winter (known as a “green bridge”).

The Diamondback Moth (DBM) is a worldwide pest of brassica vegetable crops (e.g. Broccoli). DBM is most destructive when an extended season occurs or where temperatures during the production season are high (Deuter, 1995). With a warming climate DBM is likely to have an increased impact on susceptive crops.

Climate change is likely to make a major horticultural pest, the Queensland fruit fly *Bactrocera tryoni*, a significant threat to other parts of Australia. Apple, orange and pear growers in endemic Queensland fruit fly areas are likely to have cost increases of 42 to 82%, and 24 to 83% in the current fruit fly-free zone (Sutherst et al, 2000). Similarly, Silverleaf Whitefly will extend its current range to more southerly production districts as temperatures continue to rise.

There is a potential for increased risk of soil erosion in from the expected increase in the frequency of intense rainfall events (Cerri, Sparovek et al. 2007), together with a potential increase in nutrient and pesticide runoff into waterways and groundwater, requiring a change to the way in which runoff is managed in intensive production systems (McKeon, Howden et al. 1988).

The Great Barrier Reef is vulnerable to climate change (Hennessy, Fitzharris *et al.* 2007), and the impact of runoff after extreme rainfall events is exacerbated by nutrients (Wooldridge, Brodiec et al. 2006).

The March 2007 Next Steps Workshop on Climate Change in Agriculture (Department of Agriculture, Fisheries and Forestry) noted – ‘there is a dearth of user-friendly, adoptable tools that are useful in climate change adaptation at an enterprise level’.

Consumers may require assistance to accept some changed quality of produce (e.g. colour changes). More of a range of tropical produce may become available, as increasing temperatures drive horticultural production in a southerly direction.

Sugar Industry

The sugar industry generates $1 billion per annum in Queensland (Table 1), and is located in the coastal zone. Sea level rise, and intrusion of sea water into aquifers are a threat to this industry from climate change. Drought resistance will be increasingly important to the future of this industry. Biofuel targets could provide an additional market for this industry. Changes in temperature, CO_2 and rainfall will combine to impact on productivity. Modelling can determine the regional impacts, and assess adaptation options.

Implications for current farm enterprises and possible future industries

There is now clear evidence suggesting that Australian and Queensland agricultural production is likely to be constrained by drier and warmer conditions. In isolation, some of the already observed and expected changes, as described above could to some extent, be managed using readily available approaches (Howden, 2002). Modelling of a 2000 ha farm business from Central Queensland indicates that the greatest gains (that is to maximise profits while minimising downside risk and environmental degradation) can be made by identifying good seasons early enough to make the most of those opportunities (Rodriguez et al, 2007).

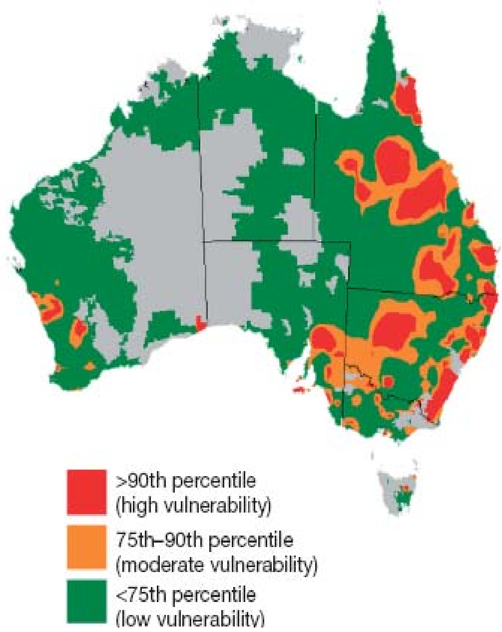
Other impacts, however, might require a complete re-think of current enterprises and farm business strategies and the application of more integrative analyses including all drivers for change, e.g., changes in markets, changes in productivity (driven by the adoption of new technologies), changes in natural and human resources, and changes and opportunities introduced by changes in mitigation policies (Meinke et al, 2007; Rodriguez et al, 2007). The wine industry is currently developing a climate change strategy and mapping future production areas and those likely to be lost. Similarly, some players in Australia's pastoral industry are purchasing land in South America. Further adaptation actions incorporated into Farm Management Systems will be some steps down the track.

This calls for longer term or planned adaptation strategies that would include changes in enterprise mix, diversifying into off-farm employment, investing in non-farm assets, migrating to new industries and regions and research into new technologies (Ellis 2000; Nelson et al., 2005). Options available to irrigated industries include improving water use efficiency, modifying the portfolio of irrigated enterprises, and water trading (Heyhoe et al., 2007). In most cases this will require integrative simulation exercises that account for all the major interactions emerging from the combination of changing climate, markets, human and natural resources, thereby providing a tool for rapid assessments of alternative futures (Meinke et al., 2007). Promising adaptive management, farm business strategies and policies that emerge from such systems analyses then need to be assessed for their socio-economic merits via participatory systems analyses. Open discussion of these outcomes will empower decision makers to choose their own alternative future while increasing their degree of preparedness and adaptive capacity to cope with a changing production environment.

The adaptive capacity or resilience of rural livelihoods can be enhanced through policies that increase the diversity of both farm and non-farm assets and activities from which rural livelihoods are derived, and the flexibility to switch between them (Ellis, 2000; Nelson et al, 2007). Nelson et al, (2005) showed that the capacity of Australian rural households to cope with risk can be broadly determined by the human, social, natural, physical and financial assets from which rural livelihoods are derived. Their derived standardised index of vulnerability for Queensland shows that present vulnerability is already high (>90th percentile) for most of the Western Downs and Central Queensland regions, indicating that these areas are likely to suffer the most from any further economic – social stress imposed by changes in climate.

Although the knowledge and the systems tools to conduct such an integrated, participatory scenario analyses exist, significant resources would be required and an institutional support structure would need to be in place to enable engagement with the rural sector in an on-going and sustained fashion (Meinke et al, 2007).

Risk assessment tools are being developed for the wine industry (linked with similar work for the tourism industry) to assess climate change impacts on a regional basis. The outcome of these risk assessments will be regional climate change action plans.



Standardised indices of the vulnerability of Australian broad acre farms using equally weighted indices of human, social, natural, physical and financial capital (Nelson et al., 2005).

2. The need for a national strategy to assist Australian agricultural industries to adapt to climate change

The Queensland Government supports the need for a national strategy to assist Australian agricultural industries to adapt to climate change. The Queensland Government is in the process of implementing its ClimateSmart Adaptation Plan (2007–12), which specifically includes primary industries and supports the National Agriculture and Climate Change Action Plan 2006–2009.

Climate change is a global problem hence a response which prioritises issues at a broad scale is required. As climate change appears to now be upon us, it is timely to increase the focus on adaptation. A national adaptation strategy would allow a national perspective in prioritising issues to be addressed and provide economies of scale in addressing issues that are common across the country.

Synergies would arise from the state and territory governments and the Australian Government working together on adaptation. Sharing of knowledge, coordination to minimise duplication, alignment of funding programs, coordination of partnerships with industry, interstate competition to lift performance, and the development of centres of expertise in particular aspects of climate change adaptation are possible through a national adaptation strategy.

The adoption of a national strategy could assist to send a clear message about the reality of climate change to the agriculture sector. It could facilitate the migration or development of new industries in response to climate change. This strategy needs to be aligned with the NHT3 program, and should shape the direction and purpose of drought assistance towards implementing climate change adaptation measures.

The Queensland Government is keen to continue to work with its interstate partners on adaptation to climate change. The strengths that Queensland has to offer are expertise in mixed farming (cropping and grazing) systems and climate modelling, grazing land management, tropical horticulture and irrigated agriculture. The climatic conditions previously experienced in Queensland will extend into NSW and SA, so the knowledge base of the Queensland Government will be useful to its interstate counterparts. Queensland has been at the coal face of fighting the invasion of tropical pest plants, animals and diseases, which will be increasingly important as temperatures increase further south. Queensland also has a strong and relatively well resourced agricultural extension service. However, resources are needed to prioritise needs and assess adaptation options.

3. Adequacy of existing drought assistance and exceptional circumstances programs to cope with long-term climatic changes

The Queensland Government is committed to continuing to work with rural communities to ensure they have the resources, tools and skills to be prepared for greater climate variability. The primary industries sector is increasingly challenged by sustainability pressures which include water availability, price, climate variability and climate change. Water and climate directly implicate the ability of producers to increase or even maintain the productivity of their systems and deliver high value products. Using the historical record for drought declaration processes may no longer be indicative of future conditions, with implications for sensible drought planning. Drought assistance programs were not designed to cope with long-term climatic change.

The focus of national drought policy is on self reliance and drought preparedness, but recognises a continuing role for governments in drought assistance programs. The ability to implement this policy focus has been limited in recent years due to continuing drought conditions. Through the Primary Industries Ministerial Council (PIMC), plans are being developed to phase out business assistance during exceptional drought events to be replaced by financial incentives to ensure producers are better prepared for future drought events. Better risk management practices and a focus on being better prepared for drought benefits producers seeking to effectively manage greater climate variability.

Consideration should be given to providing greater support for proactive incentive-based assistance programs that provide assistance based on the long-term efforts of an enterprise to improve land care management and farming sustainability. Improved economically-based multivariate evaluation frameworks and models are needed to ensure that the quantum and nature of any assistance provided is guided by viability and sustainability prospects in the long-term. While welfare and community support is important, it is only one component of what should be a broader and more strategic assistance response. It would be advantageous for PIMC to continue developing this policy.

The Queensland Government has spent substantial resources in assisting producers, regional businesses and communities cope with drought events. The Queensland Government has also invested more than any other State or territory in drought preparedness programs to help producers be better prepared for drought and climate variability. These include the development of climate forecasting techniques and a range of farm management tools that practically integrate these climate forecasting systems into producers' operations. Queensland Government climate forecasting systems such as the Southern Oscillation Index (SOI) phase system have become widely adopted internationally. Continued development of these applied forecasts and integrated decision support tools are integral to ensuring producers are able to adapt to an increasingly variable climate.

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Appendix 1

Summary of climate change projections for Queensland

Future changes in rainfall tend toward a decrease over much of the state with annual average changes in the range of −13% to +7% by 2030 and −40 to +20% by 2070 compared to averages calculated over the 1961 to 1990 period. Strong decreases in rainfall are projected for winter with most of the inland regions projected to change in the range of −26% to +7% by 2030 and −80% to +20% by 2070. Widespread reductions in rainfall are also projected over much of the state in spring, with decreases in the range of 0% to 20% by 2030 and 0 to 80% by 2070. In summer, increases or decreases of equal magnitude are possible over much of the state except for the eastern side of the Cape York Peninsula and the south-west of the state where there is a greater tendency towards rainfall increases in the range of −7% to +13% by 2030 and −20% to +40% by 2070. In autumn, there is a tendency toward rainfall decreases over much of the southern and eastern parts of the state in the range of −13% to +7% by 2030 and −40% to +20% by 2070. In the centre and west of the state, stronger decreases in the range of 0 to 20% by 2030 and 0 to 80% by 2070 are possible (Caie et al, 2005).