AGRICULTURE IN THE NORTHERN WHEATBELT: RURAL LANDHOLDER SOCIAL BENCHMARKING REPORT 2021

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WITH

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Disclaimer

The views expressed in this report are solely the authors', and do not necessarily reflect the views of Southern Cross University, the Soil Cooperative Research Centre or the people consulted during the research project.

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LIST OF ACRONYMS

SCU – Southern Cross University
CSU – Charles Sturt University
GIS – Geographic Information System
LGA – Local Government Area
WMG – West Midlands Group
NRM – Natural Resource Management
Soil CRC – Soil Cooperative Research Centre
WANTFA - Western Australian No-Tillage Farmers Association

LEGEND

= Significant difference by Farmer Type

*** = Significant difference by Rainfall Zone

FTF = Full-time Farmer

PTF = Part-time Farmer

HF = Hobby Farmer

NF = Non-farmer

THE CONTEXT

The Soil CRC national survey project, *Surveying On-Farm Practices*, was initiated in 2019 to implement surveys in all six states, in partnership with local farming organisations. The regions were selected to represent a range of different farming systems and bioregions, with a major factor being the willingness of local groups to partner with the survey team to develop the survey and support its implementation. The purpose of the survey was to gain a broad understanding of the drivers of on-farm decision making across, and in-depth understanding within, Australian farming systems.

The 2020 Northern Wheatbelt social benchmarking survey is part of this national Soil CRC project led by Dr Hanabeth Luke of Southern Cross University (SCU), jointly funded by the Soil CRC, and the West Midlands Group. Data gathered will contribute to wider Soil CRC research efforts. For example, Soil CRC researchers will be able to explore farmer knowledge of soil heath and management; the impact of farmer participation in soil health groups; and the implementation of best practice soil management by farmers.

The overall survey design was developed in the early stages of the national social benchmarking survey project, building on the work of Professor Allan Curtis[1]. The general approach is that surveys are physically mailed landholdings in a region over ten hectares (10 ha) in size, to either a random selection or, in low population areas, to all. The surveys include questions on farmers' actual and intended practices, their challenges, and aspirations. Important background information is also collected on farm management styles and farmer values, as well as items that focus on self-assessed knowledge of, and confidence in, best practice, and perceptions of risk.

The overarching Soil CRC project will ultimately collate a dataset of national significance, showing both breadth and depth of information on factors involved in on-farm decision-making for Australian farmers. The key strength of this project is that the general survey approach is customised through collaboration with regional partners to ensure regional relevance. Whilst a core of questions remains to enable cross-survey comparisons and the development of the national dataset, each region has different priorities which are built into the survey instrument. In this way, each survey report can directly inform strategic planning and decisions around present and future directions, whilst providing clear pathways toward better engagement between the Soil CRC partners' regional farmer base in their activities

DEVELOPING THE SURVEY

The Soil CRC survey project leader Dr Hanabeth Luke first visited the Wheatbelt in October 2019. During that visit, the West Midlands Group, WANTFA and Wheatbelt NRM all agreed to participate as local partners in the West Australian component of this national Soil CRC project. The Liebe Group joined shortly after. Workshops were run with both WANTFA and the West Midlands Group to identify key topics to inform survey development. First, we were invited by David Minkey to run a workshop with WANTFA in their Perth office, where a list of priorities was developed and distilled into two main areas:

1) Building a profile of growers in the Wheatbelt, including their needs and aspirations, their trusted sources of information and levels of coping in times of stress.

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[1] Curtis, A., & Luke, H. (2019). Social benchmarking for natural resource management: 2019 North Central Victoria. Southern Cross University, NSW, 2480.

2) Identifying opportunities for building resilience across the farming systems, including uptake of conservation/sustainable/regenerative agricultural practices; use of legumes; precision agriculture; increased biodiversity on farms and new pathways to market. Also, the impact of factors such as temperature extremes on crops; compaction, herbicide resistance; chemical use; and corporate farming models.

Figure 1: Developing the survey priorities at Dandaragan

Following this, Dr Nathan Craig organised for some of the research team to attend a strategy meeting where key areas of focus for the West Midland Group's present and future efforts were to be identified and discussed. While Nathan drew up a list of topics for their purposes, Hanabeth mind-mapped the main areas of interest (Figure 2).
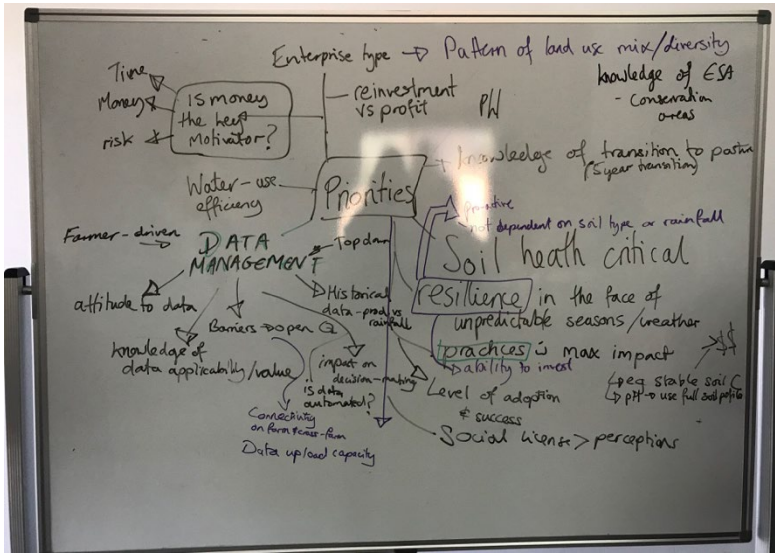
Figure 2: The mind-mapped priorities covered during the workshop with the West Midlands Group

Each of the topics raised was voted on by the group, using a methodology where hands were raised, with arms' length indicating extreme importance, while a hand on the table indicated no importance to them, with a sliding scale in between (shown in Figure 1). These processes helped to distil the topics into four main areas used to develop the Northern Wheatbelt survey. A draft survey was developed and Hanabeth returned in February 2020 to meet with local partners to check and refine the survey. Following further refinement, the survey was finalised, drawing on the following areas of focus:

A) Profile of farming in the Northern Wheatbelt, including farmer engagement
B) Data management and use
C) Farm management practices, risk and resilience
D) The future of farming in the Northern Wheatbelt

A draft survey was pre-tested, including with a small group of rural landholders. A copy of the final 16-page survey booklet is included as an appendix to this report.

The survey was posted to all rural property owners (properties of 10 ha and above) identified using spatially referenced landholder contact lists for the Northern Wheatbelt region provided by the local governments of Dandaragan, Moora, Coorow, Wongan-Ballidu and Dalwallinu Surveys were posted to 980 property owners. After removing return-to-sender, duplicate ownerships, properties that had been sold, owners who were ill or overseas and others who took the option to opt-out of the survey, there were 756 possible respondents. A total of 163 surveys were completed. Of these, 31 were completed online and linked to the spatial property identifier, which enables these responses to be included in the total. A 24% response rate was thus recorded. It is also useful to note that the median number of landholdings per respondent was two. Thus, it can be estimated that our sample represents about half of landholdings in the region.

Checks for non-response bias included a comparison of the mean property size of respondents and non-respondents, which found a bias towards respondents with larger properties. This may have been due to part of the process during list-cleaning, when landholders with multiple properties were connected to their property with the largest area.

In addition to the collection of background personal and property information (e.g. property size, absentee ownership) and data on land use/enterprise mix, the survey gathered information about respondents' values; beliefs (e.g. in climate change, the primacy of private property rights); issues of concern (i.e. threats to those values); knowledge of best practice; confidence in best-practices; implementation of best-practice; preferred sources of information and modes of engagement with farming and NRM organisations, platforms and processes; and long-term plans for the property, including the progress of succession planning where relevant. With more than 130 survey items across these topics, the report summarises a large data set. The focus in the Executive Summary is on directly responding to the four objectives listed above and identifying key lessons or conclusions.

EXECUTIVE SUMMARY

This research employed a survey of all rural landholders in the Northern Wheatbelt with a land holding greater than 10 hectares. Soil CRC researchers from Southern Cross University partnered with local groups WANTFA, West Midlands Group, Wheatbelt NRM and the Liebe Group to develop and undertake the survey. The analysis was focussed on areas highlighted as being of particular importance to our local research partners.

PROFILE OF FARMING IN THE NORTHERN WHEATBELT

The Northern Wheatbelt was confirmed to be a primarily agricultural landscape, dominated by full and part-time farmers. Based on established methodology, survey participants self-identified into one of four groups based on their engagement with farming:

- Full-time farmers: 72%
- Part-time-farmers: 10%
- Hobby farmers: 8%
- Non-farming land holders: 10%

The most common land use was for cereal cropping (73%), pastures (54%), legumes (46%), and sheep for wool (45%) and meat (45%). For all landholders the median land holding was 3227 hectares across a median of two properties. For full-time farmers, this increased to 3902 hectares. Overall, 83% of respondents reside on their Wheatbelt property, rising to 91% of full-time farmers, with the median length of land ownership by the respondent's family reported as 55 years. Across all respondents, the median age was 55 years and 92% of those who completed the survey were male.

VALUES

The Northern Wheatbelt encompasses landholders with a range of intersecting values, some of which are intrinsic or 'held', while others relate to their landholding. When looking across the whole sample, there is a fairly even spread among the top four ways in which the property is valued by landholders. These were the property representing the ability to pass on a healthier environment to future generations (84%), as an asset that is an important part of family wealth (83%), a great place to raise a family (82%), and the property as a source of accomplishment from building and maintaining a viable business (82%). When looking at intrinsic values that guide landholders' lives, there was a strong dominance of the principle 'Looking after my family /loved-ones and their needs' across all landholder types' (99%), representing a strong focus on the family unit.

Key attributes of the survey sample are summarised in Table A, with a further breakdown of key attributes and issues by LGA in Table X1, in the Appendix.

Table A: Key attributes summary table 2020 (n=116 to 176)

Key attributes	For all respondents 2020 (median unless indicated)
Property size (area owned)	3227ha (mean 4712ha)
Bought additional land in region in past 20 years	56%
Subdivided or sold part of property past 20 years	27%
Property leased, share farmed or agisted **by** others (mean)	Median 225.8ha (mean 27.5ha)
Property leased, share farmed or agisted **from** others (mean)	1500ha
Age of respondent	60 years (mean 70 years)
Farmer by occupation (i.e. Full-time Farmer)	72%
Gender of respondent (n=142)	8% female
Resident on property	83%
Length of family ownership	55 years (mean 90 years)
Other family members working on property	73%
Paid off-property work last 12 months (n=121) mean score	47 days (mean 20 Days)
Hours work on-property per week (n= 160)	46 hours (mean 46 hours)
Income from agriculture in Wheatbelt region 2018/19	89%
% all survey respondents net profit from agriculture >$50k	74%
Received net off-property income 2018/19	2% primary respondent 34% spouse 23% both
% all survey respondents net income from off-property >$50k	42%
WANTFA member	9% (16% was)
Regional NRM group member	14% (11% was)
West Midlands member	18% (6% was)
Liebe member	18% (8% was)
Completed short course related to property management past 5 years	19% primary respondent 3% partner 10% both
Property management or whole farm plan	47%
Attended a field day/farm walk/ demonstration on soil health last 12 months	55% yes
Proportion of land lost to production due to soil problems	55% yes Area: 310ha

FARMER ENGAGEMENT

Survey respondents were asked what their top sources of information were in regards to topics related to the management of their property. For full and part-time farmers, field days and magazines were the most nominated way of sourcing information (both 59%), with Farm Weekly and Elders Weekly nominated as popular publications. The most popular source of knowledge was other farmers (76%), followed by independent advisors such as agronomists and agricultural consultants (60%).

More than half of all full- and part-time farmers (54%) agree that grower groups are the best way to drive and direct local research, development and extension. 66% of full-time farmers and 40% of part-time farmers had attended field days/farm walks/demonstrations focused on soil health and productivity in the

past 12 months. In terms of group membership, there was a relatively equal spread of membership rates amongst full- and part-time farmers for local grower groups West Midlands Group and Liebe (both 20%), and associated with the local NRM group (17%), with 10% of the sample being members of WANTFA. It is important to note that membership of the grower groups was largely linked to LGA given the geographical distribution of the groups, with Dandaragan, Moora and Coorow covered by West Midlands Group, and Wongan-Ballidu and Dalwallinu covered by Liebe. Table X1 provides further useful details by LGA.

DATA MANAGEMENT AND USE

The majority of full-time farmers agreed that data is an important part of farm management yet more than half (51%) reported internet connectivity to be a barrier to using on-farm data more effectively. 71% of full-time farmers agreed that decision-making needs to be strongly influenced by data and 61% reported to already having good systems in place to manage farm data. Soil testing was perceived as an integral part of data gathering, with 92% of full-time farmers agreeing that it is an essential step in understanding soil condition.

On-farm management was reported to be largely collaborative, with 86% of full-time farmers (79% overall) including another person or people in their management decisions. Most often, this was a spouse/partner, family or an advisor such as an agronomist.

FARMING PRACTICES, RISK AND RESILIENCE

Soil testing stands out as the most common best-management practice in the reported period 2015 – 2020, at a rate of 82%. This was followed by the application of lime (76%), and the planting of legumes or pulses (70%). While some topics had a sound level of self-reported knowledge, particularly '*strategies to maintain ground cover to minimize erosion in this area*', many other topics have low reported knowledge levels. Part-time farmers' knowledge tends to be much lower than that of full-time-farmers across most topics, and to be relatively low overall.

Overall, the data indicates a strong level of personal responsibility to maintain the productivity of soil and soil testing as an essential step, particularly amongst full-time farmers. Full-time farmers show strong support across most of the soil management items.

REGIONAL AND ON-FARM CHALLENGES

On the regional scale, items seen as relating to climate change featured in the top five issues across all landholder types. Given the dominance of full-time farmers in the sample, particularly when combined with part-time farmers, it is useful to look across these two groups as the dominant group of landholders. When combined, the top three issues for the region were changes in weather patterns (86%), water security (77%), and public support/opposition for agricultural practices (77%).

At the property-scale, soil issues represented less than half of the most important issues for full-time farmers. The top two issues relate to productivity and profitability concerns, in particular the impacts of temperature extremes on farm productivity (74% of full-time-farmers), and the impact of uncertain or low returns on their capacity to invest in the property (73%). When looking to the dominant group of full- and part-time farmers combined, none of the top three issues were soil-related. Rather, the top three property-level issues were the impact of temperature extremes on farm productivity (73%), uncertain/low returns limiting capacity to invest in my property (69%), and the impact of weeds or over-abundant native plant species on productivity (62%).

RISK AND OPENNESS TO CHANGE

Overall there was a very high level of openness to new ideas, with 91% of all respondents agreeing that they were open to new ideas about farming and land management, including 95% of full-time farmers. However, this was complicated by low levels of agreement on other measures, such as '*Financially, I can afford to take a few risks and experiment with new ideas*' (45% overall, 50% of full-time farmers), '*I am usually an early adopter of new agricultural practices and technologies*' (44% overall, 50% of full-time farmers), and '*I have sufficient time available to consider changing my practices*' (38% overall, 42% of full-time farmers). This suggests that whilst farmers have an open mindset, there are financial and time constraints upon adoption.

BELIEFS ABOUT CLIMATE CHANGE

Changes in weather patterns emerged as the number one issue across all landholder types, and water security was in the top four issues for all farmer types. When asked what the biggest challenge and/or opportunity might be over the next ten years, the most common answer was climate change and weather variability. Together, this demonstrates strong concern in relation to the lived impacts of climate change. There is strong data that both records and predicts increasing impacts of climate change in the Wheatbelt region. Survey respondents appeared to be largely cognisant of these risks, with only 11% of respondents disagreeing that climate change poses a risk to the region, with 70% agreeing and 19% unsure. 61% of all respondents agreed that human activities are influencing changes in climate and 57% agreed that landholders in the region should do all they can to reduce carbon emissions. More than half (55%) of all respondents agreed that if nothing is done, climate change will have dire consequences. There was a high level of confidence that local landholders in the region can adapt to changes in weather patterns (67%), yet less than half of respondents (47%) agreed that fundamental changes are required to make the region's farming systems sustainable.

THE FUTURE OF FARMING IN THE NORTHERN WHEATBELT

The responses from full-time and part-time farmers was initially broken down into three age categories, as determined by established definitions of generations: Generation Y (born 1981-1996), Generation X (born 1965-1980) and Baby Boomer and older (born prior to 1965, referred to as Baby Boomer+). However, there were not enough of the youngest age group to allow for analysis (n=8), reflecting the broader age demographics of the respondents, so the groups were amalgamated into two groups, with Generation Y and Generation X combined into one group (aged 56 years and below), with the Baby Boomer and older generation (57 years and above) retained.

As may be expected, there was clear evidence of trends toward extensification and/or intensification amongst the younger group, and slight trends of de-escalation amongst the older group. The younger cohort managed significantly more land, with an average of 2166 hectares compared to the older cohort average of 968 hectares. 81% of the younger group had purchased additional land in the region in the previous 20 years (compared to 57% of older group), with the reverse being true for the older group, who had an average of 318 hectares managed by others (compared with 31 hectares of the younger group). The younger group reported to work an average of 56 hours per week on the farm, compared to 47 hours per week for the older group. The area in which the most differences emerged was in the levels of self-assessed knowledge between the groups, with the younger generation indicating a higher level of self-assessed knowledge across a number of knowledge topics.

LONG-TERM PLANS

With only 9% of full-time farmers indicating that they intend to sell the property, ownership turnover of farmlands is intended to be low. 43% of full-time farmers indicated that they intended to purchase additional land, which is in line with broader industry trends to larger holding sizes, and around a quarter indicated they would lease additional land (26%) and intended to change the enterprise mix to diversify income (27%) or move toward intensive enterprises (20%).

Overall, 72% of respondents indicated that ownership of the property would stay within the family, including 80% of full-time farmers. However, only 52% of full-time farmers had a family member interested in taking on the property in the future. When asked what the biggest challenge and/or opportunity might be over the next ten years, after climate change and weather variability, succession planning was noted as an issue. This emerged in the figures, with very low levels of succession planning in train, however full-time farmers are the most likely to have commenced succession planning.

INTRODUCTION

The 2020 Northern Wheatbelt social benchmarking survey is part of a Soil CRC project led by Dr Hanabeth Luke of Southern Cross University (SCU), jointly funded by the Co-operative Research Centre for High Performance Soils (Soil CRC) and the West Midlands Group. Data gathered will support the activities of local Soil CRC partners, while contributing to the wider Soil CRC research portfolio. For example, Soil CRC researchers will be able to explore farmer knowledge of soil heath and management; the impact of farmer participation in soil health groups; and the implementation of best practice soil management by farmers. Similar surveys funded by the Soil CRC have taken place or are in development in Victoria, South Australia, New South Wales, Queensland and Tasmania.

The research team includes social scientists from Southern Cross University and Charles Sturt University. The survey methodology draws on a widely accepted approach to social benchmarking for regional land and natural resource management developed by Allan Curtis[2]. This survey-based methodology has previously been applied across Australia, including as part of the Australian Government's National Action Plan for Salinity and Water Quality, with case studies in Victoria, New South Wales and Queensland.

STUDY FRAMEWORK

The conceptual framework underpinning this study further builds on the work of Curtis and Luke[3]. The framework recognises that changing human behaviour can be difficult, and engaging rural property owners in practice change is no exception. There is a large set of possible factors influencing decisions and these vary according to each technology, property owner, social context and intervention over seasons and years. Without strong and well-understood drivers to support the implementation of best-practice farm and land management, supporting practice change can be hampered by a range of factors. This may involve everything from inconsistent governance frameworks, weather, and rising property prices, to demographic factors, including what farmers view as important, their knowledge of 'best-practice' and how they perceive their own role as landholders.

While it is possible that values, beliefs and personal norms (i.e. accepted behaviour and decision-making patterns) may mediate or moderate some of these other factors, it is difficult to change these deep-seated personal attributes in the short or medium term. Nevertheless, it is essential to understand the values and beliefs of landowners if they are to be effectively engaged. Values-Belief-Norm Theory (VBN) is a theoretical approach that has been developed and applied to explain the relationship between values and behaviour, particularly in regards to human-environment interactions and land management. It is an important theory that underpins much contemporary social research, including the Rural Landholder Social Benchmarking Report 2021.

In short, landholder **values** and **beliefs** may be difficult to change but are extremely important for effective engagement. The two main elements of this we explore in the survey are: 'assigned values' and 'held values', both of which are deemed as important for guiding personal action[4] .'Held', or intrinsic values are

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[2] Curtis, A., Byron, I., & MacKay, J. (2005). Integrating socio-economic and biophysical data to underpin collaborative watershed management. *Journal of the American Water Resources Association, 41*(3), 549-563.

[3] Curtis, A., & Luke, H. (2019). Social benchmarking for natural resource management: 2019 North Central Victoria. Southern Cross University, NSW, 2480.

[4] Lockwood, M. (1999). Humans Valuing Nature: Synthesising Insights from Philosophy, Psychology and Economics.

ideas or principles that people hold as important to them and may be abstract and conceptual[5] whereas we describe 'assigned' or 'attached values' as how landholders relate to, or assign value to, their land and farm.

Value orientations are the position a person takes when a particular set of held values are more important to them than other held values[6]. It is important to note that individuals can hold more than one value orientation simultaneously[7]. Beyond knowledge of these values, how should researchers and practitioners proceed? And what topics should be included in a survey setting out to inform engagement of rural property owners in the Northern Wheatbelt region?

Effective applications or adoption of best-practice and new innovations can be improved by identifying a number of 'levers' to effect change. If a landholder does not have knowledge of a best-practice approach, then it is unlikely that they will adopt it. If they have some knowledge of it, but little confidence in its effectiveness, then they are unlikely to adopt it. If they view it as too expensive or time consuming to implement, they are also unlikely to take it up. Therefore, the survey must identify both **knowledge** of, and **confidence** in, relevant best-practice land and farm management[7].

It is also helpful to identify **personal 'norms'**, or the level of personal responsibility that landholders feel towards managing their soil, land and farm. Personal norms in relation to **risk**-taking have also been found to be extremely important, with a predisposition to take risks being an important driver of practice change[8].

The next step is identifying the most **effective 'extension'** or information-sharing approaches, processes or platforms for engaging rural property owners in learning, dialogue and action. In identifying these approaches, it is also important to gain an understanding of how landholders perceive and trust their key local and regional organisations, for **trust** is a key builder of confidence in knowledge-sharing organisations[9].

SURVEY DEVELOPMENT

The Soil CRC survey project leader Dr Hanabeth Luke first visited the Wheatbelt in October 2019. During that visit, the West Midlands Group, WANTFA and Wheatbelt NRM all agreed to participate as local partners in the South Australian component of this national Soil CRC project. The Liebe Group joined shortly after. Workshops were run with both WANTFA and the West Midlands Group to identify key topics to inform survey development. Processes helped to distil the topics into five main areas used to develop the Northern Wheatbelt survey. The survey drafts were developed and Hanabeth returned in February 2020 to meet with local partners to check and refine the survey which was then pre-tested with a small

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Environmental Values, 8(3), 381-401.

[5] McIntyre, N., Moore, J., & Yuan, M. (2008). A place-based, values centred approach to managing recreation on Canadian crown lands. *Society & Natural Resources*, 21, 657-670.

[6] Axelrod, L. J. (1994). Balancing personal needs with environmental preservation: identifying the values that guide decisions in ecological dilemmas. *Journal of Social Issues, 50*(3), 85-104.

[7] Lockwood, M. (1999). Humans Valuing Nature: Synthesising Insights from Philosophy, Psychology and Economics. *Environmental Values*, 8(3), 381-401; Stern, P. C. (2000). Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues*, 56(3), 407-424.

[8] Curtis, A., & Luke, H. (2019). Social benchmarking for natural resource management: 2019 North Central Victoria. Southern Cross University, NSW, 2480.

[9] Luke, H. (2017). Social resistance to coal seam gas development in the Northern Rivers region of Eastern Australia: Proposing a diamond model of social license to operate. *Land Use Policy*, 69, 266–280.

group of farmers by Nathan Craig. Following further refinement, the survey was finalised, drawing on the following areas of focus:

A) Profile of farming in the Northern Wheatbelt, including farmer engagement
B) Data management and use
C) Farm management practices, risk and resilience
D) The future of farming in the Northern Wheatbelt

Following the workshop, the project team built these topics into the existing core survey instrument, with sections on major issues faced by landholders, their values, practices, experience and understanding of various topics, as well as confidence in a range of best practices in soil, farm and land management. The draft survey was sent to all workshop participants for comment and input.

SURVEY ADMINSTRATION AND RESPONSE RATE

In advance of the survey, in mid-August 2020, notices were sent to all Northern Wheatbelt properties over ten hectares, which included a link to an online survey posted on the Soil CRC website. In mid-September, the comprehensive survey booklets and reminder notes were mailed out to all relevant landholders in the five partner local government areas. Forty-two online surveys were completed, with 31 linked to the spatial property identifier, which enables these responses to be included in the total. 980 paper surveys were sent out, with 224 return to senders and opt-outs. A 24% response rate was recorded from 756 surveys once the online responses from LGAs outside the target region were removed from the sample. It is useful to note that the median number of landholdings per respondent was two. Thus, it can be estimated that our sample may represent almost half of landholdings in the region. The data was spatially referenced, which means that we can show social, economic and environmental trends spatially across the region. We can also cross-reference our findings with other spatial data such as soil type and rainfall.

DATA ANALYSIS

Descriptive statistics such as frequencies, means and medians were used to summarise responses to all survey items ("not applicable" and missing responses were removed from the analysis of means).

Further analyses include examination of data for statistically significant differences between different groups (e.g. full-time farmer, part-time farmer, hobby farmer and non-farmer). Kruskal Wallis Rank Sum Tests were used to test for differences on a continuous variable or a Likert scale variable (e.g. age or agreement with an issue) based on a grouping variable (e.g. farmer identity cohorts). Chi-squared test were used to examine dependence between two grouping variables. Similarly, Pearson's Chi-squared test with simulated values was used to test for differences on a Yes/No (i.e. nominal data as for Landcare participant) based on a grouping variable (e.g. the farmer identity cohorts).

To explore relationships between variables in the survey, pairwise comparisons were conducted between each item and all other items in the survey. Kruskal Wallis Rank Sum Tests were used to test for relationships between Likert-type response and a grouping variable (e.g. full-time farmer, part-time farmer, hobby farmer and non-farmer) (results in an H value). Chi-squared test were used to examine dependence between two categorical (or grouping) variables (e.g. between Yes/No for management action implemented and WMG member/non-membership).

Pairwise comparisons tested for relationships (positive and negative) between variables expected to influence adoption (i.e. independent variables) of best-practice management (i.e. the dependent variables). Those practices consisted of sustainable or regenerative agricultural practices and ecological

management. Most practices were thought to be relevant to most property contexts. However, respondents were given the opportunity to choose Don't know/ Not applicable. As might be expected, the proportion selecting this option varied across the best-practice items.

In all analyses the p statistic represents the significance level where a value below 0.05 is considered to be statistically significant. A p-value below 0.05 means that it is unlikely (probability of less than five percent) that the observed relationship or difference has occurred purely by chance. All statistical analyses were performed using SPLUS software and Microsoft Excel.

Interpretation of the results of the pairwise comparisons (e.g. to eliminate significant relationships that were irrelevant/nonsense) allowed the research team to identify a small number (approximately 27) of independent variables to include in the modelling for each best-practice. Some variables were included in most models. The selected variables were then entered in a stepwise modelling process using Akaikes Information Criterion (AIC) as the step criteria.

Logistic regression modelling was used to explore the extent a small number of independent variables contribute to the presence or absence of best-practice implementation. For logistic regression modelling, a model is considered useful if it correctly predicts at least 70% of responses to the dependent variable (i.e. each best-practice), thus only models with predictive capacity of greater than 70% have been included in the reporting.

Regression modelling also addresses the thorny question of multicollinearity between independent variables (i.e. where two variables essentially have the same impact). However, experiences with social benchmarking data suggests that those efforts may lead to important variables being excluded from models. For example, pairwise comparisons may reveal a significant relationship between implementation of a best-practice and both participation in a soil health group and property size. If participation in a soil health group and property size are also correlated, regression modelling may exclude one of these variables. There are sophisticated statistical techniques that can help to further tease out causality but these are beyond the scope of this research project.

The following results sections A-D provide information related to these topics under section headings, though some of the topics are addressed across multiple sections.

SECTION A: PROFILE OF FARMING IN THE NORTHERN WHEATBELT

AN AGRICULTURAL LANDSCAPE

The Northern Wheatbelt as being primarily an agricultural landscape was confirmed in the survey, with 89% of all respondents earning an income from their property in 2018/2019. This highlights agriculture as being a central element of the regional economy, with 74% of respondents earning more than $50,000 from these activities, which sits above the national average of 69% of agricultural enterprises that have a turnover of $50,000 or above[10].

The most prevalent land use was cereal cropping (73%), pastures (54%), legumes (46%), and sheep for wool (45%) and meat (45%).

Overall, 83% of respondents reside on their Wheatbelt property, rising to 91% of full-time farmers, with the median length of land ownership by the respondent's family reported as 55 years, and the average 90 years. Across all respondents, the median age was 55 years and 92% of respondents were male. This is very close to the national median farmer age of 54 years, which itself sat well above the national general workforce median age of 40 years, and suggested lower female participation (at least in terms of respondent gender) that the national average of 32% female agricultural workers[11].

FARM MANAGEMENT AND LANDHOLDER PROFILE

56% of enterprises had bought additional land in the region in the last twenty years and just over a quarter (27%) had subdivided or sold part of their property in the last twenty years. Across all farmer types, the average number of hours of on-farm work was 60 hours per week and 73% of respondents had another family member working on the farm, most of which (53%) were a spouse or partner. Off-property income was received by 23% of both respondents and their partners, and 34% of partners only. 42% of this off-farm income was above $50,000 in the 2018/2019 financial year. 76% had completed secondary school or higher, with 29% holding tertiary education qualifications.

Farmer types present a useful way to see how different priorities influence landholder management practices. This typology was developed by Groth et al. (2014), has been published in peer-reviewed academic journals[12] and used in previous phases of this Soil CRC project[13]. Survey participants self-identify into one of four groups based on their engagement with farming:

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[10] National Farmers Federation, (2017), *Food, Fibre & Forestry Facts — A Summary of Australia's Agriculture Sector*. NFF https://nff.org.au/wp-content/uploads/2020/01/171116-FINAL-Food-Fibre-Food-Facts.pdf

[11] Binks, B., Stenekes, N., Kruger, H., & Kancans, R. (2018), *Snapshot of Australia's Agricultural Workforce*, Australian Bureau of Agricultural and Resource Economics and Sciences.

[12] Groth, T. M., Curtis, A., Mendham, E., & Toman, E. (2014). Farmer identity in multifunctional landscapes: using a collective identity construct to explore the nature and impact of occupational identity. *Australian Geographer,* 45(1), 71-86; Groth, T., Curtis, A., Mendham, E. A., & Toman, E. (2016). The utility of a collective identity construct to explore the influence of farming identity on natural resource management. *Society and Natural* Resources 29(5) 508-602; Groth, T., and Curtis, A. (2017). Mapping farmer identity. Why? How? What it tells us? *Australian Geographer,* 48:3, 365-383.

[13] Curtis, A., & Luke, H. (2019). Social benchmarking for natural resource management: 2019 North Central Victoria. Southern Cross University, NSW.

- Full-time farmers: 72%
- Part-time-farmers: 10%
- Hobby farmers: 8%
- Non-farming land holders: 10%

Full-time farmers represent the majority of respondents (72%) and 95% of these respondents were male, with an average age of 58 years. Full-time farmers had the largest holdings, with an average holding size of 3902 hectares, and they were the only group to have additional land under their management, with an average of 1712 hectares of additional land being managed. They also had the highest rates of residency (91%) and had the longest association with their land, with an average family ownership of 64 years. This group was most likely to have a family member working on the farm (84%), with 60% of this number a spouse/partner, 38% a child of the respondent, 18% a parent and 15% a sibling. Their most likely land use was for cereal cropping (89%), pasture (66%) and legumes (59%). 77% of this group have completed secondary school or higher and 31% of them hold a tertiary qualification.

The remaining landholder types were fairly equally distributed. **Part-time farmers** represented 10% of all respondents and all of these respondents were male. The average age of part-time farmers was 64 years, and they held an average of 865 hectares, with less than half (42%) residing on the property. On average, their family had owned the land for 31 years. Part-time farmers were most likely to use their land for farming beef (46%), areas of remnant vegetation (31%) and area set aside for living or recreation (31%). In terms of education, this was the most highly educated group, with 64% having completed high school and almost half (46%) holding tertiary qualifications.

Hobby farmers made up 8% of all respondents. This group had the highest level of female respondents (27%), and an average age of 59 years. 73% of hobby farmers live on their property, which had an average size of 141 hectares and had been owned by their family for an average of 33 years. This group used their land for farming sheep (42%), pasture (33%) and areas of remnant native vegetation (33%). 73% of hobby farmers had completed secondary school or higher, with 27% holding tertiary qualifications.

Non-farmers were the second most common type of landholder, comprising 10% of respondents. This group had an average age of 67 years and 20% of the respondents were female. This group held an average of 562 hectares and 60% were resident on the farm. Their family ownership of the property spanned an average of 37 years and they were the group most likely to set aside an area for living and recreation (40%), yet 53% reported that they have cereal crops. 64% of non-farmers had completed high school or higher and 14% hold tertiary qualifications.

For all landholders the median land holding was 3227 hectares across a median of two properties. For full-time farmers, this increased to 3902 hectares, which is closer to the national average of 4,331 hectares[14]. When taken in consideration with the fact that full-time farmers were the only group to have additional land under their management, with an average of 1712 hectares of additional land being managed, full-time farmers on the Wheatbelt tend to manage an area of land greater than this national average. (For a further breakdown of land use and enterprise type, see Table X2 in Appendix 1).

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[14] Jackson, T., Zammit, K., & Hatfield-Dodds, S. (2020), *Snapshot of Australian Agriculture 2020*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.
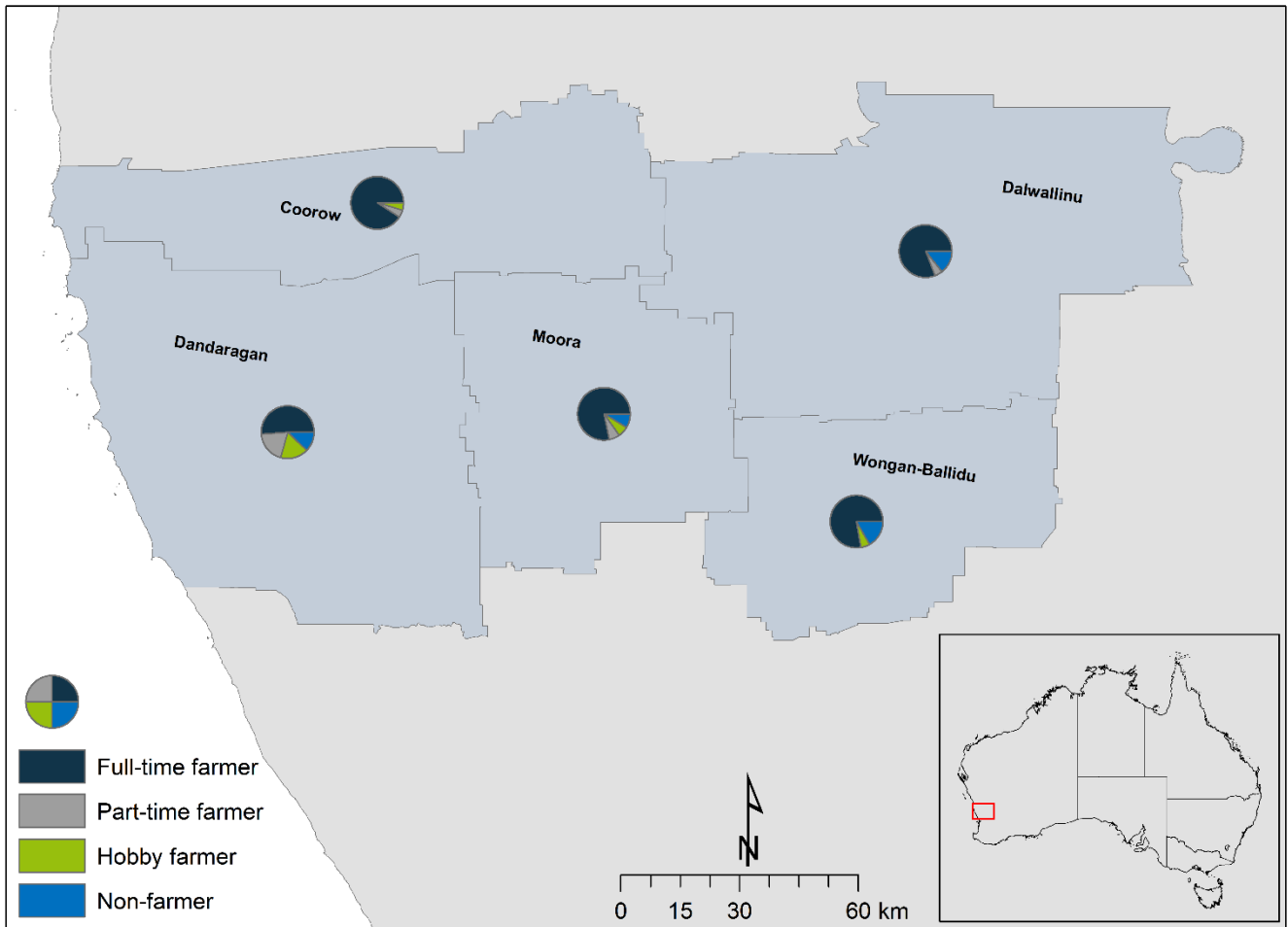
Figure 3: Diagram showing distribution of farmer type by local government area, 2020

VALUES, BELIEFS AND DECISION-MAKING

A key element of the conceptual basis for this social research is that farmer behaviour is derived from "core elements of personality and belief structures"[15,] where these can be seen through underlying values, beliefs and norms. Prior research has shown the usefulness of this Values-Belief-Norm (VBN) theory of understanding environmental behaviours, by suggesting that individuals were more likely to act when something that they value may be threatened[16]. In this section, we explored both values connected to the property by the landholder ('attached values') and underlying values and principles held by the landholder ('held values'). This informs understanding of the complex priorities and considerations that landholders contend with, and that may in turn drive land management behaviours, by showing what is considered to be important.

The results show that different types of landholders attach different values to the land that they own and manage. The Wheatbelt is dominated by full- and part-time farmers (together making up 82% of

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[15] Curtis, A., & Luke, H. (2019). Social benchmarking for natural resource management: 2019 North Central Victoria. Southern Cross University, NSW, p28.
[16] Ibid, p28.

respondents) and encompasses landholders with a range of intersecting 'attached values', the values attached to the property (Table A). The values landholders attached to their property were measured across environmental or biospheric (green shading), social or altruistic (blue shading) and economic or egoistic (orange shading) realms. These different groupings reflect the links between agriculture and the natural and social landscapes in which it occurs, particularly given the high levels of on-farm residency expressed earlier. Farms provide a range of value to those who live, work and recreate on the land.

The top three values by farmer type are indicated with grey shading, but when looking across the whole sample, there is a fairly even spread amongst the top four ways in which the property is valued by landholders. These are the property representing the ability to pass on a healthier environment to future generations (84%), as an asset that is an important part of family wealth (83%), a great place to raise a family (82%), and the property as a source of accomplishment from building and maintaining a viable business (82%). This represents a spread of attached values across each of environmental, economic and social realms. Whilst it is interesting to note the spread of top values across the farmer types, given the dominance of the full-time-farmer type in the sample, it is most representative to look at the aggregated figure to get an overall picture of the area.

Table B: Attached Values 2020 (n = 13 to 147), both overall and by full-time farmer (FTF), part-time farmer (PTF), hobby farmer (HF) and non-farmer (NF.) Grey shading indicates the top three responses for each farmer type.

ATTACHED VAUES – Why your property is important to you	% INDICATING IMPORTANT/ VERY IMPORTANT				
	% OVERALL (Mean)	% FTF	% PTF	% HF	% NF
Ability to pass on a healthier environment for future generations ###	84% (4.3)	91%	62%	82%	67%
An asset that is an important part of family wealth	83% (4.1)	85%	77%	64%	67%
A great place to raise a family	82% (4.3)	88%	77%	73%	69%
Sense of accomplishment from building/maintaining a viable business ###	82% (4.1)	92%	69%	70%	67%
The productive value of the soil on my property ### ***	78% (4.1)	85%	62%	73%	46%
An attractive place/area to live	74% (4)	76%	69%	91%	67%
An important source of household income ###	73% (4)	85%	54%	20%	57%
Sense of accomplishment from producing food and fibre for others ###	72% (3.9)	87%	46%	40%	31%
My property is an important part of who I am	71% (3.8)	80%	54%	82%	40%
Native vegetation provides habitat for birds and animals ###	68% (3.8)	66%	77%	100%	60%
Provide opportunities to learn new things ###	65% (3.7)	76%	46%	64%	33%
An asset that will fund my retirement	64% (3.8)	70%	77%	46%	86%
Provides a sense of belonging to a place	63% (3.7)	66%	54%	64%	57%
Native plants and animals make the property an attractive place to live ###	61% (3.7)	61%	62%	91%	43%
Provides a sense of belonging to a community	61% (3.6)	65%	54%	55%	69%
A place or base for recreation	47% (3.3)	42%	54%	82%	64%

In addition to the values attached to the property examined above, the survey also considered the principles that guide a respondent's life, as represented by the underlying values held by respondents ('held values'). Table B shows incorporated items built upon a typology measuring egoistic (orange shading), biospheric (green shading) and altruistic (blue shading).

Table C: Principles that guide your life, both overall and by farmer type, including full-time farmer (FTF), part-time farmer (PTF), hobby farmer (HF) and non-farmer (NF) 2020 (n= 145).

PRINCIPLES THAT GUIDE YOUR LIFE	% INDICATING IMPORTANT/ VERY IMPORTANT				
	% OVERALL	% FTF	% PTF	% HF	% NF
Looking after my family /loved-ones and their needs	99% (4.8)	98%	100%	100%	100%
Creating wealth and striving for a financially profitable business ***	85% (4.1)	86%	85%	82%	79%
Preventing pollution and protecting natural resources	81% (4.1)	80%	62%	100%	79%
Respecting the earth and living in harmony with nature ###	68% (3.8)	65%	69%	100%	64%
Caring for the weak/vulnerable and correcting social injustice	48% (3.4)	45%	39%	73%	36%
Fostering equal opportunities for all community members ###	42% (3.4)	38%	39%	82%	36%
Being influential and having an impact on people and events	32% (3)	32%	31%	55%	50%

This shows a strong dominance of the principle 'Looking after my family /loved-ones and their needs' across all landholder types' (99%), representing a strong focus on the family unit. In comparison with the attached values above, there is a much stronger cohesion amongst the landholder types across the top four principles guiding their lives, this time with a focus on more egoistic items (looking after family and creating a financially profitable business) and environmental values (preventing pollution and protecting natural resources, and respecting the earth and living in harmony with nature).

FARMER ENGAGEMENT

The provision of information, support and education are important ways to increase knowledge and confidence in farm management practices. Understanding the ways in which landholders engage with processes of knowledge sharing and education, as well as with industry and land management groups, provides useful insights into how information can best be shared and landholders can be meaningfully engaged with. Well-developed engagement approaches, aiming to support improved productivity, land management and soil stewardship can be informed by a better understanding of landholder views, beliefs and experiences.

ACCESS TO INFORMATION

Respondents were asked what their top sources of information were in regards to topics related to the management of their property. For full- and part-time farmers, field days and magazines (with Farm Weekly nominated as a popular publication) both presented as the most nominated information source (both 59%), and the top source of knowledge was other farmers (76%), followed by independent advisors such as agronomists and agricultural consultants (60%).

Table D: Information sources and modes of information for all full-time and part-time farmers, 2020 (n = 138)

MODE OF INFORMATION	% YES
Field days	59%
Magazines	59%
Email(s)	51%
Websites	49%
Radio	41%
Brochures/leaflets/newspapers	40%
Newspapers	39%
Academic journals/research papers	25%
Books	18%
Television	17%
Twitter	12%
Podcasts	12%
WhatsApp or Messenger groups	11%
YouTube	6%
Facebook	6%
Other	1%
Instagram	0%

SOURCE OF KNOWLEDGE	% YES
Other farmers	76%
Independent agricultural consultants, agronomists or stock agents	60%
Bureau of Meteorology	51%
Commercial agricultural consultants, agronomists or stock agents	48%
Friends/neighbours/relatives	47%
Department of Primary Industries and Regional Development (DPIRD)	25%
Rural R&D organisations (e.g. GRDC)	25%
West Midland Group	24%
Liebe Group	22%
Regional NRM group e.g. Wheatbelt NRM, NACC	13%
Universities/CSIRO	12%
WANTFA	11%
Direct contact with researchers/extension officers	7%
Commodity groups	7%
Soil CRC	3%
Local Council	2%
Environmental organisations, e.g. Greening Australia	2%

In terms of up-skilling, only 25% of full-time farmers and 12% of both respondents and their partners, have completed a short course/ workshop relevant to property management in the past five years. Respondents were asked to respond to a series of open questions relating to their sources of support for agricultural and land management practices. This qualitative data complemented the aggregated quantitative above, as it showed that informal support from friends, family and neighbours was of great importance. Beyond this, support from agronomists and other agricultural consultants, as well as local grower groups, were the most popular responses. When asked what sort of support would enhance their agricultural and land management activities, there was a strong nomination of financial support, improved internet coverage, and more access to localised research and development outcomes, including greater access to data. Practical on-farm supports were also suggested, such as the provision of water for those who have to cart water in, as well as grants for weed eradication and the planting of native vegetation, including the free use of tree-planting equipment, as a form of support. When asked which group/organisation/department would be most appropriate to provide that support, the government and Department of Agriculture was a common response (federally this is the Department of Agriculture, Water

and the Environment, at state level there is the Department of Primary Industries and Regional Development), as well as grower groups such as the West Midlands Group and Liebe.

More than half of all full- and part-time farmers (54%) agree that grower groups are the best way to drive and direct local research, development and extension. 66% of full-time farmers and 40% of part-time farmers had attended field days/farm walks/demonstrations focused on soil health and productivity in the past 12 months. When asked what had prevented them from attending field days, time constraints/being too busy and a lack of available options (particularly due to COVID-19) were the most common answers.

Table E: Views and experiences overall and by Farmer Type, 2020 (n= 135 to 138). Mean is out of 5, with 5 indicating 'strongly agree'.

VIEWS & EXPERIENCE: STATEMENT	% AGREE/ STRONGLY AGREE				
	OVERALL MEAN	FTF	PTF	HF	NF
Grower groups are the best way to drive and direct local research, development and extension	3.6	56%	46%	30%	50%
I feel adequately supported to conduct farming and land management activities on my property	3.4	54%	54%	30%	50%
I feel a personal responsibility to be part of a local grower group	3.2	42%	23%	18%	36%
There is adequate compensation or support for conservation activities on my farm	2.7	17%	15%	9%	8%

RESULT FOCUS: LOCAL SUPPORT

Views on local support groups were sought, including membership rates and views on the services these groups provide. The Regional NRM group stood out as the group with the highest levels of trust and reliability, as demonstrated in Figure 4.

Views on local support groups from full-time and part-time farmers
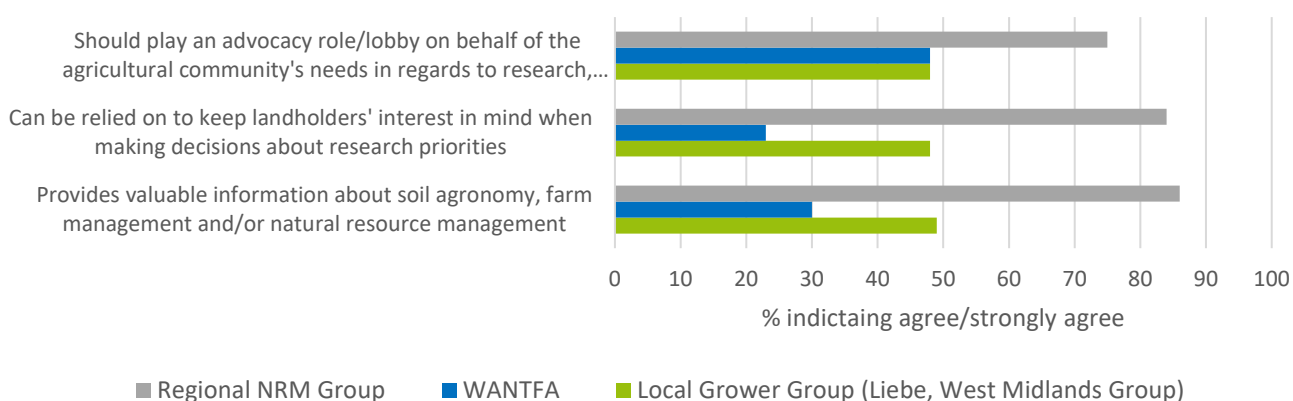
Figure 4: Views on local support groups from full-time and part-time farmers, 2020.

Respondents were asked what they would like to see from each of these groups. For local grower groups, respondents listed help to gain independent funds for research to reduce the influence of large chemical companies, a greater focus on regenerative agriculture, help to return non-productive land to native vegetation, and increased local research and development trials. These suggestions were repeated for

WANTFA, with an additional call for a greater focus on soil biology and how to improve it, including looking at no-till approaches by similar groups in other states and a call for more events such as the Soil Amelioration Day at Bolgart in 2020. With regard to the regional NRM group, respondents called for recognition that farmers need to be profitable first, provision of rewards for good soil stewardship, protecting the natural environment and practical strategies to integrate native plants into profitable production systems, and more research on livestock and pasture trials.

In terms of group membership, there was a relatively equal spread of membership rates amongst full- and part-time farmers across the local grower groups West Midlands Group and Liebe (both 20%) and the local NRM group (17%), with WANTFA having the lowest rates of membership in the sample (10%).

Table F: Group membership for full-time and part-time farmers, 2020. (n= 128 - 134).

GROUP	% OF FULL-TIME AND PART-TIME FARMERS		
	CURRENT MEMBER	PAST MEMBER	NON-MEMBER
WANTFA	10%	19%	71%
Regional NRM	17%	11%	71%
Local grower group – West Midlands Group	20%	7%	73%
Local grower group – Liebe	20%	8%	73%

This requires further breakdown by area given the differing geographical coverage of the groups. As shown in Table G, there are strong differences in membership rates by LGA.

Table G: Group membership by LGA, 2020.

GROUP	LGA				
	Dandaragan n = 42 (28% of respondents)	Moora n = 47 (31% of respondents)	Coorow n = 22 (15% of respondents)	Wongan-Ballidu n = 18 (12% of respondents)	Dalwallinu n = 22 (15% of respondents)
WANTFA member	3% (3% was)	11% (16% was)	5% (24% was)	11% (11% was)	10% (20% was)
Regional NRM group member	8% (8% was)	17% (2% was)	24% (10% was)	6% (12% was)	21% (26% was)
West Midlands member	34% (5% was)	21% (2% was)	14% (5% was)	0% (0% was)	0% (0% was)
Liebe member	0% (0% was)	5% (2% was)	15% (15% was)	33% (17% was)	60% (25% was)

Modelling showed that members of the West Midlands Group used them as an important and reliable information source which provides valuable agricultural information; were likely to 'attend field days, farm walks and demonstrations focused on soil health & productivity'; and have 'changed their financial or on-

property operations as a result of seasonal changes in weather patterns'. They were also likely to consider that their local NRM group should play an advocacy role for growers in the region.

Modelling also showed that WMG members were more likely to be diversifying their practices, or be implementing time controlled, cell or rotational grazing (R^2 = 0.392-0.436).

For members of the Liebe group, the modelling showed that Liebe members were likely to use the Liebe Group and rural research organisations such as GRDC as key information sources; have a larger property, be applying soil ameliorants other than fertiliser and lime, and have bought additional land in the region in the previous two decades (R^2=0.553)

SECTION B: DATA MANGEMENT AND USE

DATA MANAGEMENT

Business management at the farm level will have a direct impact on land management decisions and has important consequences for profitability. The majority of full-time farmers agreed that data is an important part of farm management yet more than half (51%) report that internet connectivity is a barrier to using on-farm data more effectively. 71% of full-time farmers agreed that decision-making needs to be strongly influenced by data and 61% agreed that they already have good systems in place to manage farm data. Soil testing was perceived as an integral part of data gathering, with 92% of full-time farmers agreeing that it is an essential step in understanding soil condition. See Table X7 in the Appendix for a further breakdown of data use and management by farmer type.

When it came to knowledge levels on using data, there were mixed results. Figure 5 demonstrates the varying levels of knowledge of how to use data to inform decision-making. Of particular note is the low rate (39%) of self-assessed knowledge by full-time farmers of existing data analysis tools to support on-farm decision-making. Results were significantly different between farmer groups on all items. Only 29% of full-time farmers and 26% of all respondents would like to do some sort of study/activity to improve their farm management skills.
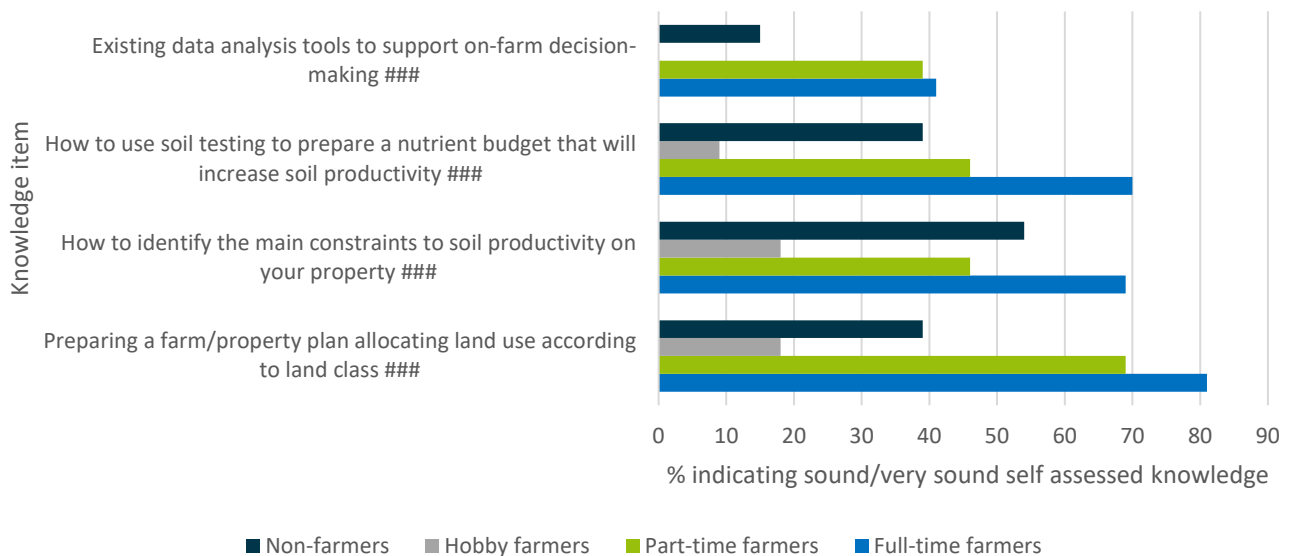
Figure 5: Self-assessed knowledge of data use by farmer type, 2020 (n = 145).

On-farm management was largely collaborative, as 86% of full-time farmers (79% overall) include another person or people in their management decisions. Most often, this was a spouse/partner, family or an advisor such as an agronomist. When asked if there was a particular decision-making tool used, 41% of full-time farmers agreed. When asked to name this tool, most responses (n=25) were their own experience and their knowledge, as well as calling on the expertise of advisors, and the only specific name given was one mention of the Bureau of Meteorology data and one of 'grazing chart'.

Resilience appeared to be high, with a high number of full-time farmers (86%) agreeing that they were satisfied with their farm's productivity given the seasonal conditions experienced, and a majority (71%) agreeing that they are coping well with the associated stresses and challenges of managing the farm.

Modelling showed that farmers who were coping well with the associated stresses of managing their farm were happy with their farm as it is, cared strongly about passing on a better farm for future generations, were not risk adverse, with more financial capacity to experiment with new ideas. They also were likely to view grower groups as the best way to drive local agricultural improvements (R^2 = 0.252).

Of full-time farmers, 84% reported to have generated a profit over the last ten years. 88% of full-time farmers agreed that they feel confident working with numbers and managing their farm accounts. Whilst overall 86% of full-time farmers are satisfied with the productivity of their farm, only 51% report that their on-farm income is enough for about everything they want with some left over for savings. 29% of both full- and part-time farmers would like to do some sort of study/activity to improve their farm management skills. For a more detailed breakdown, see Table X7 in Appendix 1.

Table H: Implementation of data management practice compared with related knowledge and confidence in the practice for full-time and part-time farmers (data amalgamated), 2020. (n= 138 - 140).

Management Practice	Implemented in the last 5 years	Confidence	Agree or strongly agree	Knowledge	Sound or very sound
Testing of soils for nutrient status in paddocks where have applied fertiliser/soil conditioners in the past	79%	Soil testing is an essential first step in understanding soil condition	91%	Preparing a farm/property plan allocating land use according to land class	79%
		Decision making needs to be strongly influenced by data	68%	How to identify the main constraints to soil productivity on your property	69%
Preparation of a nutrient budget for all/most of the property	52%	I feel confident working with numbers and managing my farm accounts	86%	Preparing a farm/property plan allocating land use according to land/soil characteristics	79%
		I have good systems in place to manage my data	68%	Existing data analysis tools to support on-farm decision-making	38%

The modelling showed that those who felt they had good systems in place to manage farm data were far more likely to have a decision-support tool they use regularly and were confident with managing their

accounts; and likely to have prepared a property plan according to land class (R^2 = 0.345). Salient but less strong relationships in the models were that they were also likely to be working a slightly greater number of hours per week, likely to embrace risk and be coping well with the associated stresses of managing their farm. They were also likely to be trusting of people, as well as being confident that landholders can effectively adapt to changing weather patterns. Being female appeared in the models as associated with this item.

Modelling indicated that those who viewed their pathway to market to be clear were likely to have turned a profit in the previous financial year and include another person in their decision-making, most likely a parent. They were also likely to have plans to diversify their operations and have confidence that landholders in the region can adapt to increased seasonal variability (R^2 = 0.303).

Modelling also showed that farmers who had tested their soils for their nutrient status in recent years were also likely to have planted legumes or pulses; have other family working with them on their property and have completed Year 10 or above. They were also likely to be wary of other people. The model showed a weak (non-significant) association between those who were soil testing and those who were earning above the national average farmer income (R^2 = 0.428).

SECTION C: FARMING PRACTICES, RISK & RESILIENCE

FARMING PRACTICES: KNOWLEDGE, VIEWS AND RISK

The actual practices that farmers incorporate in their management – both historically, currently and those that they intend to undertake – are themselves important outcomes of decision-making. Figure 6 shows the change in practices over time for full-time farmers.
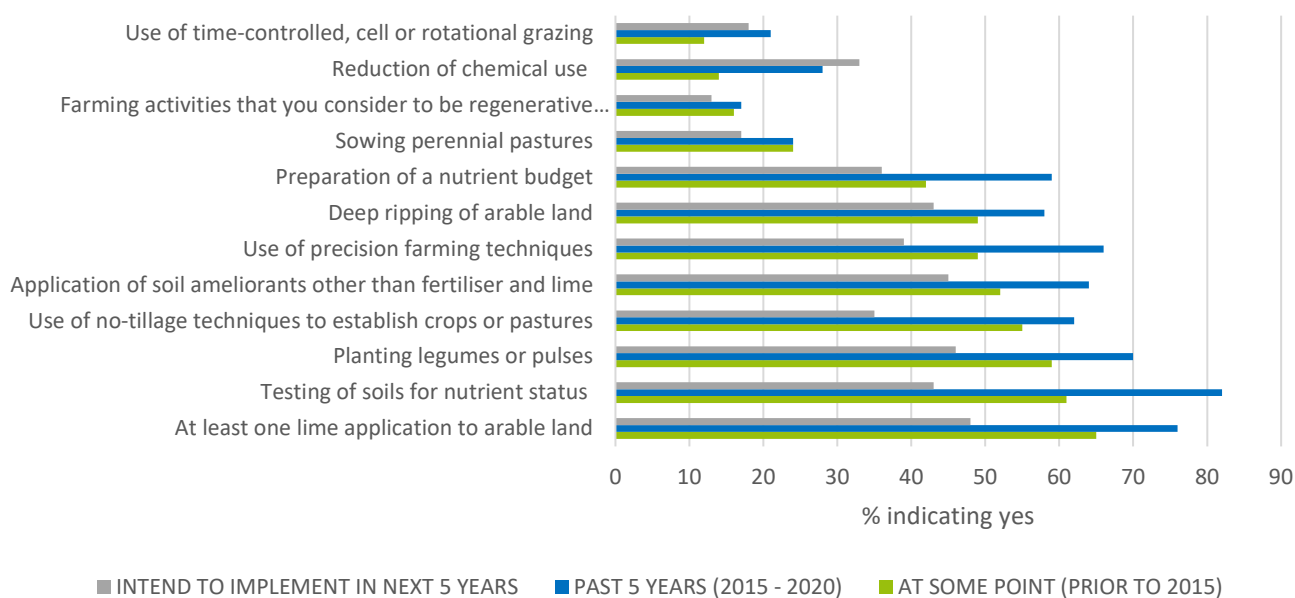
Figure 6: Full-time farmer practices over time 2020 (n = 126 to 142).

This figure demonstrates a general decline in intended practices over time, whilst also showing the relative popularity of particular practices. Soil testing stands out as the most common practice in the current period (2015 – 2020) at a rate of 82%, followed by the application of lime (76%), and the planting of legumes or pulses (70%). Practices that include an initial investment that lasts over time understandably show as a decline (for example fencing and planting of trees), but all other practices also show a decline in intended implementation over time. The exception to this is the reduction in chemical use, which shows a steady increase in practice.

Modelling found that farmers who had reduced their chemical input within the last five years were also more likely to be have had the property in the family for a greater number of years; be conducting farming activities they considered to be regenerative, and believe that farmers should be doing all they can to reduce emissions (R^2=0.478).

Respondents were asked to assess their level of knowledge on various farm management practices. Table I shows the mean and percentage of each farmer type that indicate a 'sound' or 'very sound' level of knowledge of the listed topics. Whilst there are some topics for which there is a sound level of knowledge, particularly 'strategies to maintain ground cover to minimize erosion in this area', many other topics have low reported knowledge levels. Part-time farmers' self-reported knowledge tends to be much lower than that of full-time-farmer across most topics, and to be relatively low overall.

Table I: Self-assessed sound or very sound knowledge by farmer type, 2020 (n=144 to 145). Mean is out of 5. Grey shading indicates knowledge level below 50%.

KNOWLEDGE TOPIC	FULL-TIME FARMER	PART-TIME FARMER	HOBBY FARMER	NON-FARMER
Strategies to maintain ground cover to minimise erosion in this area ###	87% 4.3	85% 4.1	36% 3.4	46% 3.2
Preparing a farm/property plan allocating land use according to land/soil characteristics ###	81% 4.2	69% 3.9	18% 3.1	39% 3.1
How to (re)introduce more legumes/pulses into your enterprise mix ###	76% 4.0	31% 3.2	18% 2.6	23% 2.6
How to use soil testing to prepare a nutrient budget that will increase soil productivity ###	70% 3.9	46% 3.4	9% 2.4	39% 2.8
How to identify the main constraints to soil productivity on your property ###	69% 3.9	46% 3.7	18% 2.8	54% 2.9
How to build soil organic matter/soil carbon ###	56% 3.6	46% 3.3	18% 2.8	23% 2.7
The role of soil carbon in maintaining soil health ###	55% 3.6	46% 3.2	9% 2.8	39% 2.9
The processes leading to soil structure decline in this area ###	55% 3.6	39% 3.3	9% 2.9	39% 2.9
The role of remnant vegetation in supporting the natural ecosystem	49% 3.4	69% 3.8	46% 3.5	39% 3.1
The production benefits of applying biological soil supplements)	44% 3.4	39% 3.4	18% 3.1	23% 2.9
Existing data analysis tools to support on-farm decision-making ###	41% 3.4	39% 3.2	0% 2.3	15% 2.3
Options and strategies to (re)establish perennial pastures in this area ***	39% 3.3	54% 3.8	18% 2.9	8% 2.3
The role of on-farm biodiversity for supporting soil and landscape health ###	39% 3.2	39% 3.2	0% 2.4	8% 2.3
Farming practices that can lead to more nutrient-dense food ***	38% 3.1	23% 3.1	0% 2.4	0% 2.1
The extent and type of biological activity in soils on your property ### ***	30% 3.0	23% 2.9	9% 2.2	8% 1.9
Time controlled, holistic or cell grazing strategies	26% 2.9	46% 3.2	18% 2.5	8% 2.3
Regenerative agriculture and holistic farm management	25% 2.7	39% 3.1	9% 2.6	8% 2.3
How land in your district was used and managed before European settlement	21% 2.5	15% 2.3	9% 2.5	15% 2.3
The Aboriginal group/s is connected to the area where your property is located	13% 2.3	8% 2.4	0% 2.4	0% 2.2
How to support the persistence of native grasses in this area	12% 2.5	15% 2.9	0% 2.2	0% 1.9

Apart from degree of knowledge, an equally important element of decision-making in farm management practice is the set of views that farmers hold toward particular practices, otherwise understood as the level of confidence in a particular practice. Table J presents a set of views related to soil and soil management practices, with the mean (out of 5) and percentage of respondents who agree or strongly agree with the view statement listed, with the top three for each farmer type shaded grey.

Table J: View statement agreement overall and by farmer type, 2020 (n= 69 - 141). Mean is out of 5. The top three for each group are shaded grey.

VIEWS & EXPERIENCE: STATEMENT	% AGREE/ STRONGLY AGREE				
	OVERALL MEAN	FTF	PTF	HF	NF
I feel a personal responsibility to maintain the productive capacity of my soil	4.3	95%	77%	91%	73%
Soil testing is an essential step in understanding soil condition ###	4.3	92%	77%	9%	75%
The costs of applying lime to address soil acidity are justified by increased production ###	4.2	89%	77%	50%	58%
Fencing to manage stock access is an essential element of protecting the health of waterways and native vegetation	4.1	80%	77%	100%	73%
Biological activity is an important (first) indicator of the productive capacity of soils	4.1	78%	75%	82%	67%
The benefits of stubble retention outweigh problems arising from the practice	4	80%	58%	44%	64%
I would like to use less chemicals on my farm but it is too difficult in practice ###	3.7	77%	46%	55%	36%
I am interested in learning more about regenerative/holistic farming approaches	3.2	37%	39%	73%	27%
The costs of establishing perennial pasture are justified by the returns ***	3.2	36%	69%	18%	36%
Adopting regenerative/holistic farming practices is justified by the returns	2.8	19%	23%	36%	0%

Overall, the data indicates a strong level of personal responsibility to maintain the productivity of soil and soil testing as an essential step, particularly amongst full-time farmers. Full-time farmers show strong support across most of the soil management items and results are variable across the other farmer types, so it is useful to keep in mind the dominance of the full-time farmer group in this cohort.

In complement to the quantitative data presented above, farmers were asked to nominate the most important influence on profitability in the last twelve months, in an open-text question. Of those full- and part-time farmers who responded, the overwhelming response was rainfall, followed by markets and prices (including a decrease in demand as a result of COVID-19 trade impacts) and good farming decisions, for example using information to match stocking rate to carrying capacity. This was consistent over the last 12 months also.

More specifically, respondents were asked to nominate any particular practice change over the last ten years that had had a major influence on their farm's profitability. The most popular response was the

move to practice changes such as deep ripping, minimum-till and dry seeding, as well as diversifying into wool and sheep production. Other responses included a greater investment in GPS technologies, soil amelioration strategies, improved stock breeding techniques and working with agronomists.

REGIONAL AND ON-FARM CHALLENGES

Respondents were asked to rate the importance of a set of issues at the district and property scale, and the percentages presented here indicate the number of respondents indicating an issue was important or very important. Issues at this scale can be seen to indicate a threat to the values expressed in Section A, and therefore play a role in land management behaviours as a possible driver of action. Issues at the regional scale are presented in Figure 7, presented as the top five issues by landholder type. Items seen as relating to climate change featured in the top five issues across all landholder types, indicated here by green shading. Given the dominance of full-time farmers in the sample, particularly when combined with part-time farmers, it is useful to look across these two groups as the dominant group of landholders. When combined, the top three issues for the region were changes in weather patterns (86%), water security (77%), and public support/opposition for agricultural practices (77%).

Full-time farmer	Part-time farmer	Hobby farmer	Non-farmer
Changes in weather patterns (87%)	Availability of water for livestock (85%)	Risk to life and property from wildfires (91%)	Water security (79%)
Water security (80%)	Changes in weather patterns (77%)	Absence of important services and infrastructure (91%)	Availability of water for livestock (64%)
Public support/ opposition for agricultural practices (79%)	Water security (77%)	Changes in weather patterns (82%)	Public support/ opposition for agricultural practices (64%)
Absence of important services and infrastructure (77%)	Declining soil health and/or soil productivity (69%)	Water security (82%)	Herbicide resistance (64%)
Herbicide resistance (73%)	Risk to life and property from wildfires (69%)	Availability of water for livestock (73%)	Absence of important services and infrastructure (60%)

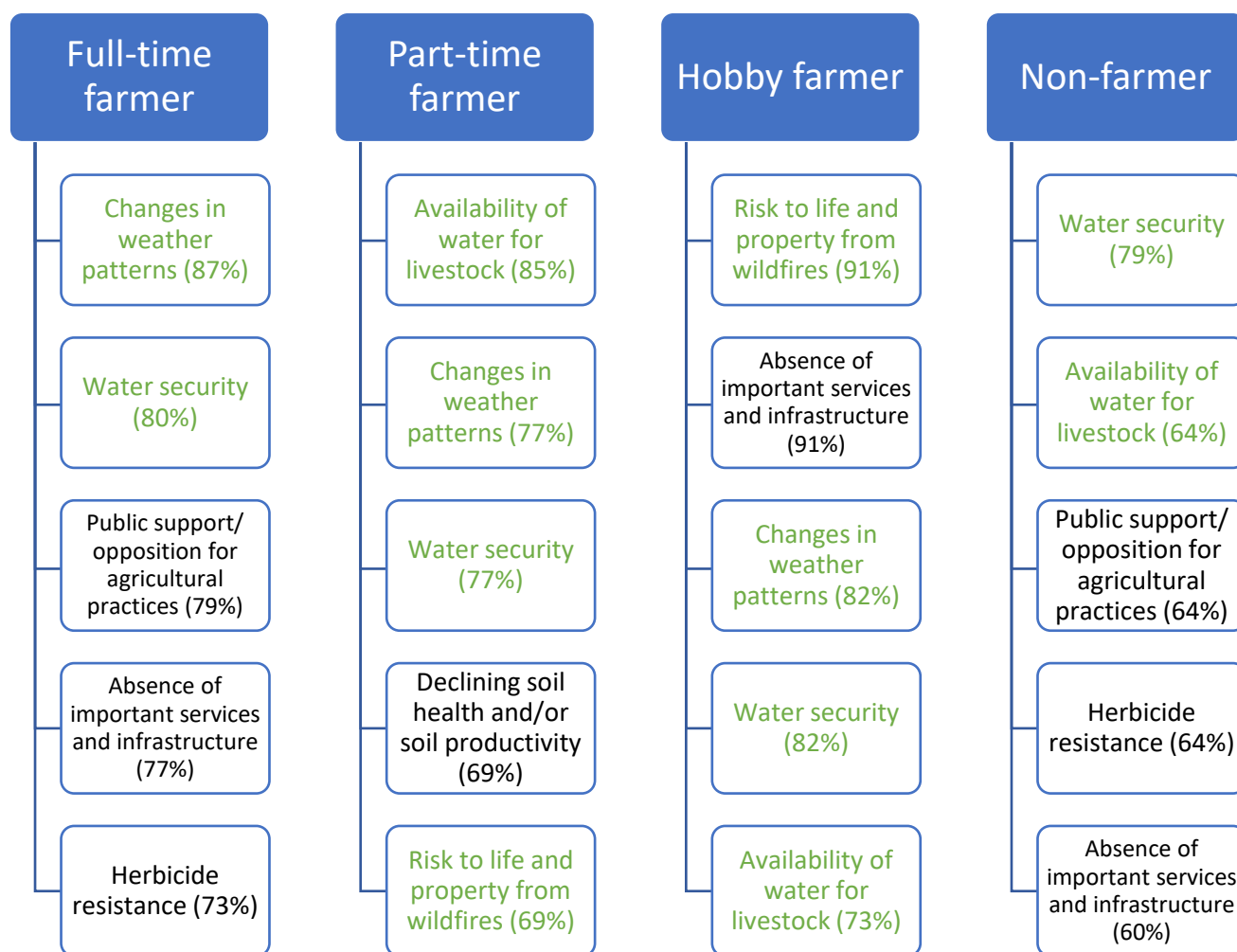*Figure 7: Top five most important regional issues by farmer type (n= 139 to 146), with the issues related to climate change in the region highlighted by the use of the colour green.*

At the property-scale (Figure 8), soil issues represent less than half of the most important issues for full-time farmers. The top two issues relate to productivity and profitability concerns, in particular the impacts

of temperature extremes on farm productivity (74% of full-time-farmers), and the impact of uncertain or low returns on their capacity to invest in the property (73%). When looking to the dominant group of full- and part-time farmers combined, none of the top three issues were soil-related. Rather, the top three property-level issues were the impact of temperature extremes on farm productivity (73%), uncertain/low returns limiting capacity to invest in my property (69%), and the impact of weeds or over-abundant native plant species on productivity (62%).

Full-time farmer	Part-time farmer	Hobby farmer	Non-farmer
Impact of temperature extremes on farm productivity (74%)*	Non-wetting soils (69%)	Non-wetting soils (73%)	Impact of weeds or over-abundant native plant species on productivity (55%)
Uncertain/low returns limiting capacity to invest in my property (73%)	Uncertain/low returns limiting capacity to invest in my property (62%)	Impact of weeds or over-abundant native plant species on productivity (73%)	Soil erosion (e.g. due to wind or water) (50%)
Soil acidity undermining productive capacity of soils (61%)	Declining nutrient status of soils (62%)	Impact of temperature extremes on farm productivity (73%)*	Soil acidity undermining productive capacity of soils (50%)
Soil erosion (e.g. due to wind or water) (60%)	Soil erosion (e.g. due to wind or water) (58%)	Declining nutrient status of soils (55%)	Low biological activity in soils (50%)
Impact of weeds or over-abundant native plant species on productivity (60%)	Impact of weeds or over-abundant native plant species on productivity (58%)	Soil-borne diseases (55%)	Impact of temperature extremes on farm productivity (46%)*

*Figure 8: Top five property-level issues by farmer type, 2020 (n= 111 to 145). Orange colour indicates soil-related items common across farmer types. * relates to factors potentially influenced by accelerated climate-change (see section below).*

The modelling showed that growers facing uncertain returns were likely to see 'declining nutrient status of soils' and the 'impact of weeds or over-abundant native plant species on productivity' as important property-level issues. They were likely to view their property as 'an important asset to fund their retirement' and were likely to wish to 'use less chemicals on their farm but find it too difficult in practice'. A less strong relationship in this model was having good knowledge of strategies to minimise erosion. R^2=0.417

The modelling also showed that growers who had issues with acidic soils were more likely to also have issues with sodic soils, low levels of biological activity; have a strong focus on 'creating wealth and striving for a financially profitable business'; as well as to 'attend field days, farm walks and demonstrations focused on soil health & productivity'. They were also likely to feel adequately supported to conduct farming activities. R^2=0.604.

In an open-ended question, landholders were asked to nominate what they saw as their biggest challenge or opportunity in the next ten years. In terms of challenges, the strongest emergent theme was that of rainfall and weather, described as 'Increased seasonal variability', and frequently linked to climate change. Although, one issue mentioned was 'global cooling,' seen as related to increasing frost problems. Issues such as costs, labour and soil were also important. These issues were put succinctly by one respondent: "mother nature and market conditions", though there were some intensely personal responses, such as one farmer that stated his biggest challenge was "keeping my marriage together, wife needs challenges that the farm can't provide", demonstrating the mix of personal and practical challenges for farmers. In terms of opportunities cited, several were mentioned that relate to reducing inputs, building soil capacity and improving the land to market value chain, particularly for more niche products.

The following word cloud (Figure 9) lists the responses, with each word made larger the more often it was reported.

Figure 9: Wordle™ word-cloud representation of responses to the open question: 'In the next 10 years, what would you see as likely being your biggest challenge and/or opportunity?', with each word emphasised in relation to times used in responses.

RISK AND OPENNESS TO CHANGE

Overall there was a very high level of openness to new ideas, with 91% of all respondents agreeing that they were open to new ideas about farming and land management, including 95% of full-time farmers. However, this was complicated by low levels of agreement on other measures, such as '*Financially, I can afford to take a few risks and experiment with new ideas*' (45% overall, 50% of full-time farmers), '*I am usually an early adopter of new agricultural practices and technologies*' (44% overall, 50% of full-time farmers), and '*I have sufficient time available to consider changing my practices*' (38% overall, 42% of full-time farmers). This suggests that whilst farmers have an open mindset, there are financial and time constraints upon adoption. For a further breakdown of measures of trust and risk, refer to Table X6 in the Appendix.

The modelling showed that those who self-identified as early adopters were more likely to use Twitter and field days as primary information sources; view risks as a 'challenge to embrace', and have trust in the West Midlands group as an information provider. They were also likely to have planted legumes or pulses in recent years (R^2 =0.423).

BELIEFS ABOUT CLIMATE CHANGE

In the analysis we draw out a section specifically related to accelerated climate change because of the notable presence of climate change items related to the most important issues for landholders. In terms of the level of concern expressed by respondents, the survey included three regional issues related to climate change: '*Water security*', '*Changes in weather patterns*', and '*Risk to life and property from wildfires*. Results for these three items are shown in Table K.

Table K: Issues affecting local region, 2020 (n=182 to 183). Mean is out of 5 (with 5 being Very Important).

ISSUE AFFECTING LOCAL REGION	Mean	% Imp/ Very imp	Highest concern by farmer type
Changes in weather patterns	4.3	85%	FTF
Water security	4.2	78%	FTF
Risk to life and property from wildfires ### ***	3.4	50%	HF

Changes in weather patterns emerged as the number one issue across all landholder types, and water security was in the top four issues for all farmer types (see Figure 7). When asked what the biggest challenge and/or opportunity might be over the next ten years, the most common answer was climate change and weather variability. Together, this demonstrates strong concern with the lived impacts of climate change. The prominence of fire risk as an issue for part-time and hobby farmers echoes similar results in other survey phases and reflects the increased tension between peri-urban settlements and the increasing effects of climate change, in particular increasing fire risk[17].

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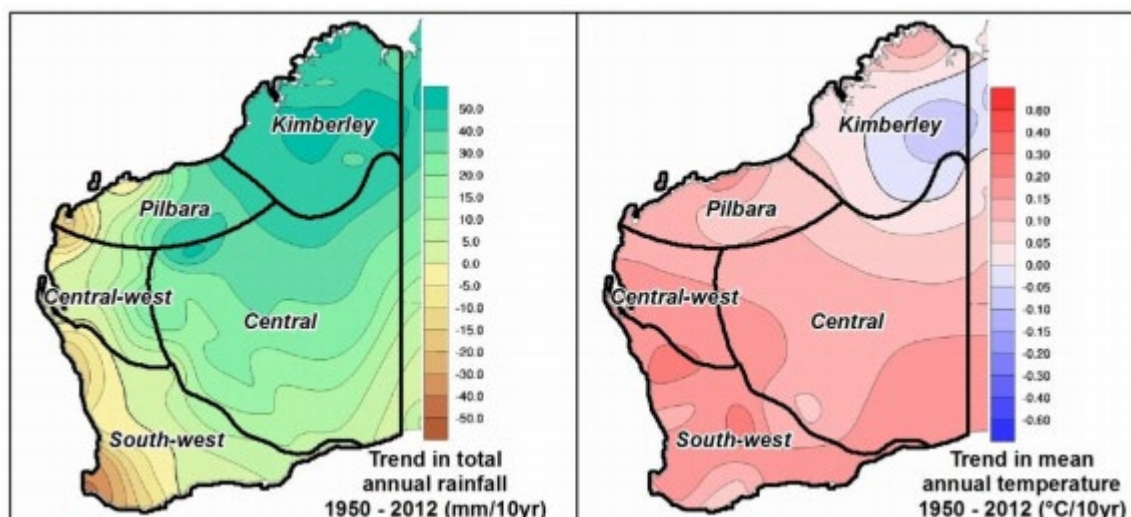
[17] Norman, B., Newman, P. & Steffen, W. 2021. Apocalypse now: Australian bushfires and the future of urban settlements. *npj Urban Sustainability* 1, 2.

The concern over these climate change indicators is unsurprising given the impacts in the region. Figure 10 is based on historical Bureau of Meteorology data that demonstrates the trends of decreasing total annual rainfall and increasing mean annual temperature increase since 1950. The North Western Wheatbelt sits within the broader region of the Southern and South-Western Flatlands West (SSWFW) sub-cluster as defined by NRM regions. Based on climate observations, within the SSWFW area projections include[18]:

- Very high confidence that average temperatures will continue to increase in all seasons.
- Very high confidence that there will be more hot days and warm spells.
- Fewer frosts are projected with *high confidence*.
- A continuation of the trend of decreasing winter rainfall is projected with *high confidence*. Spring rainfall decreases are also projected with *high confidence*.
- Increased intensity of extreme rainfall events is projected, with *high confidence*.
- A harsher fire-weather climate in the future (*high confidence*).

Beliefs About Climate Change

	Agree	Neutral	Disagree

Climate change poses a risk to the region

Human activities are influencing changes in climate

It is not too late to take action to address climate change ###

If we do nothing, climate change will have dire consequences for all living things, including humans ###

I'm confident that landholders in this region can adapt to expected changes in weather patterns

Primary producers should do all they can to reduce carbon emissions from their activities

Fundamental changes are required to make our region's farming systems sustainable

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
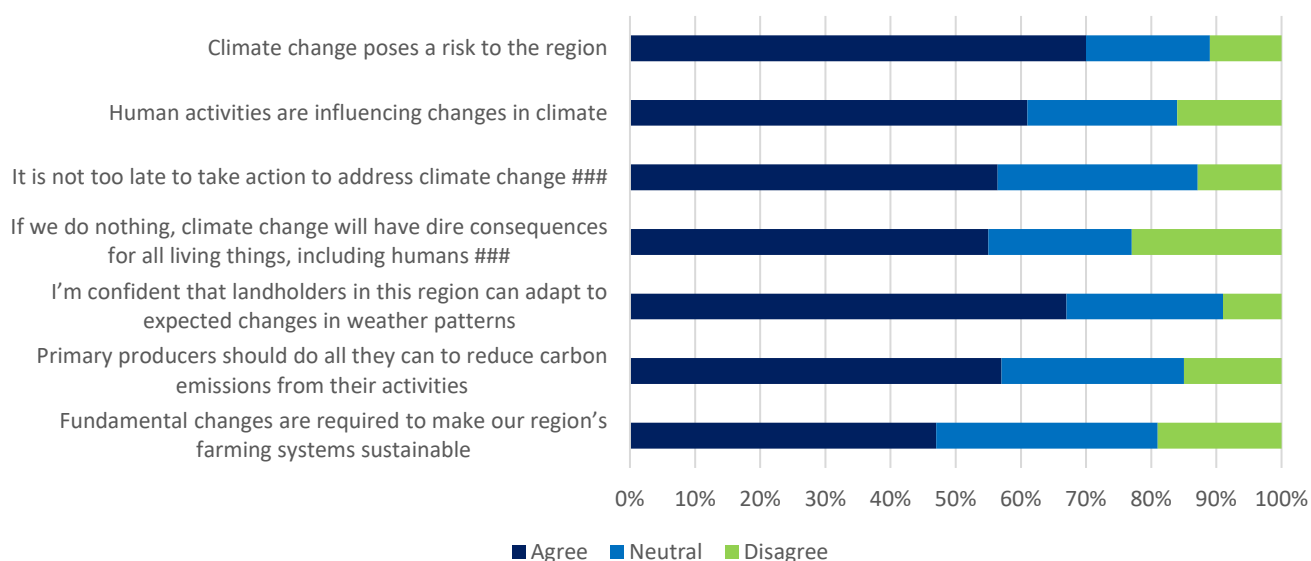
■ Agree   ■ Neutral   ■ Disagree

Figure 11: Landholder beliefs about climate change, 2020 (n = 171 to 179).

As demonstrated in Figure 11, survey respondents were largely cognisant of these risks, with only 11% of respondents disagreeing that climate change poses a risk to the region, with 70% agreeing and 19% unsure. 61% of all respondents agreed that human activities are influencing changes in climate and 57% agreed that landholders in the region should do all they can to reduce carbon emissions. More than half (55%) of all respondents agree that if nothing is done, climate change will have dire consequences. There

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[18] Hope, P et al., 2015, Southern and South-Western Flatlands Cluster Report, *Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports*, eds. Ekström, M et al., CSIRO and Bureau of Meteorology, Australia. Climate Futures Tool (climatechangeinaustralia.gov.au)

was a high level of confidence that local landholders in the region can adapt to changes in weather patterns (67%), yet less than half of respondents (47%) agreed that fundamental changes are required to make the region's farming systems sustainable. This data is shown by landholder type in Figure 12.

Modelling indicated that those who believe that human activities are changing the climate were also likely to view it to have 'dire consequences for all living things', but also that 'it's not too late to take action' to address climate change. They were also likely to set aside a part of their property for conservation purposes. They were not risk averse, and also there was a weak relationship with WANTFA membership in most of the models generated (R^2=0.713).

Beliefs About Climate Change, % Agreement By Landholder Type
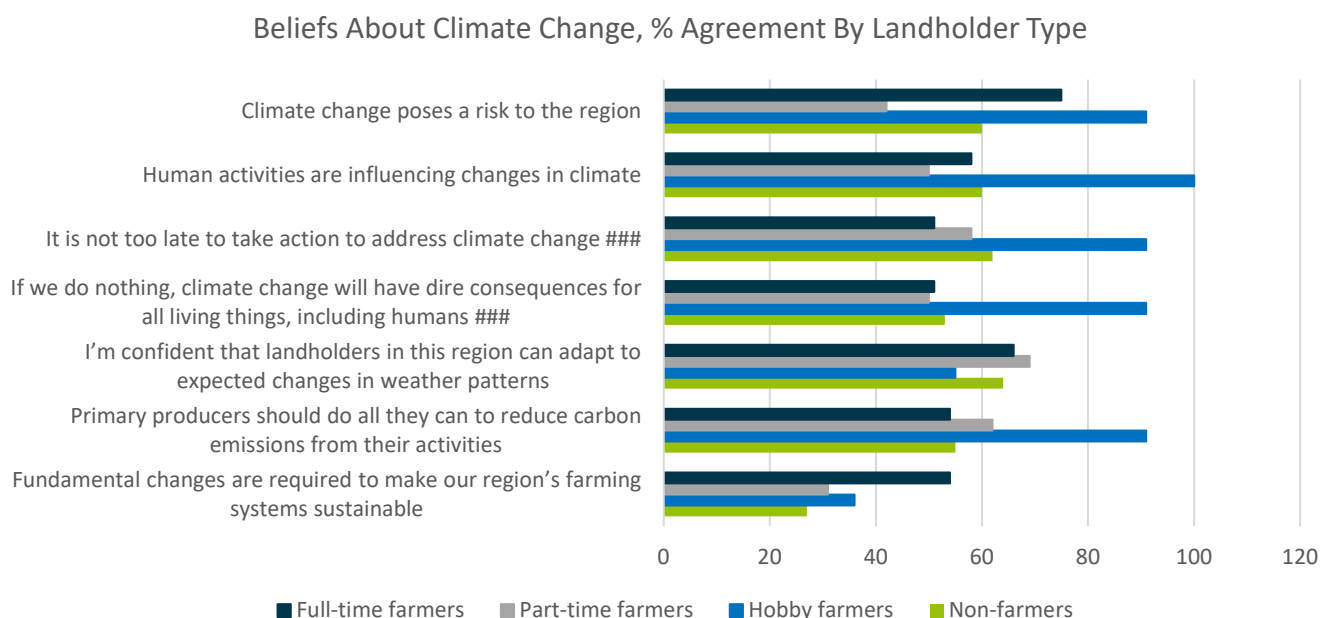
Figure 12: Beliefs about climate change by farmer type, 2020 (n = 137 to 144).

This set of views and beliefs translated into reasonable levels of current action, and higher levels of intended action. In the last 12 months, over half (52%) of full-time farmers had changed their financial or on-property operations as a result of seasonal changes to weather patterns, and 44% of all respondents. These rates were lower for both increasing soil carbon (41% of full-time farmers, 34% overall), and lower again for reducing carbon emissions (20% of full-time farmers, 17% overall). For a further breakdown, see Table L. However, with regard to long-term plans, 58% of all respondents were likely to set part of their property aside for conservation purposes, and 63% were likely to buy property outside of their current area to mitigate against increased seasonal variability (see Table M).

Table L: Practices related to climate change issues overall and by farmer type, 2020 (n= 137 to 173).

CURRENT PRACTICE	% Yes TOTAL	% Yes FTF	% Yes PTF	% Yes HF	% Yes NF
In the past 12 months have you changed your operations to increase the soil carbon on your property (e.g. by revegetation, soil management)	34%	41%	27%	0%	9%
In the past 12 months have you changed your financial or on-property operations as a result of seasonal changes in weather patterns? ###	44%	52%	36%	20%	0%

In past 12 months have you changed your on-property operations as a result of considering opportunities to reduce carbon emissions (e.g. generating solar and/or Wind power, increased power use efficiency, improved grazing practices, improved nitrogen use efficiency)	17%	20%	36%	0%	0%

Table M: Long-term plans related to climate change for all landholder types, 2020 (n=136 to 140).

LONG-TERM PLANS	% LIKELY	% UNSURE	% UNLIKELY
Some part of my property will be set aside for conservation purposes	58%	24%	18%
Buying property outside of my current area to mitigate increased seasonal variability ###	63%	25%	12%

SECTION D: THE FUTURE OF FARMING

AGE DIFFERENCES

Age can be an important influence on farmer decision-making, both through the impact of changing life stages and associated priorities, as well as the level of experience of landholders. The respondent data from full-time and part-time farmers was initially broken down into three age categories, as determined by established definitions of generations[19]: Generation Y (born 1981-1996), Generation X (born 1965-1980) and Baby Boomer and older (born prior to 1965, referred to as Baby Boomer+). However, there were not enough of the youngest age group to allow for analysis (n=8), reflecting the broader age demographics of the respondents, so the groups were amalgamated into two groups, with Generation Y and Generation X combined into one group (aged 56 years and below), and the Baby Boomer and older generation (57 years and above) was retained. Given the age demographics of the cohort, the Baby Boomer + group (aged 57 years and older group) was the largest group, so tests for significance were undertaken, where significance was set at $p < 0.05$. From this analysis, some interesting differences emerged:

As may be expected, there was clear evidence of trends toward extensification and/or intensification amongst the younger group, and slight trends of de-escalation amongst the older group. As a group, the younger cohort managed significantly more land, with an average of 2166 hectares compared to the older cohort average of 968 hectares. 81% of the younger group had bought additional land in the region in the last 20 years (compared to 57% of older group), and the reverse for the older group, with an average of 318 hectares of their land managed by others (compared with 31 hectares of the younger group). The younger group work an average of 56 hours per week on the farm, compared to 47 hours per week by the older group.

The area in which the most differences emerged was in the levels of self-assessed knowledge between the groups, with the younger generation indicating a higher level of self-assessed knowledge across a number of knowledge topics, as shown in Figure 13.

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[19] Dimock, M. (2019). Defining generations: *Where Millennials end and Generation Z begins.* Pew Research Centre. Washington. https://www.pewresearch.org/fact-tank/2019/01/17/where-millennials-end-and-generation-z-begins/

Significant differences in self-asessed knowledge between age groups

% indicating sound/ very sound knowledge

- 57 years and older
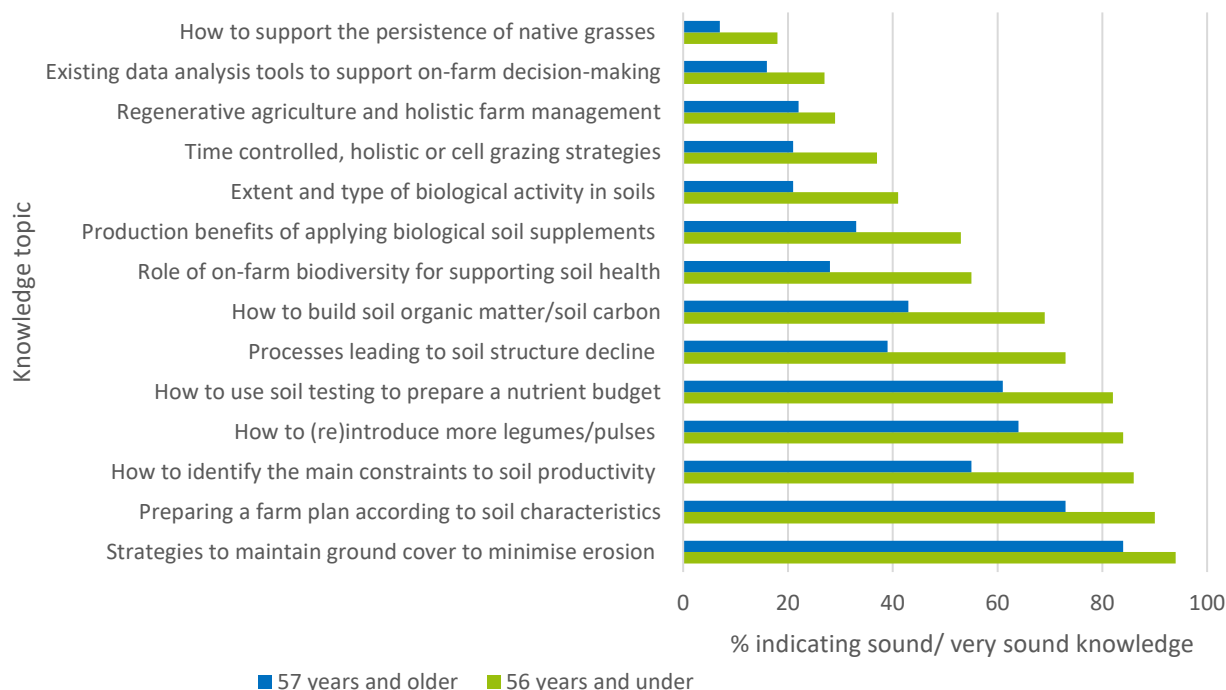- 56 years and under

Figure 13: Items with levels of self-assessed knowledge that are significantly different between age groups, 2020.

This higher level of knowledge translated into a higher rate of actual practice over a number of items, both those that have been put in place and intended practice. In terms of past practice, there were only two items for which there was a significant difference between the groups for practices implemented at some point prior to 2015. The first of these was the use of precision farming techniques, for which 59% of the 56 years and younger group had implemented this and only 35% of the older group had. Similarly, the use of time-controlled, cell or rotational grazing had been implemented by only 5% of the older group compared with 19% of the younger age group. As shown in Figure 14, there were five items in which there was a significant difference in implementation over the past five years.

Practices over past 5 years, significant differences by age group
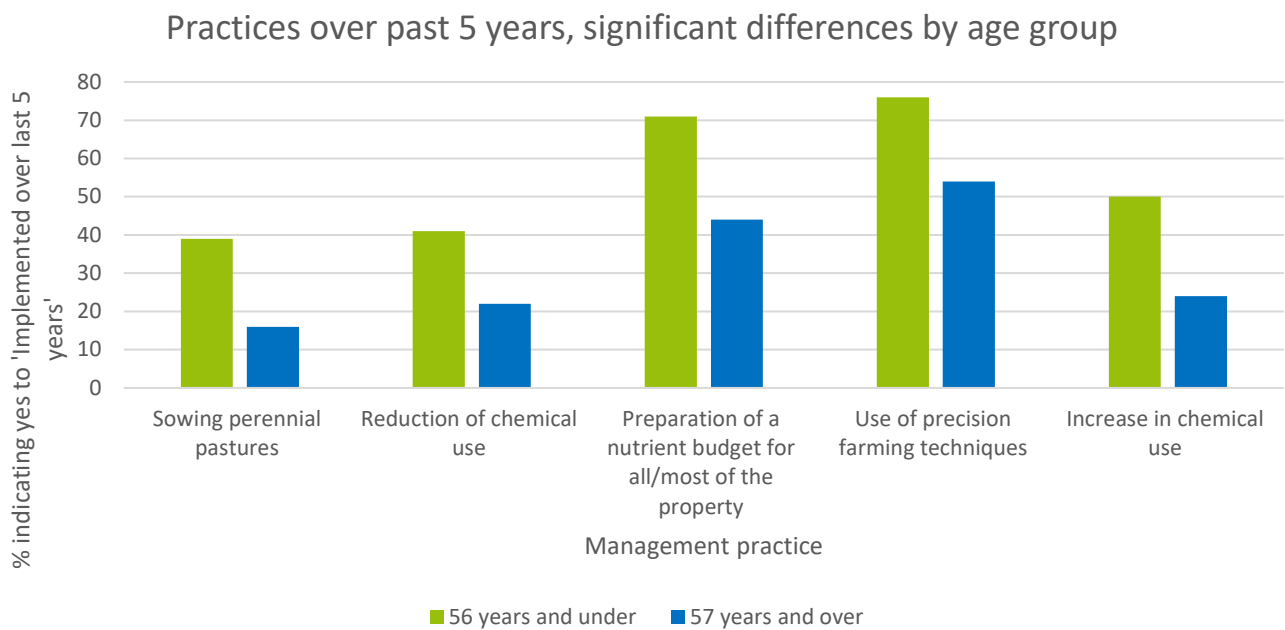
Figure 14: Management practices that show a significant difference between age groups, 2020.

As shown in Figure 15, this extended to six practices when considering intended implementation. All of these items correspond to self-assessed knowledge items that were rated with higher levels of confidence by the younger group, which demonstrates how higher levels of self-assessed knowledge can lead to increased practice uptake.
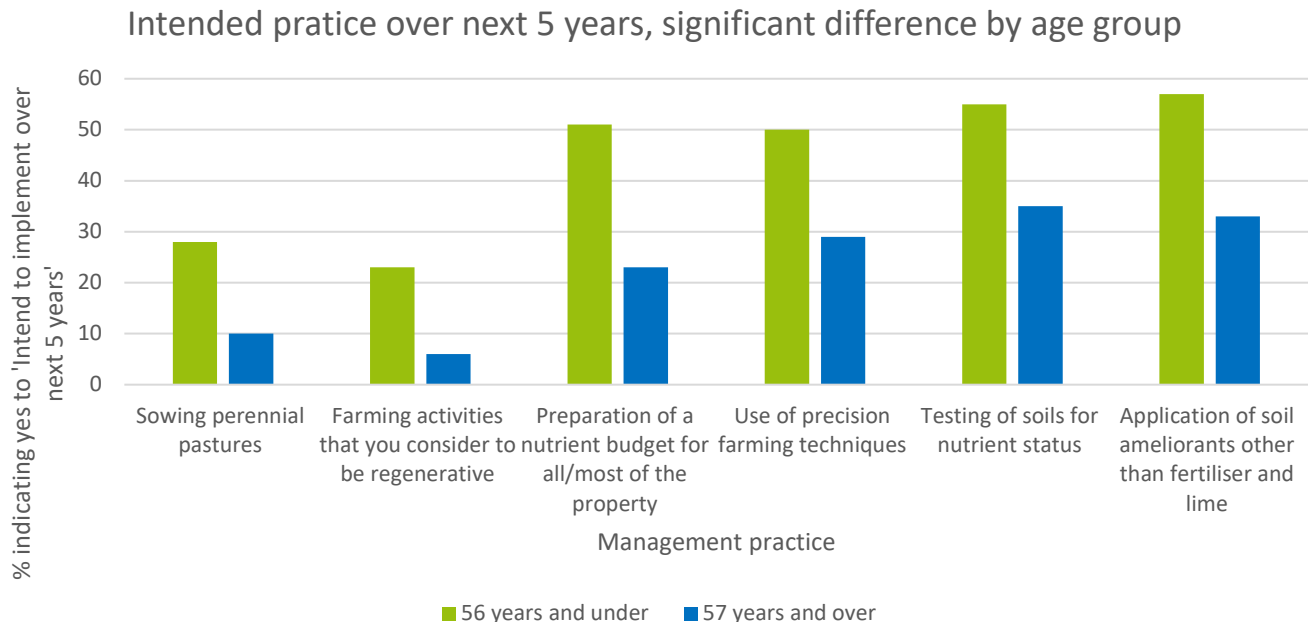
Intended pratice over next 5 years, significant difference by age group

Figure 15: Intended management practices that show a significant difference by age group, 2020.

The only two issues on which there were significant differences between the groups relate directly to these practices. As a group, the younger cohort had stronger levels of agreement with the statements 'internet connectivity is a barrier to my using on-farm data more effectively' (60% compared with 47% of older group), and that they 'feel a personal responsibility to maintain the productive capacity of my soil'

(100% of agreement by younger cohort and 89% by older cohort). The younger group also all agreed (100%) that they were open to new ideas about farming and land management, with 88% of the older group also agreeing.

LONG-TERM PLANS

With only 9% of full-time farmers indicating that they intend to sell the property, ownership turnover of farmlands is intended to be low. 43% of full-time farmers indicated that they intended to purchase additional land, which is in line with broader industry trends to larger holding sizes[20], and around a quarter indicated they would lease additional land (26%) and intended to change the enterprise mix to diversify income (27%) or move toward intensive enterprises (20%).

Overall, 72% of respondents indicated that ownership of the property would stay within the family, including 80% of full-time farmers. However, only 52% of full-time farmers had a family member interested in taking on the property in the future. When asked what the biggest challenge and/or opportunity might be over the next ten years, after climate change and weather variability, succession planning was noted as an issue. This emerged in the figures, with very low levels of succession planning in train, as demonstrated in Figure 16, however full-time farmers are the most likely to have commenced succession planning.

Progress of succession planning by farmer type

■ Full-time farmers ■ Part-time farmers ■ Hobby farmers ■ Non-farmers
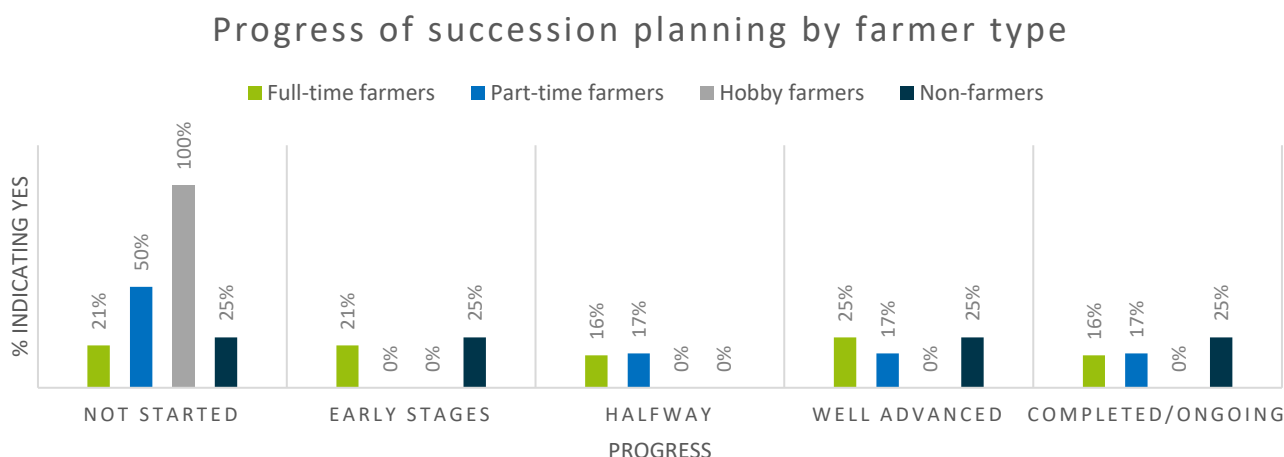
Figure 16: Progress of succession planning by farmer type, 2020 (n = 87).

[20] Jackson, T., Zammit, K., & Hatfield-Dodds, S. (2020), *Snapshot of Australian Agriculture 2020*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

CONCLUSION

This survey confirms the Northern Wheatbelt to be a primarily agricultural landscape dominated by full-time farmers with an average landholding of 3902 hectares across two properties. While the vast majority of our respondents were males of around 60 years in age, on-farm management appears to be largely collaborative, with 86% of full-time farmers including their spouse/partner, other family or an independent advisor in their on-farm management decisions. The most common land uses are cereal cropping, pasture, legumes and sheep. The results indicated that farmers in this region sit a little above the national average farmer income. However, the results indicate that financial and time constraints can have an important impact on their capacity to consider practice-change or try something new, despite Northern Wheatbelt farmers self-reporting a high level of openness to new ideas. The uncertainty of returns was a major issue raised in relation to farmer capacity to invest in the future.

A relatively high proportion of farmers reported to have good systems in place to manage their farm data, and overall farmers reported a high level of confidence with managing their farm business. The results also indicate that younger farmers in the Northern Wheatbelt report higher-knowledge levels on a whole range of best-management practices, which a higher proportion of the younger group wish to implement in the near future. Half of those who responded to the survey have well-advanced succession plans in place. Similar to our findings in other regions, while farmers wish to keep the farm within the family, there is not always a younger family member in place to take on the farm-management into the future.

It is clear that the impacts of increased seasonal variability are being felt across the region, emerging as a major issue for all respondents, with a notably large portion of respondents (70%) linking these threats to climate change. Almost half of respondents indicated that they believe fundamental changes will be required to make the region sustainable. Other important issues that emerged were an absence of regional infrastructure and public perceptions of farming activities impacting their social license to operate. On farms, the impact of temperature extremes on farm productivity, herbicide resistance, soil erosion and acidity emerged as key challenges, with some farmers indicating that the reduction of inputs and building of soil productive capacity were both challenges and opportunities for the future.

APPENDIX 1 – DATA TABLES

Table X1: Key attributes by LGA

Key attributes (medians unless indicated)	Dandaragan n = 42 (28% of respondents)	Moora n = 47 (31% of respondents)	Coorow n = 22 (15% of respondents)	Wongan-Ballidu n = 18 (12% of respondents)	Dalwallinu n = 22 (15% of respondents)
Property size (area owned)	1250ha	2950ha	2643ha	2700ha	6500ha
Property principal place of residence	67%	87%	75%	94%	95%
Bought additional land in region in past 20 years	31%	61%	65%	72%	68%
Subdivided or sold part of property past 20 years	18%	28%	40%	33%	36%
Property leased, share farmed or agisted by others (mean)	117ha	139ha	533ha (n=9)	195ha (n=11)	426ha (n=15)
Property leased, share farmed or agisted from others (mean)	1144ha (n=18)	1133ha (n=21)	1192ha (n=6)	2346ha (n=10)	2024ha (n=12)
Age of respondent	60 years	58 years	60 years	56 years	60 years
Gender of respondent (n=142)	15% female	7% female	5% female	6% female	0% female
Length of family ownership	30 years mean (median 20 yrs)	61 years mean (median 60 yrs)	53 years mean (median 52 yrs)	79 years mean (median 95 yrs)	76 years mean (median 90 yrs)
Other family members working on property	64%	70%	90%	78%	79%
Paid off-property work last 12 months mean score	27% Yes both 0% Yes me 27% Yes partner	19% Yes both 2% Yes me 36% Yes partner	30% Yes both 0% Yes me 30% Yes partner	12% Yes both 6% Yes me 53% Yes partner	15% Yes both 0% Yes me 30% Yes partner
Hours work on-property per week	37 hours	50 hours	60 hours	50 hours	50 hours
Income from agriculture in Wheatbelt region 2018/19	81%	89%	95%	89%	100%
If yes, % all survey respondents net profit from agriculture >$50k	58% (n=24)	79% (n=38)	86% (n=14)	81% (n=16)	75% (n=16)
Received net off-property income 2018/19	0% me 27% spouse 27% both	2% me 36% spouse 19% both	0% me 30% spouse 30% both	6% me 53% spouse 12% both	0% me 30% spouse 15% both
% all survey respondents net income from off-property >$50k	42%	39%	33%	31%	18%
WANTFA member	3% (3% was)	11% (16% was)	5% (24% was)	11% (11% was)	10% (20% was)
Regional NRM group member	8% (8% was)	17% (2% was)	24% (10% was)	6% (12% was)	21% (26% was)
West Midlands member	34% (5% was)	21% (2% was)	14% (5% was)	0% (0% was)	0% (0% was)

Key attributes (medians unless indicated)	Dandaragan n = 42 (28% of respondents)	Moora n = 47 (31% of respondents)	Coorow n = 22 (15% of respondents)	Wongan-Ballidu n = 18 (12% of respondents)	Dalwallinu n = 22 (15% of respondents)
Liebe member	0% (0% was)	5% (2% was)	15% (15% was)	33% (17% was)	60% (25% was)
Completed short course related to property management past 5 years	17% me 3% partner 6% both	19% me 2% partner 7% both	15% me 0% partner 10% both	28% me 0% partner 11% both	32% me 11% partner 16% both
Property management or whole farm plan	36%	52%	47%	50%	55%
Attended a field day/farm walk/ demonstration on soil health last 12 months	47%	55%	57%	67%	53%
Proportion of land lost to production due to soil problems	21% Median 100ha, mean 91ha	50% Median 50ha, mean 474ha	85% Median 175ha, mean 408ha	72% Median 200ha, mean 243ha	76% Median 145ha, mean 257ha
Family members interested in taking on property	44%	44%	35%	39%	57%
Self-assessed knowledge – selected items					
How to identify main constraints to soil productivity on property	44%	63%	71%	78%	71%
How to build soil organic matter/soil carbon	34%	48%	62%	72%	43%
The processes leading to soil structure decline in this area	32%	50%	52%	72%	48%
How to use soil testing to prepare a nutrient budget that will increase soil productivity	39%	59%	67%	78%	86%
The production benefits of applying biological soil supplements (e.g. compost, manure, microbial inoculants)	44%	35%	48%	33%	33%
The extent and type of biological activity in soils on your property	17%	20%	38%	39%	30%
Regenerative agriculture and holistic farm management	22%	20%	43%	11%	24%
Confidence measures - selected items					
Soil testing is an essential first step in understanding soil condition	79%	93%	86%	100%	95%

Key attributes (medians unless indicated)	Dandaragan n = 42 (28% of respondents)	Moora n = 47 (31% of respondents)	Coorow n = 22 (15% of respondents)	Wongan-Ballidu n = 18 (12% of respondents)	Dalwallinu n = 22 (15% of respondents)
Biological activity is an important indicator of the productive capacity of soils	79%	72%	67%	83%	90%
I would like to use less chemicals on my farm but it is too difficult in practice	53%	77%	74%	89%	62%
The costs of applying lime to address soil acidity are justified by increased production	67%	88%	80%	94%	95%
Beliefs - selected items					
Belief in climate change (Climate change poses a risk to the region)	64%	80%	75%	72%	64%
Predisposition to accept risk (I am usually an early adopter of new agricultural practices and technologies)	87%	93%	95%	94%	81%
Predisposition to resist risk (My farm is doing ok the way things are, I see no reason to change)	16%	23%	16%	17%	5%
Enterprise mix - top 3	Pasture (54%), Remnant vegetation (46%), Cereals (44%)/ Sheep for wool / meat (44%)	Cereals (81%), Pasture (62%), Sheep for wool (53%)	Cereals (82%), Legumes (64%), Pasture (59%)	Cereals (89%), Oilseeds (56%), Legumes (50%)	Cereals (100%), Legumes (68%), Sheep for wool (50%)
Farmer identity: Full-time	51%	78%	90%	78%	81%
Farmer identity: Part-time	20%	7%	5%	0%	5%
Farmer identity: Hobby	17%	7%	5%	5%	0%
Farmer identity: Non	12%	8%	0%	17%	14%
Used minimum or no tillage in the past 5 years	31%	52%	75%	71%	45%
Tested soils for nutrient status I n the past 5 years	64%	72%	75%	89%	68%
Top 3 Attached Values	Ability to pass on a healthier	An asset that is an	Ability to pass on a healthier environment	Sense of accomplishment	An important source of

Key attributes (medians unless indicated)	Dandaragan n = 42 (28% of respondents)	Moora n = 47 (31% of respondents)	Coorow n = 22 (15% of respondents)	Wongan-Ballidu n = 18 (12% of respondents)	Dalwallinu n = 22 (15% of respondents)
	environment for future generations (83%), Sense of accomplishment from building/maintaining a viable business (80%)/ An attractive place/area to live (80%)/ A great place to raise a family (80%)	important part of family wealth (87%), Sense of accomplishment from building/maintaining a viable business (86%), A great place to raise a family (85%)	for future generations (90%), Productive value of the soil on my property (90%), Sense of accomplishment from producing food and fibre for others (90%)	from building/maintaining a viable business (94%), Ability to pass on a healthier environment for future generations (89%)/ Productive value of the soil on my property (89%)/ An asset that is an important part of family wealth (89%)/ A great place to raise a family (89%)/ My property is an important part of who I am (89%)	household income (86%)/ Sense of accomplishment from building/maintaining a viable business (86%)/ Productive value of the soil on my property (86%)/ A great place to raise a family (86%)
Top 3 Regional Issues	Non-wetting soils (80%), Risk to life and property from wildfires (76%), Water security (76%)	Water security (76%), Changes in weather patterns (73%), Public support/oppos	Changes in weather patterns (95%), Uncertain/low returns limiting capacity to invest in my property (86%), Public support/opposition for	Changes in weather patterns (83%), Herbicide resistance (83%), Absence of important services	Herbicide resistance (90%), Changes in weather patterns (86%), Water security (81%)/ Effects of pesticide

Key attributes (medians unless indicated)	Dandaragan n = 42 (28% of respondents)	Moora n = 47 (31% of respondents)	Coorow n = 22 (15% of respondents)	Wongan-Ballidu n = 18 (12% of respondents)	Dalwallinu n = 22 (15% of respondents)
		ition for agricultural practices (61%)	agricultural practices (85%)	and infrastructure (82%)	use on soil biota (81%)

TABLE X2: LAND USE AND ENTERPRISE MIX, 2020 (n=190)

LAND USE/ ENTERPRISE TYPE	% Yes 2021	Difference by rainfall zone	Difference by farmer type (highest response group)
Cereal	73%	***	### (FTF)
Pasture	54%	Nil	### (FTF)
Legumes	46%	***	### (FTF)
Sheep for wool	45%	Nil	### (FTF)
Sheep for meat	45%	Nil	### (FTF)
Area of remnant native vegetation (e.g. trees, grasslands, wetlands)	42%	Nil	Nil (FTF)
Oil seeds	40%	***	### (FTF)
Other tree planting (e.g. shelter, habitat, erosion or recharge control, carbon)	25%	Nil	Nil (FTF)
Beef cattle	21%	***	### (FTF)
Area set aside for living/recreation (e.g. gardens, pets, water bodies, vehicles)	20%	Nil	Nil (FTF)
Farm forestry	7%	Nil	Nil (FTF)
Other commercial livestock enterprises (e.g. goats, pigs, deer, horse studs, poultry, alpaca, dogs)	6%	Nil	### (PTF)
Heritage agreement/ covenant	5%	Nil	Nil (FTF)
Horticulture	4%	Nil	Nil (FTF)
Irrigated agriculture	3%	***	Nil (FTF)
Farm-based tourism (e.g. farm stays, B&B)	3%	***	### (FTF, HF)
Viticulture	1%	Nil	Nil (HF)
Dairying	0%	-	-

TABLE X3: MOST IMPORTANT ISSUES 2020, (n = 111 to 145).

REGIONAL ISSUES	% AGREE/ STRONGLY AGREE				
	OVERALL	FTF	PTF	HF	NF
Changes in weather patterns	85%	87%	77%	82%	57%
Water security	78%	80%	77%	82%	79%
Public support/opposition for agricultural practices (e.g. GMs, animal welfare, pesticide use) ###	73%	79%	54%	55%	64%
Absence of important services and infrastructure (e.g. health, schools, internet, phone coverage)	75%	77%	62%	91%	60%
Herbicide resistance ### ***	68%	73%	62%	45%	64%
Availability of water for livestock	62%	60%	85%	73%	64%
Declining soil health and/or soil productivity	59%	58%	69%	73%	43%
Dry, salinised land undermining long-term productive capacity ***	48%	54%	23%	64%	29%
The impact of pest plants and/or animals on native plants and animals	50%	50%	23%	73%	57%
Long-term negative impacts of property purchased by absentees or corporate farms	48%	48%	38%	73%	29%
Risk to life and property from wildfires ### ***	50%	45%	69%	91%	43%
Loss of native plants and animals in the landscape ###	47%	41%	67%	73%	50%
Non-agricultural land use (e.g. residential, wind farms, mining) encroaching on farming land	24%	20%	38%	45%	23%
ON-FARM ISSUES		FTF	PTF	HF	NF
Impact of temperature extremes on farm productivity (i.e. frost, heat damage) ###	69%	74%	38%	73%	45%
Uncertain/low returns limiting capacity to invest in my property ###	63%	73%	62%	45%	27%
Soil acidity (lower pH) undermining productive capacity of soils	56%	61%	54%	45%	50%
Soil erosion (e.g. due to wind or water)	58%	60%	58%	45%	50%
The impact of weeds or over-abundant native plant species on productivity.	60%	60%	58%	73%	55%
Low biological activity in soils	58%	59%	46%	45%	50%
Effects of pesticide use on soil biota ### ***	51%	59%	23%	36%	25%
Non-wetting soils ***	56%	55%	69%	73%	38%
Low organic carbon in soils	53%	51%	38%	45%	42%
Declining nutrient status of soils ***	51%	49%	62%	55%	31%

Soil (re)compaction ###	40%	46%	33%	20%	18%
Soil-borne diseases	44%	44%	42%	55%	33%
Gravels and duplex soil amelioration	41%	42%	33%	30%	25%
Chemical residue in soils	40%	41%	42%	45%	25%
Salinity undermining productive capacity of soils ***	37%	38%	25%	45%	31%
Soil sodicity	30%	29%	33%	36%	20%
Secondary impact of previous amelioration strategies ###	23%	23%	14%	14%	0%

TABLE X4: VIEWS AND BELIEFS REGARDING CLIMATE CHANGE, 2020 (n= 137 to 144)

VIEW	Mean	% Disagree	% Unsure	% Agree	% Don't Know/ N/A	Farmer Type with highest rate of agreem't
I'm confident that landholders in this region can adapt to expected changes in weather patterns	3.7	9%	24%	67%	0%	PT
Primary producers should do all they can to reduce carbon emissions from their activities	3.5	15%	28%	57%	0%	HF
Fundamental changes are required to make our region's farming systems sustainable	3.4	19%	34%	47%	0%	FT
BELIEF						
Climate change poses a risk to the region	3.9	11%	19%	70%	0%	HF
It is not too late to take action to address climate change ###	3.6	13%	31%	57%	0%	HF
Human activities are influencing changes in climate	3.6	16%	23%	61%	0%	HF
If we do nothing, climate change will have dire consequences for all living things, including humans ###	3.5	23%	22%	55%	0%	HF

TABLE X5: MANAGEMENT PRACTICES OVER TIME, 2121 (n=126 TO 142)

MANAGEMENT PRACTICE	At some point (prior to 2015)		Past 5 years (2015-2020)		Intend to implement in next 5 years	
	FT	PT	FT	PT	FT	PT
Testing of soils for nutrient status ###	61%	45%	82%	64%	43%	36%
At least one lime application to arable land ###	65% ***	36%***	75%	45%	48%	18%
Planting legumes or pulses ###	59%	18%	70%	82%	46%	27%
Lethal control of pest animals ###	55%	36%	67%	45%	45%	18%
Use of precision farming techniques ###	49% ***	0%***	66%	10%	39%	10%
Application of soil ameliorants other than fertiliser and lime (e.g. gypsum, organic manure) ###	52%	30%	64%	20%	45%	10%
Use of no-tillage techniques to establish crops or pastures ###	55% ***	18%***	62%	27%	35%	27%
Deep ripping of arable land ###	49% ***	20%***	58%	20%	43%	10%
Planting of trees and shrubs	69%	82%	50% ###	55% ###	38%	27%
Preparation of a nutrient budget for all/most of the property ###	42% ***	9%***	41%	9%	36%	18%
Fencing of native bush/grasslands to manage stock access	59%	45%	39%	18%	18%	18%
Increase in chemical use	22% ###	10% ###	36% ###	10% ###	9%	10%
Reduction of chemical use	14%	40%	28%***	50%***	33% ###	20% ###
Sowing perennial pastures	24%	27%	24% ***	36%***	17%	18%
Use of time controlled, cell or rotational grazing	12%	0%	21%	20%	18% ###	0% ###
Farming activities that you consider to be regenerative practice/s	16%	0%	17%	1%	13%	1%
Organic farming	1%	0%	3%	0%	3%***	0% ***

TABLE X6: VIEWS ABOUT RISK AND TUST BY FARMER TYPE, 2020 (n= 138 to 142). Mean is out of 5, shading indicates top 3

VIEW STATEMENT	OVERALL % (Mean)	% AGREE/STRONGLY AGREE			
		FTF	PTF	HF	NF
I am open to new ideas about farming & land management ###	91% (4.2)	95%	67%	100%	58%
You can't be too careful when dealing with people	50% (3.5)	47%	75%	36%	64%
I usually view risks as a challenge to embrace ###	51% (3.5)	58%	42%	64%	15%
Financially, I can afford to take a few risks and experiment with new ideas	45% (3.3)	50%	42%	60%	17%
I am usually an early adopter of new agricultural practices and technologies ###	44% (3.3)	50%	33%	30%	18%
People are almost always interested only in their own welfare ###	34% (3.1)	27%	50%	64%	50%
I have sufficient time available to consider changing my practices	38% (3.1)	42%	25%	30%	25%
I prefer to avoid risks ###	33% (3)	29%	42%	55%	54%
My farm is doing ok the way the way things are, I see no reason to change	15% (2.7)	16%	17%	10%	27%

TABLE X7: VIEW STATEMENT AGREEMENT DATA USE AND MANAGEMENT BY FARMER TYPE, 2020 (n = 137 to 141)

VIEW STATEMENT	% AGREE/ STRONGLY AGREE				
	OVERALL	FTF	PTF	HF	NF
Soil testing is an essential step in understanding soil condition ###	91%	92%	77%	91%	75%
I feel confident working with numbers and managing my farm accounts ###	82%	88%	69%	40%	60%
Most years I am satisfied with my farm's productivity given the seasonal conditions experienced ***	80%	86%	77%	60%	70%
I usually include another person or people in my on-farm management decisions ###	79%	86%	62%	50%	55%
I am coping well with the associated stresses & challenges of managing my farm	68%	71%	69%	30%	70%
Pathway to market for my produce is clear	68%	73%	77%	40%	36%
Decision-making needs to be strongly influenced by data	66%	71%	69%	50%	55%

I have good systems in place to manage my farm data ###	62%	69%	54%	20%	40%
Internet connectivity is a barrier to my using on-farm data more effectively	49%	51%	77%	30%	40%

Table X8: LONG TERM PLANS BY FARMER TYPE, 2020 (n = 132 to 172)

LONG TERM PLANS	% OVERALL	% FTF	% PTF	% HF	% NF
Ownership of the property will stay within the family ###	72%	80%	58%	50%	43%
Additional land will be purchased ###	33%	43%	0%	0%	8%
I will move off the property around/soon after reaching retirement age	29%	28%	33%	38%	30%
The enterprise mix will be changed to diversify income sources ###	22%	27%	20%	10%	0%
Additional land will be leased or share farmed ###	19%	26%	0%	0%	0%
Some part of my property will be set aside for conservation purposes	18%	13%	20%	11%	27%
All or most of the property will be leased or share farmed	17%	15%	17%	20%	42%
The enterprise mix will be changed to more intensive enterprises ### ***	16%	20%	9%	0%	0%
The property will be sold ###	16%	9%	25%	20%	54%
Buying property outside of my current area to mitigate increased seasonal variability ###	12%	12%	17%	0%	18%
A family member will seek additional off-property work to support the farm	12%	12%	9%	22%	18%
The enterprise mix will be changed to less intensive enterprises ###	6%	5%	0%	0%	9%
The property will be subdivided and a large part of the property sold	4%	4%	0%	0%	8%

APPENDIX 2 – SURVEY

SUPPORTING LANDHOLDERS IN THE WEST AUSTRALIAN WHEATBELT

RURAL LANDHOLDER SURVEY 2020

SUPPORTING LANDHOLDERS IN THE WHEATBELT REGION

This comprehensive survey is a vital part of efforts to understand the important social and economic factors shaping landholder decision making. Information you provide will guide decision-making and strategic planning by WANTFA, the West Midlands Group, the Liebe Group and Wheatbelt NRM, all organisations working to support landholders to enable viable futures in the Wheatbelt region. Information will also be used to inform the activities of the Australian Soil Cooperative Research Centre.

Surveys are being sent to landholders with properties in the Wheatbelt, identified via ratepayer lists. Each survey has a serial number that links to the property, enabling us to spatially reference our survey results with soil and weather data. There is no other way to obtain this property level information. Our plans are to follow up this survey in about five years, to provide insights into trends over time.

We recognise that you may not be involved in decision making for this property. We are seeking the views of the person/s primarily responsible for managing the property. If you are not involved in the management of the property, please forward the survey to the property manager or return the survey in the postage-paid return envelope. We ask that you only provide information for property/s within the Wheatbelt region.

This voluntary survey should take approximately 25-40 minutes to complete. There are no right or wrong answers and there is no need to think at great length about your responses. If you have any questions about the survey, please contact Dr Hanabeth Luke on 1800 317 503 or by email at Hanabeth.Luke@scu.edu.au

You are assured of complete confidentiality. Your name will never be placed on the survey or used in any of the reports. No group outside the research team will have access to the survey data. Information is published at the regional scale and individual data is never published.

Thank you for your assistance,

Dr. Hanabeth Luke

1. OCCUPATIONAL IDENTITY

Please **circle** the descriptor/term that best describes your **occupational identity:**

Full-time farmer   Part-time farmer   Hobby farmer   Non-farmer

Please circle the **Rainfall zone** most relevant to your main/home property:

○ Low (Under 325mm)   ○ Medium (325-450mm)   ○ High (Over 450mm)

What is your local government area? _____

2. ENTERPRISE/ LAND USE MIX

This topic is seeking **information about your current land use/enterprise mix.** *Please place a tick besides any correct response in the 'Situation Now' column. Please answer with the land you own and manage within the WA Wheatbelt region in mind.*

ENTERPRISES / LAND USE ON YOUR PROPERTY IN 2020	SITUATION NOW	ENTERPRISES / LAND USE ON YOUR PROPERTY IN 2020	SITUATION NOW
Cereal	○	Horticulture	○
Legumes/Pulses	○	Irrigated agriculture	○
Oil seeds	○	Area of remnant native vegetation (e.g. trees, grasslands, wetlands)	○
Pasture	○	Farm forestry	○
Dairying	○	Other tree planting (e.g. shelter, habitat, erosion or recharge control, carbon)	○
Beef cattle	○	Farm-based tourism (e.g. farm stays, B&B)	○
Sheep for wool	○	Heritage agreement/covenant	○
Sheep for meat	○	Area set aside for living/recreation (e.g. gardens, pets, ocean access, vehicles)	○
Other commercial livestock enterprises (e.g. goats, pigs, deer, horse studs, poultry, alpaca, dogs)	○	Other (please specify):	○
Viticulture	○		

3. YOUR ASSESSMENT OF ISSUES

This set of statements seeks your opinion about the importance of a **range of issues that may be affecting your property and your local district.** *Examine each statement in the table, then place the number of your response option in each space provided for 'Your view'.*

RESPONSE OPTIONS:

NOT IMPORTANT	MINIMAL IMPORTANCE	SOME IMPORTANCE	IMPORTANT	VERY IMPORTANT
1	2	3	4	5

IMPORTANCE OF ISSUES AFFECTING YOUR LOCAL REGION	YOUR VIEW
Absence of important services and infrastructure (e.g. health, schools, internet, phone coverage). **For example:**	
Risk to life and property from wildfires	
Availability of water for livestock	
Dry, salinised land undermining long-term productive capacity	
Long-term negative impacts of property purchased by absentees or corporate farms	
The impact of pest plants and/or animals on native plants and animals	
Loss of native plants and animals in the landscape	
Water security	
Changes in weather patterns	
Public support/opposition for agricultural practices (e.g. GMs, animal welfare, pesticide use)	
Herbicide resistance	
Non-agricultural land use (e.g. residential, wind farms, mining) encroaching on farming land **Please specify:**	
Declining soil health and/or soil productivity	

IMPORTANCE OF ISSUES AFFECTING YOUR PROPERTY	YOUR VIEW
Uncertain/low returns limiting capacity to invest in my property	
Impact of temperature extremes on farm productivity (e.g. frost, heat damage)	
The impact of weeds or feral animals or over-abundant native species on productivity **Please indicate the most important:**	
Secondary impacts of previous amelioration strategies **If important, please indicate amelioration strategy:**	

3. YOUR ASSESSMENT OF ISSUES (CONT.)

IMPORTANCE OF SOIL RELATED ISSUES ON YOUR PROPERTY	YOUR VIEW
Soil erosion (e.g. due to wind or water)	
Non-wetting soils	
Declining nutrient status of soils	
Salinity undermining productive capacity of soils	
Soil acidity (lower pH) undermining productive capacity of soils	
Soil sodicity	
Low organic carbon in soils	
Low biological activity in soils	
Soil-borne diseases	
Chemical residue in soils	
Effects of pesticide use on soil biota	
Soil (re)compaction	
Gravels and duplex soil amelioration	

4. THE PRINCIPLES THAT GUIDE YOUR LIFE

The next set of statements seeks information about the **principles that guide your life**. Please number each.

RESPONSE OPTIONS:

NOT IMPORTANT	MINIMAL IMPORTANCE	SOME IMPORTANCE	IMPORTANT	VERY IMPORTANT
1	2	3	4	5

THE PRINCIPLES THAT GUIDE YOUR LIFE	YOUR VIEW
Looking after my family/loved-ones and their needs	
Preventing pollution and protecting natural resources	
Being influential and having an impact on people and events	
Fostering equal opportunities for all community members	
Respecting the earth and living in harmony with nature	
Caring for the weak/vulnerable and correcting social injustice	
Creating wealth and striving for a financially profitable business	

5. WHY YOUR PROPERTY IS IMPORTANT TO YOU

The next set of statements seeks information about the **reasons your property is important to you**. Examine each statement in the table and place the number for your response in the space provided for *'Your View'*.

RESPONSE OPTIONS:

NOT IMPORTANT	MINIMAL IMPORTANCE	SOME IMPORTANCE	IMPORTANT	VERY IMPORTANT
1	2	3	4	5

WHY YOUR PROPERTY IS IMPORTANT TO YOU	YOUR VIEW
Sense of accomplishment from producing food and fibre for others	
Ability to pass on a healthier environment for future generations	
Sense of accomplishment from building/maintaining a viable business	
Provides opportunities to learn new things	
A place or base for recreation	
An asset that will fund my retirement	
A great place to raise a family	
Its native vegetation provides habitat for birds and animals	
An important source of household income	
An attractive place/area to live	
Provides a sense of belonging to a community	
Provides a sense of belonging to a place	
My property is an important part of who I am	
The productive value of the soil on my property	
Native plants and animals make the property an attractive place to live	
An asset that is an important part of family wealth	
Other? Please specify:	

6. YOUR KNOWLEDGE OF DIFFERENT TOPICS

In this section we would like you to provide **an assessment of your knowledge** for a number of different topics. Examine the response options. For each choice in the table, place the number of your response in the 'Your view' column.

RESPONSE OPTIONS:

NO KNOWLEDGE	VERY LITTLE KNOWLEDGE	SOME KNOWLEDGE	SOUND KNOWLEDGE (sufficient to act)	VERY SOUND KNOWLEDGE (can give a detailed explanation)	NOT APPLICABLE
1	2	3	4	5	6

YOUR KNOWLEDGE OF DIFFERENT TOPICS	YOUR VIEW
Preparing a farm/property plan allocating land use according to land/soil characteristics	
The Aboriginal group/s connected to the area where your property is located	
The role of remnant vegetation in supporting the natural ecosystem	
Strategies to maintain ground cover to minimise erosion in this area	
Options and strategies to (re)establish perennial pastures (e.g. Lucerne/native grasses) in this area	
How to identify the main constraints to soil productivity on your property	
The production benefits of applying biological soil supplements (e.g. compost, manure, microbial inoculants)	
The processes leading to soil structure decline in this area	
The role of soil carbon in maintaining soil health	
How to build soil organic matter/soil carbon	
How land in your district was used and managed before European settlement	
How to use soil testing to prepare a nutrient budget that will increase soil productivity	
Regenerative agriculture and/or holistic farm management	
How to support the persistence of native grasses in this area	
Farming practices that can lead to more nutrient-dense food	
How to (re)introduce more legumes/pulses into your enterprise mix	
Time controlled, holistic or cell grazing strategies	
The role of on-farm biodiversity for supporting soil and landscape health	
Existing data analysis tools to support on-farm decision-making	
The extent and type of biological activity in soils on your property	

7. YOUR VIEWS & EXPERIENCE

We would like to know **how closely the statements presented below reflect your views.** Examine each statement in the table, then place the number for your response in the space provided for 'Your view'.

RESPONSE OPTIONS:

STRONGLY DISAGREE	DISAGREE	UNSURE/ DON'T KNOW	AGREE	STRONGLY AGREE
1	2	3	4	5

STATEMENTS	YOUR VIEW
The benefits of stubble retention outweigh problems arising from the practice If relevant, how do you manage your stubble?	
The costs of applying lime to balance soil acidity is justified by increased production	
The costs of establishing perennial pasture are justified by the returns	
Soil testing is an essential step in understanding soil condition	
Biological activity is an important indicator of the productive capacity of soils	
Fencing to manage stock access is an essential element of protecting waterways and native vegetation	
I feel a personal responsibility to be part of a local grower group	
I feel a personal responsibility to maintain the productive capacity of my soil	
There is adequate compensation or support provided for conservation activities on my farm	
Pathway to market for my produce is clear	
I usually include another person or people in my on-farm management decisions If yes, please indicate who (i.e. spouse, agronomist):	
I have good systems in place to manage my farm data	
Decision-making needs to be strongly influenced by data	
Internet connectivity is a barrier to my using on-farm data more effectively	
I feel confident working with numbers and managing my farm accounts	
Most years I'm satisfied with my farm's productivity given the seasonal conditions experienced	
I am coping well with the associated stresses and challenges of managing my farm	
Grower groups are the best way to drive and direct local research, development and extension	
I am interested in learning more about regenerative/holistic farming approaches	
Adopting regenerative/holistic farming practices is justified by the returns	

7. YOUR VIEWS & EXPERIENCE (CONT.)

STATEMENTS	YOUR VIEW
I'm confident that landholders in this region can adapt to expected changes in rainfall patterns	
Primary producers should do all they can to reduce carbon emissions from their activities	
Fundamental changes are required to make farming systems more resilient in our region	
I feel adequately supported to conduct farming and land management activities on my property	
I would like to use less chemicals on my farm but it is too difficult in practice	
I have a preferred decision-making tool that I regularly use **If yes, please indicate the name of tool:**	

OPEN QUESTIONS

What is your main source of support for your agricultural and land management activities (e.g. grower groups, friends)?

What sort of support would enhance your agricultural and land management activities?

Which group/organisation/department do you think would be the most appropriate to provide this support?

Is there a particular technology/tool/innovation that would support your farm management goals?

Are you a member of WANTFA?	○ No	○ Yes	○ I was a member
Are you a member of/associated with your regional NRM group?	○ No	○ Yes	○ I was previously
Are you a member of the West Midlands group?	○ No	○ Yes	○ I was a member
Are you a member of the Liebe group?	○ No	○ Yes	○ I was a member

STRONGLY DISAGREE	DISAGREE	UNSURE/ DON'T KNOW	AGREE	STRONGLY AGREE
1	2	3	4	5

STATEMENTS (please indicate the extent to which you agree with the following, for the corresponding groups)	WANTFA	Regional NRM group	Local grower group (eg. West Midlands Group, Liebe)
Provides valuable information about soil, agronomy, farm management and/or natural resource management			
Can be relied on to keep landholders' interests in mind when making decisions about research priorities			
Should play an advocacy role/lobby on behalf of my community's needs in regards to research, development & extension (R,D & E)			

What would you most like to see from these groups?

Local Grower Group:

WANTFA:

Regional NRM group:

8. TOP SOURCES OF INFORMATION

In the past 12 months, what have been your top sources of information about topics related to the management of your property in the WA Wheatbelt region? *Please place a tick besides relevant sources in the table below.*

MODE OF INFORMATION		ORGANISATION/PERSONS	
Television	○	Other farmers	○
Books	○	West Midlands Group	○
Magazines	○	Liebe Group	○
Newspapers	○	WANTFA	○
Email(s)	○	Regional NRM group (eg. Wheatbelt NRM, NACC)	○
Radio	○	Local Council	○
Field days	○	Department of Primary Industries and Regional Development (DPIRD)	○
Websites	○	Soil CRC	○
Instagram	○	Rural R&D corporations (e.g. GRDC)	○
Twitter	○	Extension officers	○
Brochures/leaflets/newsletters	○	Environmental organisations (e.g. Greening Australia)	○
YouTube	○	Commodity groups	○
Podcasts	○	Friends/neighbours/relatives	○
Academic journals/research papers	○	Universities/CSIRO	○
Facebook	○	Bureau of Meteorology	○
Whatsapp or Messenger groups	○	**Independent** agricultural consultants, agronomists or stock agents	○
Other	○	**Commercial** agricultural consultants, agronomists or stock agents	○

For your selection/s above, please indicate the title of your preferred top source: (e.g. name of newspaper or website)

9. YOUR VIEWS ABOUT RISK, TRUST AND CLIMATE

In this section we would like to explore your **views about the taking risks, trusting others, and climate change**. For each statement in the table, place the number of your response in the 'Your view' column.

RESPONSE OPTIONS:

STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
1	2	3	4	5

STATEMENTS	YOUR VIEW
You can't be too careful when dealing with people	
I am usually an early adopter of new agricultural practices and technologies	
People are almost always interested only in their own welfare	
My farm is doing ok the way the things are, I see no reason to change	
I prefer to avoid risks	
I am open to new ideas about farming and land management	
I usually view risks as a challenge to embrace	
Financially, I can afford to take a few risks and experiment with new ideas	
I have sufficient time available to consider changing my practices	
Climate change poses a risk to the region	
Human activities are influencing changes in climate	
It is not too late to take action to address climate change	
If we do nothing, climate change will have dire consequences for all living things, including humans	

10. MANAGEMENT PRACTICES ON YOUR PROPERTY

This section asks about **practices undertaken** on your main or 'home' property in the WA Wheatbelt region during the full period of your management; and the past 5 years. **Tick all relevant**: _Some actions may not be relevant to your situation: please ignore those topics._

PRACTICES IMPLEMENTED ON YOUR MAIN OR "HOME" PROPERTY IN THE WHEATBELT REGION	AT SOME POINT (prior to 2015)	PAST 5 YEARS (2015-present)	INTEND TO IMPLEMENT IN NEXT 5 YEARS
Planting of trees and shrubs (incl. direct seeding)	O	O	O
Fencing of native bush/grasslands to manage stock access	O	O	O
Use of time-controlled, cell, or holistic grazing	O	O	O
Sowing perennial pastures	O	O	O
Use of no-tillage techniques to establish crops or pastures	O	O	O
Use of precision farming techniques	O	O	O
At least one lime application to arable land	O	O	O
Deep ripping of arable land	O	O	O
Application of soil amendments other than fertiliser and lime (e.g. gypsum, organic manure)	O	O	O
Testing of soils for nutrient status	O	O	O
Preparation of a nutrient budget for all/most of the property	O	O	O
Lethal control of pest animals	O	O	O
Reduction of chemical use	O	O	O
Increase in chemical use	O	O	O
Plant legumes/pulses	O	O	O
Organic farming. **List certification scheme, if applicable:**	O	O	O
Farming practices you consider to be regenerative **Example/s:**	O	O	O

What is the most important influence on your soil health?

Have you had any notably successful or unsuccessful soil amelioration practices? Please explain.

11. YOUR PROPERTY AND YOU

BACKGROUND INFORMATION	PLEASE TICK OR FILL IN YOUR RESPONSE
What is the total area of land you own in the WA Wheatbelt region? (excluding land you manage but do not own)	_____ total Ha owned
Is this Wheatbelt property your principal place of residence?	◯ No ◯ Yes
What area of additional land do you manage (lease/sharefarm/agist from others) in the WA Wheatbelt region (additional to the figure you provided above)?	_____ Additional Ha managed
How long have you or your family owned or managed all/some part of your property?	_____ yrs
How many rural properties do you own **within** the WA Wheatbelt?	_____ No. of properties
What area of your property is leased, share farmed or agisted by others?	_____ Ha

INFORMATION ABOUT YOU AND YOUR MAIN OR 'HOME' PROPERTY	PLEASE TICK OR FILL IN YOUR RESPONSE
Has this enterprise bought additional land in this region in the past 20 years?	◯ No ◯ Yes
Have you subdivided or sold part of your property in this region over the past 20 years?	◯ No ◯ Yes
Estimate the number of **hours per week** that you worked on **farming/property** related activities (**average over the past 12 months**).	_____ hrs/week
What is your **age**?	_____ years
What is your gender? ◯ Male ◯ Female ◯ Non-Binary	
What is your main occupation (e.g., farmer, teacher, investor, retiree)? _____	
What is the highest level of formal education you have completed? ◯ Trained in life but no formal quals ◯ Year 10 ◯ Year 12 ◯ Vocational Certificate ◯ Tertiary/Uni	
Are other **family members** working on your property **on a daily or weekly basis**? **If yes**, please indicate who they are: ◯ Spouse/partner ◯ Children ◯ Parent/s ◯ Sibling/s ◯ Other/s	◯ No ◯ Yes
Have you prepared/are you preparing a property management or whole farm plan that involves a map or other documents that address the existing property situation and include future management and development plans?	◯ No ◯ Yes
Is any proportion of your land presently lost to production due to soil problems? If yes, how many hectares have been lost due to soil _____ Ha **Please specify the issue:**	◯ No ◯ Yes

11. YOUR PROPERTY AND YOU (CONT.)

INFORMATION ABOUT YOU AND YOUR MAIN OR 'HOME' PROPERTY	PLEASE TICK OR FILL IN YOUR RESPONSE
In the past 12 months have you changed your financial or on-property operations as a result of seasonal changes in weather patterns?	◯ No ◯ Yes
In the past 12 months have you changed your operations to increase the soil carbon on your property (e.g. by revegetation, soil management)	◯ No ◯ Yes
In the past 12 months have you changed your on-property operations as a result of considering opportunities to reduce carbon emissions (e.g. generating wind power, improved practices)	◯ No ◯ Yes
Did you earn income from agriculture on your Wheatbelt property during 2018/2019 financial year?	◯ No ◯ Yes
Did your Wheatbelt property return a net profit during the 2018/2019 financial year?	◯ No ◯ Yes
If yes, was your net 2018/2019 agricultural income above $50,000?	◯ No ◯ Yes
Did you or your spouse/partner receive a net off-property income (after expenses and before tax) in the financial year (2018/2019)?	◯ No ◯ Yes, me ◯ Yes, my partner
If yes, was the total off-property income for you and/or your spouse above $50,000?	◯ No ◯ Yes
In the 2018/2019 financial year, what percentage of you (and your spouse's) income was earned off farm? (eg from shares, rental income, employment, other business)	_____ %
Estimate the number of **days** you were involved in **paid off-property** work in the **past 12 months**	_____ days per year
Has your WA Wheatbelt property returned a net profit over the last 10 years? (i.e. income exceeded all expenses before tax, on balance, over the 10 year period)	◯ No ◯ Yes
In the past 5 years have you or your partner **completed a short course/workshop** relevant to property management? (e.g. financial planning, integrated pest management)	◯ No ◯ Yes, me ◯ Yes, my partner
In the last 12 months, did you attend field days, farm walks and demonstrations focused on soil health and productivity?	◯ No ◯ Yes

If you ticked no to attending field days/farm walks/demonstrations, what may have prevented you?

In the last **12 months**, what was the most important influence on your profitability?

What has been the top influence on your **profitability** over the last **ten years**?

Over the last 10 years, if there is a particular **practice change** that has played a major role in your farm's profitability, **please describe:**

In the **next 10 years**, what would you see as likely being your **biggest challenge and/or opportunity?**

12. LONG TERM PLAN OPTIONS

Please indicate the possibility that your **long-term plans** for your property in the **next 10 years** will involve each of the choices in the table below. Examine the response options underneath this paragraph. For each choice in the table, place the number of your response option in the 'Your view' column.

RESPONSE OPTIONS:

HIGHLY UNLIKELY	UNLIKELY	UNSURE	LIKELY	HIGHLY LIKELY
1	2	3	4	5

LIKELIHOOD YOUR LONG-TERM PLANS WILL INVOLVE	YOUR VIEW
Ownership of the property will stay within the family	
The property will be sold	
The property will be subdivided and a large part of the property sold	
I will move off the property around/soon after reaching retirement age	
All or most of the property will be leased or share farmed	
Additional land will be purchased	
Additional land will be leased or share farmed	
The enterprise mix will be changed to diversify income sources	
The enterprise mix will be changed to more intensive enterprises	
The enterprise mix will be changed to less intensive enterprises	
A family member will seek additional off-property work to support the farm	
Some part of my property will be set aside for conservation purposes	
Buying property outside of my current area to mitigate increased seasonal variability	

Do you have **family members interested in taking on your property in the future**? Please tick your answer.

O Yes   O No   O Unsure/too early to know

If **Yes**, has your family agreed to a **succession plan**? Please circle your answer.

Not started   Early stages   Halfway   Well advanced   Completed/Ongoing

OTHER COMMENTS AND THANK YOU FOR YOUR TIME

Do you have any other comments about any of the topics covered in the survey, or other aspects of land and water management in the WA Wheatbelt region? Please use the space provided to write your comments or attach additional sheets. Your comments will be recorded by the research team.

We appreciate the time you have spent answering the questions. **Please return the completed survey in the postage-paid envelope provided**

If you need assistance with the survey, or wish to make specific comments about it, please contact Dr Hanabeth Luke via **1800 317 503**.