

Australian Primary Industries Transforming Project: Climate Champion case study

The Project

This information sheet provides a summary of the main findings of the first round of interviews with Climate Champions, as part of the Australian Primary Industries Transforming project. Climate Champions are a group of farmers interested in managing risks associated with climate and weather to improve productivity. The program is industry supported and based on sharing knowledge between researchers and farmers, and farmer-to-farmer, to better manage climate related risks.

Primary industries in Australia are highly vulnerable to the impacts of climate change. However, by adapting to these projected changes, industries and communities can help reduce the negative impacts. Adaptation will also allow resource managers to take advantage of any opportunities provided by the new conditions. Small, incremental adaptations to management practices and operations are continuously being made in primary industries in response to climate shifts.

This CSIRO project asks: *What social and economic conditions and processes drive resource managers to make more significant, transformative shifts?* Transformative shifts could include relocating industries from irrigated and drying areas to higher rainfall zones, or completely changing the industry or land use mix in a specific location.

This project aims to gather information about the economic, environmental, social conditions and support required for primary industry and communities to significantly change their practices in response to climate change. It is about understanding what encourages people to change their practices and what knowledge, skills and support are required to transform.

This round included interviews with thirty Climate Champions from a range of different industries and enterprises around Australia: mixed horticulture, olives, wine, cotton, sugar, beekeeping, dry land grain cropping, seed production and/or livestock (beef, wool and/or lamb). The interviews included questions about:

- Type, scale and level of complexity of changes
- Reasons for changing practices

- The change process
- Approach to risk and decision-making
- Influences on changes
- Challenges and opportunities of changes

Summary of main interview findings

Climate change observations and perspectives

Climate changes reported by participants were predominately about rainfall and included: volatile seasons; warmer winters; more record hot months; unseasonal heat and cold; less frosts; more severe and late frosts; more catastrophic fire days; reduced and unreliable rainfall; less winter rainfall and more spring/summer rainfall; bigger hail events; more and larger (summer) thunderstorm events that provide the majority of annual rainfall; more extreme storms, heat and rain events; and, drier and warmer on average. One participant had undertaken a trend analysis of historical rainfall records on his temperate operation and found that although the annual rainfall average had changed little over the years there had been a loss of around 100mm of rainfall in the critical autumn period and a gain of about the same amount in late spring and summer.

Participants covered the spectrum of views on climate change. Most participants believed or accepted that the climate was changing based on farming experience and scientific evidence. Some participants said they were not sure why the change in climate was happening. Other participants either believed climate change was anthropogenic or natural variability exacerbated by humans. Several participants were very concerned about the rate of change in climate, the catastrophic consequences for future generations, and the lack of government acceptance of the science and action to reduce carbon emissions. However, a number of participants were not convinced that the change in climate was going to be as dramatic as what is predicted or that the climate change was happening relatively slowly from season to season. One participant reflected that there was a difference between acknowledging climate variability (that involves small short-term adaptive changes) and climate change (that involves long-term planning). Numerous participants said that they thought many producers believed climate extremes were a cycle,

compared to believing the extremes are a permanent scenario requiring a different approach. One participant believed that most producers are changing their farm practices, even if subtly, for the change that they are seeing or experiencing, rather than planning for a permanent long-term shift in climate. Regardless of how participants perceived the causes of climate change, they were all making changes to adapt.



Drivers, influences and challenges

Participants were motivated to make changes to their operations based on a range of interrelated drivers. Most drivers were based on improving the economic viability of the operation: improving efficiency; reducing labour costs; increasing profitability and productivity; becoming less short-term profitable, but more long-term economically sustainable; lowering costs; getting more from less-inputs; and, maintaining a consistent cash flow. Other drivers included: improving animal welfare; being inspired by new education and information; managing and reducing risk in relation to a changing climate and market; and, allowing for flexibility and learning in the operation.

High production costs were reported to be a main driver for the changes they were implementing. For example, high electricity costs were a main reason for changing to solar; high diesel prices were motivating beekeepers to be less nomadic; high costs for wages, fuel, fertiliser and equipment were motivating participants to implement changes to reduce costs. Participants stated that high debt could either lead producers to intensify and push the system for short term profit or be a driver for change and innovation to improve viability and efficiency. Several participants believed that succession creates change through the younger generation, with a long span of farming ahead of them, taking over the farm and being open to new ideas and innovations.

Related to climate change

Participants stated that changes in climate were a main driver (e.g. experiencing extreme events, less water availability, excess water), or an indirect driver (e.g. changes to water regulation and entitlements) of change. Many participants described reducing and managing climate risks as a main focus of their business. Risks to enterprises from climate change was

said to depend on geography (e.g. if situated in a flood and fire prone area). One participant said that if his decision-making was still based on every year being an average to good year the enterprise would have become unviable. Participants whose enterprises were 100 percent rain fed with no irrigation said that they were more susceptible to climate variations than others. One participant said that the biggest challenge was trying to manage oscillating extremes (e.g. from drought to flood). Many participants said that they were implementing changes to conserve water resources and soil moisture, including improving soil structure and nutrients. For example, several participants reported keeping different maturing varieties so that they can change varieties and time of planting depending on the seasonal outlook. Some participants said they had increased chemical weed control to conserve soil moisture. A livestock producer said he had started trading cattle so that it is possible to work with the seasons and easily change stock numbers. Another livestock producer said that worm resistance measures had become a priority because sheep graze lower to the ground in drier years. A reduction in growing season rainfall was motivating grain growers to look for more secure alternatives (e.g. increases in livestock or geographically diversifying). A grain producer said that over the last ten years extreme hot and dry conditions had burnt the tops of grains and floods had changed the quantity of grain and/or made it impossible to harvest. One participant believed that the seasonal variability was a barrier to building relationships for niche markets if one year in three it is not possible to fulfil obligations.

Participants mentioned a range of positive and negative consequences for their industries from climate changes. A few participants spoke of positive consequences. For example, one sugarcane grower believed that the increases in temperature and water in his area would benefit cane growing. Several grain producers said that the season volatility had provided an opportunity to market grain at a high price when seasons are good to then be able to invest in innovations and land. However, many participants mentioned negative consequences. Wine producers said that the rising vintage temperatures were creating challenges for wine production through advancing vintage, an imbalance between sugar and flavour ripeness, and an increase in yields and decrease in quality. Insufficient rainfall was said to be a barrier to preparing the soil for cropping. One participant, who had undertaken a trend analysis of soil moisture for his operation, found that the soil was below permanent wilting point 52% of the time, and under the data for climate change would increase to 62%. This participant also said that increased summer rainfall posed a risk of deep drainage, thus

accelerating a salinity problem. In the beekeeping industry, more extreme heat and rain events was impacting honey production through plants (mainly *Eucalypts*) not flowering as frequently, regularly, or as long as before and producing low nectar. The increased temperature was also causing beeswax to become soft and collapse, and creating ideal conditions for a pest beetle to spread and cause hive damage.

Related to market

Some enterprises were more strongly market focused than others. For example, one producer said that he has regular meetings and heavy liaison with marketing companies, and receives regular feedback from customers. Whereas another participant believed that production of a bulk commodity like grain did not provide a lot of opportunity for interaction with markets or consumers. Participants were supplying to a mix of local, domestic and international markets. Some grain producers were contract selling before growing the crop.

Markets were, in addition to climate change, a main influence on changes that participants were making to their enterprises. Many market driven changes were to reduce risk and increase returns, including: diversifying crops to diversify markets in case one collapses; planting earlier to get early produce and a higher price; investing in on-farm storage to stagger sales and maximise returns on premium grain; choosing a process, breed, variety and crop for a premium price and market; and, producing organic meat for premium markets. Some changes were in response to changing market trends such as: becoming carbon neutral; breeding non-mules and non-horn sheep; breeding cattle for different domestic, feedlot or export trends (e.g. flat backs, rather than Brahmins). Some changes were a consequence of new regulation and changes in societal and community expectations of farmers (e.g. health food safety, environmental and animal welfare standards; conditions on the milling process; and increased monitoring practices). A few participants were making changes to have a closer connection to the customer (e.g. buying a cafe and selling meat direct).

Challenges that participants highlighted in relation to the market included: unfair terms of trade due to subsidised and risk insured agriculture and/or lower standard of living in other countries (compared to high costs, low commodity prices and high dollar in Australia); a possible partial ban on the reverse osmosis process by European wine markets; quality assurance programs forced onto industries by supermarket chains; costs of environmental, health

and safety regulations not being adequately recognised in produce prices; fluctuating prices of stock exchange traded commodities; monopoly of price, cheap imports and discounting of consumer price from supermarket conglomerates; downturn in the European market with the Global Financial Crisis; changing consumer trends (e.g. Wagyu to lean beef); and, difficulty accessing high value grain markets (e.g. chemical residues compliances in other countries).



Related to government and industry

Participants provided a range of opinions in regard to government and industry policy and support for agricultural industries. Participants were encouraged by government support for: tree planting and restoration programs, water infrastructure investment grants, research programs (e.g. Reef Rescue), purchasing low fuel tillage equipment and the Climate Change Champions program. Several participants believed low government subsidies had encouraged self-determination, innovation and improved business management; however, others praised government for providing drought subsidies. Concerns and challenges for participants included: the reduction in food production areas from urbanisation, a carbon pricing system based on community expectations rather than scientific evidence, excessive paperwork for water and bore licences, the social and environmental impacts from mining and gas company communications and developments, poor internet access and mobile phone coverage, termination of the National Broadband Network roll out, reduction in local knowledgeable extension officers, closure of agriculture departments and the consequent loss of mentoring and facilitation services to link producers with organisations, a lack of financial support to implement new regulations (e.g. meters), poor leadership and disunity from industry faction groups, and a lack of planned collaborative responses to animal welfare concerns (e.g. live export ban).

There was also a list of concerns from participants in relation to industry research and development and facilitating adaptations to climate change, which

included: low support for collaborative research with producers and scientists acknowledging and solving problems together; the dominance of biophysical knowledge above other knowledge; low support for research on alternative ideas, diversifying the enterprise and becoming skilled in alternative industries, and increasing financial security through a less intensive system (e.g. low chemical and fertiliser use, high value seed crops); research timeframes mismatched with political and funding timeframes; and, unreliable weather forecasts and the lack of support for increasing the reliability of forecasts.

Changes to operations

Some participants perceived the changes they were making to their operations as large, deliberate and systematic across the whole enterprise. Whereas others said they were making 'smaller' incremental changes that were adjustments or changes to an existing system, sometimes leading to a significant change. All participants believed the changes were fundamental to the future sustainability and financial viability of their enterprise, that they were making progress to become more innovative and efficient, and seeing benefits from their changes.

Participants managing cropping enterprises were implementing a range of changes. These changes included water planning and irrigation changes such as installing new irrigation systems, water harvesting and storage structures (e.g. lined and covered dam that gravitates throughout farm, integrated gravity fed irrigation and drainage system, upgrading surface irrigation system and developing a long-term water security plan). Conversely, one participant was building levees and structures to improve drainage, keep water levels down and cope with flood events.

Cropping participants also discussed a range of agronomical and mechanical changes, including:

- diversifying crop types (e.g. different maturing times), varieties (e.g. more flood, drought, frost and/or heat tolerant and deep emergent) and markets;
- changing crop planting times (e.g. sowing earlier to avoid heat);
- improving fertilizer application efficiency through tailoring inputs or applying inputs as the season unfolds;
- modifying seeding machinery to increase flexibility with soil moisture;
- elevating canopy of grapes to reduce heat exposure;
- using fans, fog and planting on higher ground to avoid frost damage to olive trees;

- saturating soil in vineyards in preparation for extreme heat events;
- purchasing another property with a different soil type to diversify crops;
- setting the farm up into flexible management units for different crops based on the seasons and markets;
- geographically diversifying by purchasing a operation in a warmer region to try out new heat tolerant varieties and/or in a cooler areas if unable to adapt with new varieties;
- purchasing a fertiliser spreader to fertilise in front of rain events;
- purchasing a foliar sprayer to be less dependent on rainfall for fertilising; using heat sensors to guide irrigation timing; boom spray camera weed seeker;
- introducing GPS on machinery for precision cropping;
- increasing no-till cropping, direct drilling, tram lining, controlled traffic, furrow seeding and stubble retention and spraying; using stubble as a natural trellis for legume crops;
- fencing and revegetating riparian areas to reduce dry land salinity;
- increasing lime applications to improve the PH and soil condition; and
- green cane harvesting rather than burning; and, starting to grow summer crops.

Cropping participants also talked about maintaining ground cover in-between crops and rows to suppress weeds, plant annual productive pasture for livestock as a rotation crop, increase pasture for livestock. Some cropping participants were also increasing livestock numbers and reducing cropping areas. One participant decided to include livestock in the enterprise to supplement income in bad cropping years and reduce risk from big crop losses.



Grain and livestock participants were implementing a range of operational, animal husbandry, planning changes to their enterprise. Changes to the cropping and livestock composition of the operation included: either increasing livestock on cropping lands or converting to a livestock enterprise, rotating grazing with cropping, and implementing a new feeding system to store and feed grain. Changes to the livestock operation included: building an indoor sheep shed to finish lambs; trading livestock, rather than

maintain a core breed, to easily increase and decrease numbers; introducing worm resistance measures for sheep; choosing genetically fatter sheep to improve resilience in dry years; breeding non-mules and non-horned rams; and, increasing animal handling skills.

Some participants spoke of geographically diversifying by: leasing a property in a different area with higher rainfall to fatten stock during dry times, leasing a cooler property with a different soil type to run livestock separate from cropping, and using the stubbles on neighbouring cropping properties to fatten stock. Changes to improve the ecological condition of the property included: revegetating and rehabilitating for improved water infiltration, biodiversity, and reduced erosion; creating stock containment and feed areas to reduce grazing pressure; changing from set stocking to a dynamic rotational grazing system to improve pasture, and reduce supplementary feeding and weed invasions. One wool producer discussed a range of measures to adapt to climate change: trialling subtropical perennial grasses in a temperate region to take advantage of episodic summer rainfalls and milder winters; selecting rams with low methane emissions; and, planting pasture plants with methane combating qualities to supplement diet; and, implementing a drought management plan to manage stock and feed.

One participant reported a change in the beekeeping industry, due to less reliable nectar sources, from operating over a wide area and being nomadic to being more strategic about movements. This participant also said that because of more extreme flood events, beekeepers were becoming more cautious about where to situate hives. Beekeepers were also starting to leave bees in the one area and feed pollen protein and sugar syrup to supplement local nectar supplies and maintain bee health.



Participants were also making changes to business management and marketing such as:

- implementing a holistic management strategy;
- building relationships with domestic and foreign companies;

- changing to more profitable niche markets;
- negotiating with wine companies to grow larger amounts of grapes at a lower price;
- diversifying with off-farm income;
- starting new businesses (e.g. contracting and consulting);
- investing in staff development;
- increasing on-farm storage for higher quality product to access premium or specialised markets;
- engaging in carbon trading and marketing;
- purchasing more land;
- improving business farm planning to better manage unpredictable events and integrate structures and aspects of the business; and
- starting to review management operations continuously in response to climate.

Some participants were also implementing energy conservation measures on their enterprises. For example, one grape and wine producer was reducing the carbon footprint of an already certified carbon neutral operation through: implementing solar PV; shifting to light weight bottles; changing warehouse and transport arrangements; installing VF drives on every three phase motor; using high efficiency globes; reducing refrigeration demand; using a solar hot water system; purchasing EU compliant cars (e.g. under 125 grams of CO₂ per kilometre); encouraging staff to work at home; and, growing and harvesting 1.2 hectares of *Arundo donax* (giant reed or bamboo) for biochar and carbon sequestration. Another participant was converting water pumps to solar.

Participants were either starting to use, or increase their use of, a range of tools and techniques to measure the effects of climate changes and to better adapt to the changes. For example, one participant was measuring changes to grape and wine produce through a combination of a statistically validated grape sampling technique, field tests and tank tests. Some participants said they were testing nitrogen in crops (e.g. sugarcane) and soil to reduce and be more efficient with fertiliser applications. Participants also reported increased use of yield projection and mapping, and monitoring of water usage, soil moisture and weather and seasonal forecasts. One participant had started measuring likely soil moisture for his operation in the future, in terms of climate change predictions, through a trend analysis of rainfall within and between seasons and the historical situation with soil moisture on properties with a similar soil type. Livestock producers were also adopting more sophisticated pasture and stock monitoring programs.

Difference from the past and others

All participants said that their enterprises were markedly different from how the operation was managed 15-25 years ago. Operational and agronomical differences included: supplying product to a number of people rather than one, greater crop diversity, organic certification, watching forecasts closely, rotational grazing rather than set stocking, long term business management, and more sophisticated and selective marketing. Technical and mechanical differences included: increased technology and less labour; less application of inputs; and no longer slashing, burning and ploughing;

Participants perceived mostly innovative, proactive and low production changes as being different to others in their region and/or industry. Many participants believed that changes such as simplifying the level of crop rotation, combining multiple crop paddocks into one and improving water use efficiency were similar to others. Changes that were perceived to be different and more innovative to others included: becoming organic, reducing cropping intensity and inputs, reducing cropping area and increasing pastures and livestock, rotationally grazing stock, implementing water harvesting systems, installing indoor sheds for finishing lambs, fencing to landscape and soil types, and proactively managing adverse situations. Some participants described themselves as 'innovators' (i.e. being the first to try a practice) or 'early adopters' (i.e. adopting after observing others try the practice first).

There was a mixed perception among participants as to the degree of 'change' different industries and producers were making in response to climate change. Some industries were perceived to be reactionary in their response to climate change and slow to accept the long-term effects of climate change. The wine industry was perceived to be more proactive and advanced than other industries in adapting to climate change. A participant said that because vines are very sensitive to temperature changes the wine industry had been quick to accept the long-term predictions of climate change and invest in research for solutions to adapt. One participant believed that most producers were making changes to manage increased variability (e.g. buy extra water, improve irrigation, change varieties), rather than doing something different or shift their system and practice.

Planning process

Most participants stated that they always use a planned approach. Several participants described their approach as looking at the bigger picture or long-term implications of decisions, rather than each year in

isolation. Similarly, several participants said that they took a holistic or whole farm plan approach, rather than focusing on specific areas in response to certain events. One participant reported researching different aspects of the operation and combining them altogether in the one system. Planning processes that participants said they used when implementing a change to their operation included: gathering information from research, rainfall records, BOM seasonal outlooks, and talking to peers and experts; trialling a small area before implementing the change across the whole operation; mapping out high and low production and risk areas; continually reviewing and monitoring practices and thinking of possible future scenarios; taking principles and applying them to their individual situation; continually fine tuning and tweaking plan; and, working within parameters of climate, land and soil type. One enterprise had a system of continuous improvement decision-making where decisions went through staff management review and budget meetings guided by the company's goals and mission statement to be as agronomically, financially, and socially sustainable as possible.

Perceptions of risk, complexity and stress

Perception of 'risk' varied among participants. Most participants said that they took evidence based, informed and calculated risks. Some participants believed they took both planned and uncalculated risks, depending on their financial situation and the potential returns and losses of the decision. For example, some participants thought that others perceived implementing a practice that is different to the norm as 'risky', whereas they perceived the decision to be necessary to minimise, mitigate or reduce risk. Some participants described themselves as risk averse, cautious, conservative or low risk. One participant believed that you become more risk averse at you age. These participants reported assessing potential risks continuously to reduce losses, consolidating and making the best income out of the resources they had, and/or reducing the risk associated with 'boom and bust' cycles. One participant said that the moment you put a crop in it is taking a risk with climate.

Financial and production risks that participants perceived from the changes they were making included: suppliers going out of business, low market demand for new varieties, loss of high crop yields from high rainfall years through changing to livestock and a low production system, loss of return from purchasing new equipment, drops in commodity prices and risk of buying diseased animals when buying and selling livestock, leaks in water harvesting structure, probabilities of weather forecasting, bore drills not

making changes to their operations. Informal sources included: family members and friends; buyers and merchants; local, interstate and global peer networks both within their industry and other industries; conversations with, and observations of, others' practices and techniques. Participants said that they liaised and sourced information from: agronomists, research and development institutes and researchers, accountant or financial advisor, Landcare and NRM groups, agricultural departments and extension officers, private or industry consultants, and livestock nutritionists. Information was also sourced informally from: the internet (e.g. blogs of other producers and agronomical research websites, BOM weather forecasts and historical data and tools) and reading research publications and journals. More organised sources included: grower, producer systems and 'best practice' groups; workshops, courses and forums in financial, environmental and grazing management; and, on-farm open days and research trials.

Several participants said that they speak to a wide cross-section of people and experts, depending on the particular issue that they are trying to address. It was common for participants to say that they gather information through sharing ideas and practices with peers (especially innovators and risk takers) and then make a final decision of their own. Participants believed that groups and research trials, that provide on-farm opportunities for producers in similar situations and areas to learn from each other, were invaluable. One participant said that through others questioning practices it encourages critical reflection and helps to see the big picture. Some participants reported having low trust in private consultants with vested interests and reports published by consultancy firms. Several participants said private consultants were often too general with their advice and did not have the practical knowledge of implementing changes. One participant said that he trusted advisers who reinforce their decisions with scientific evidence.



Climate Champion Program

Participants said that the Climate Champions program had been an invaluable opportunity for learning about climate change and building a large and trusting

network of producers from around Australia to share knowledge and learn new ideas on climate change adaptation through inquiry. The program was discussed as an opportunity:

- to learn from producers from different age groups, businesses and production types and systems who are positive, adaptive and adopting approaches that are not a general trend;
- show similarities between industries and situations;
- spread information learned through the program among local networks;
- for researchers to interact with producers and get to know each other's language, knowledge and views;
- to learn more about aspects that cannot be controlled and become more efficient; and,
- to build connections with extension officers, researchers, and agencies to design more effective and producer relevant programs for managing climate change (e.g. soil moisture rather than rainfall and temperature focus).

One participant believed that more than ever before producers are going to need the exchange of information and experiences and the social support and network that a program like Climate Champions offers.

Insights for successful change

Participants provided a range of insights for improving the success of adaptations to climate change: maintain flexibility, adaptability, positivity, honesty, receptivity and nimbleness; be open to change and difference; follow weather forecasts carefully; know exactly what your cost of production is; become financially resilient so that you can afford to not sell produce when price is low; build emotional and physical resilience to be able to locate to a different farm if needed; keep looking at the big picture ahead, rather than little things; implement a long term plan; build a system that combines smaller parts to make a whole system; look for simple ways to implement change; critically reflect on decisions continuously to ask if something better could be done; maintain open, regular and equal communication with others in the business; maintain respect for different opinions; delegate and pay others to do little jobs so there is time for learning and business management; attend meetings and forums with business partners to maximise learning; become self-sufficient and non-reliant on external support; build and maintain strong relationships with all parts of the supply chain; realise there is no 'magic bullet' to solve problems; plan and trial implementation of new practices; take into account the opportunity of other options; be considered,

dynamic and gradual in approach; ensure the market potential of options are well-researched; and, use downturns to improve the position of the farm for when conditions improve. Participants also commented that through the experience of implementing changes they had developed a greater knowledge and understanding, become more outward looking, built information and support networks, and/or become more confident and less stressed about how to manage challenges.



Participants spoke of a range of personal and cultural aspects that they believed had a positive influence on decision-making. Personal characteristics included: being determined, optimistic, confident and positive; embracing challenges; being flexible and responsive to change; being open to change, learning and new ideas; having a medium risk profile; being a good communicator and open to criticism; having an unconventional mindset; and, being able to see outside dominant norms and practices. Skills and abilities that participants said made a positive difference included: strategic planning and business management skills; the capacity to avoid debt; leadership abilities; an ability to think through the consequences of decisions logically, self-evaluate decisions and critically reflect on practices and information; and, the skills to be able to work in areas outside of farming. Family and cultural factors that participants said had a positive influence on decision-making included: maintaining family time and a low stress/lifestyle; being well educated; having broad off-farm experiences; having a supportive family and good team of workers; and, having a partnership with common goals and shared responsibilities.

Participants mostly perceived 'being successful' as having a happy, family and time and money for holidays and a comfortable lifestyle; no financial worries; and low stress. Financial and production success was also important to many participants. For example, making enough profit to give to the community and leave the farm in good condition, producing high quality produce and being able to expand. One participant viewed 'success' as

maintaining a viable operation through the 'ups and downs' of climate change.



Future outlooks

Participants gave a range of more or less optimistic outlooks on the future of their industries. Some cropping participants felt that with aspects such as increasing global food demand, expanding markets and changing lifestyles in China and India, the grains and cotton industry had a positive and viable future. One participant believed that investment by Asian countries in industries was a good opportunity for opening up markets into these countries. One livestock producer was excited by the opportunities that could arise from carbon farming initiatives. Another participant was confident that with technology advances primary industries would evolve to cater for climate change. However, some participants were unsure of how financially viable cropping would become in semi-marginal areas with reduced growing season rainfall and increases in temperature.

Several participants were uncertain of the future of their enterprises if temperature and rainfall changes go into uncharted territory and improved varieties and technologies cannot address the problems. One participant believed that it would be easier for annual rather than permanent crops to adapt to climate change. A grain producer was concerned about the uncertainty stemming from fragmentation of the industry, foreign ownership and increase in corporate-style farming. A wine producer was unsure of the marketability of new varieties adapted to warmer climates. Several participants were concerned that older producers would not be able to, and/or interested to, make the quick, large and dynamic shifts required to adapt. One participant believed that there could no longer be Australian produce for some industries in the future. Some participants were concerned about the impacts of mining expansion on prime agricultural areas with land loss and competition for water and labour. Urban expansion onto agricultural land was another concern for the future of industries in some areas. Some participants

were concerned for producers in their industries who continue to 'roll the dice' with weather (rather than acknowledge, and plan for, climate change) and who have become dependent on government subsidies in times of crisis. There was also concern among participants for the loss of social fabric and services in rural areas, and for natural resource management on farms, with less small family farms, decreasing rural populations and greater farm amalgamation and corporate ownership. One participant said that it was getting harder and harder to maintain viable small enterprises with increasing economic and climate pressures.

Some participants discussed possible directions for their industries in the future. A bee-keeper believed that pollination services could become in higher demand and more profitable than honey production due to climate change and pest problems. A wine producer said that technological options exist to adapt the wine industry to climate change (e.g. netting the vineyard and using misters), but the options were highly energy intensive and costly. A sugar cane grower believed a viable future for the industry stemmed from manufacturing a diverse range of products (e.g. paper, energy, by-products) from the cane. Several participants believed that with the recent drought, high debts and subsequent bank foreclosures there could be a high rate of producers exiting farming and an increase in foreign company ownership of properties. One participant believed that Australian producers could have increased business opportunities through transferring our well-advanced agricultural skills and technologies to producers in countries that have easier farming conditions.



Recommendations for policy

Recommendations for policy from participants included:

Economic

- create subsidies, tax relief and/or higher prices for producers to implement animal welfare, human health, water and soil conservation and environmental measures;
- set higher prices for higher quality products;
- link consumers and producers through farmers markets and farm open days;

- increase competitiveness and protection from cheap imports through tariffs; and
- foster and facilitate diverse industries and enterprises.

Research investment

- support research that identifies new technologies, crops and varieties to increase productivity and adapt to climate change;
- support detailed analysis and information to better understand conditions and impact of temperature on crops in specific areas;
- support research that identifies strategies to manage snail, slug and pig pests and disease in retained stubble; manage wild dogs; and, reduce chemical use for weed control on retained stubbles, especially for areas adjacent to the Great Barrier Reef;
- increased support for 'bottom up', collaborative and non-corporate funded research;
- facilitate scientists/researchers to build stronger relationships with producer networks; and,
- improve health, community and communication services in rural areas.

Social

- increase diversity of stakeholders (e.g. more urban people and women producers) on commodity and industry groups;
- foster young people to enter industries;
- empower women in farming businesses;
- increase promotion of producers as professional business people;
- employ social media experts to expose quality problems in commercial produce; and,
- set a higher price on quality domestic produce to increase commodity price.

Regulations and Infrastructure

- develop collaborative animal welfare regulations;
- increase infrastructure for roads and communication; and
- form a government/industry think tank to assess agricultural policy decisions.

Education

- assist producers to learn how to utilise climate modelling;
- support research to increase the accuracy and reliability of weather and climate information as far forward as possible; and
- lead discussions into climate change with more sceptical producers through an acceptance of greater climate variability, and make the language around climate change and adapting simple and relevant.



Conclusion

The Climate Champion program, and networks formed, appears to have increased producers understanding of climate change and techniques to adapt, and the level of motivation to change and adapt. Climate change adaptations in industries such as grain and/or livestock appear to be driven more by individuals and peer networks. Whereas adaptations in industries such as wine appear to be driven by a more whole of industry approach. Changes included a mix of 'best practice' and less conventional practices. Changes reported included: tweaks to existing systems, larger system changes that require a different management outlook, and/or changing to a low cost and production operation with less 'boom and bust cycles.

Climate Change Champion participants were all making changes or adaptations to their operations to reduce risk from changes in the climate, economy and market, as well as a range of other reasons. Some participants were making smaller more short-term adjustments, whereas others were making larger more systematic changes. Changes included a mix of 'best practice' and less conventional practices. The degree of complexity of the change process depended on aspects such as the scale, number of factors involved and the amount of information available. Producers' participation in local, national and global peer networks and groups were an important influence on the change process. Finally, some participants were more positive than others about the future of their industry with climate change and other social-economic pressures.

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