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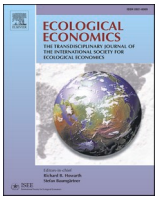

Surveys

Comparing Australian public and farmer views on agricultural land use and management practices for sustainability

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ABSTRACT

Using a survey of the public (n = 2032) and broadacre farmers (n = 351) in South Australia and Victoria, Australia, this research compares public and farmers' concerns regarding the acceptability and sustainability of agricultural operations. A principal component analysis was conducted on survey responses to 15 statements capturing environmental, social and governance issues related to agriculture practices and perceptions. This analysis revealed three dimensions: (1) issues related to animal welfare, greenhouse gas emissions and food safety; (2) issues related to farm input use; and (3) the use of socially valuable assets for private profits. Compared to farmers, the public were more concerned about the undersupply of public goods (e.g., farm animal welfare), and issues related to farm input use such as the use of synthetic fertilisers and chemicals. The public and farmers reported a similar level of concern regarding the use of socially valuable assets for private profit (e.g., irrigation water extraction). Regression analyses revealed associations between concerns and socio-demographic characteristics; environmental attitudes; sources of information; and farm characteristics. This study can act as a catalyst for developing practical strategies to analyse and overcome the issues, rather than symptoms, of concern affecting the agricultural industry and its sustainability.

1. Introduction

The agricultural industry contributes positively to livelihoods and communities across the globe. However, there is growing public concern about the sustainability of the industry across multiple domains and acceptability of several specific management actions such as those leading to adverse environmental impacts or poor animal welfare outcomes (Hampton et al., 2020; Witt et al., 2021). The public can make their concerns known through consumption choices, by demanding regulatory changes, or otherwise questioning the industry's social licence status (e.g., Bröhmer, 2011; Knook et al., 2022; Neilson, 2010). The agricultural industry would have a social licence if it enjoyed ongoing acceptance or approval by stakeholders affected by their activities, and stakeholders who can affect the profitability or ability of the industry to conduct its activities (Gunningham et al., 2004; Thomson and Boutilier, 2011; Cooney, 2017). In Australia, the level of industry acceptance is sometimes unclear, and as such this raises questions about the extent to which the public have a say and/or farmers have the right to decide how they collectively manage 51% of the continent's land (ABS, 2018a) and associated natural resources (e.g., Lockie, 2015; Lush, 2018; Chan, 2021).

With the emergence of such tensions, research has sought to understand public perceptions and concerns about the agricultural industry (e.g., Coleman et al., 2018; Witt et al., 2021) or the use of specific technologies or approaches to land management (e.g., Goddard et al., 2018; Baumber et al., 2022; Jassim et al., 2022). Negative public perceptions and consequent consumption decisions have farmers concerned about potential impacts on their market access, profitability, competitiveness, and the potential introduction of stricter regulations (Henningsen et al., 2018). However, few studies document farmers' perceptions of issues attracting community attention, or their self-assessment of performance relative to potential issues or social expectations (van Huik and Bock, 2007; Bassi et al., 2019; Buddle et al., 2021). Likewise, comparisons of public and farmers' concerns about specific

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issues are rare, and those conducted have focussed on farm animal welfare (Vanhonacker et al., 2008; Verbeke, 2009; Latacz-Lohmann and Schreiner, 2019) and to a lesser extent, environmental conservation (Howley et al., 2014; Tienhaara et al., 2020).

It is important to understand any discordance between the public and farmers' concerns about issues that underpin environmental and social sustainability of the industry or affect the agricultural industry's capacity to do business if tensions or debates are to be resolved. This research partially addresses this knowledge gap by posing two research questions: (1) what are the Australian public's views regarding agricultural sustainability issues? and (2) what are farmers' views regarding the same issues? These questions support our objective to understand the extent to which the two stakeholder groups' concerns align and what socioeconomic and attitudinal characteristics are associated with their views to inform evidence-based pathways toward the development of agricultural sustainability frameworks that account for sustainability challenges across environmental, social (including animal welfare) and governance domains (e.g., Australian Agricultural Sustainability Framework; McRobert et al., 2022).

Exploring the research questions in the Australian context provides useful insights for three key reasons. First, approximately half of Australia's land area is used for agricultural production (ABS, 2018a). While the largely urban population in Australia is sympathetic regarding the challenges facing farmers (e.g., climate change), they are increasingly concerned about farming impacts on the environment and animal welfare (Chan, 2021; Flanagan, 2021; Crampton and Ragusa, 2022). Second, natural resource-dependent industries in Australia are highly concerned about public debates that can affect future regulations, market access or business viability (Dumbrell et al., 2020). Third, Australian agricultural industry bodies have stated that information and methods to improve community-industry relations are a high priority (Lockie, 2015). The findings from this Australian case study are expected to be relevant for other countries with economically and socially important agricultural industries.

2. Comparing views on various agricultural issues

2.1. Comparing public and farmer views

Previous research seeking to understand public and farmer concerns toward agricultural issues includes studies comparing public and farmers' concerns about animal welfare (e.g., Te Velde et al., 2002; Vanhonacker et al., 2008; Latacz-Lohmann and Schreiner, 2019) and environmental conservation (Howley et al., 2014; Tienhaara et al., 2020). Comparisons between public and farmers' attitudes toward such issues have been made with the underlying assumption that individuals construct perceptions according to their frames of reference, influenced by: values, convictions, knowledge, and interests, including economic self-interest (Te Velde et al., 2002; Vanhonacker et al., 2008). The comparative approach adopted for this study is therefore based on studies such as Te Velde et al. (2002) and Vanhonacker et al. (2008).

With the approach described above, the social acceptance and stakeholder comparison literature was reviewed to guide this research. Previous comparison studies have identified greater heterogeneity in public attitudes relative to farmers' attitudes (Te Velde et al., 2002; Howley et al., 2014). Influences such as income, age, and place of residence (urban vs rural) have contributed to this heterogeneity in public attitudes (Howley et al., 2014; Wolf et al., 2016). Alongside these findings, a study examining the social acceptance of dairy farming in the Netherlands found that members of the public with greater experience and knowledge of farming were the most content and accepting of the industry (Boogaard et al., 2011). van Huik and Bock (2007) also found heterogeneity in attitudes among farmers. Differences were identified between those with a strong price and production-efficiency focus, and those with a broader definition of quality and care for environmental and social outcomes. Following this, similar heterogeneity within the surveyed stakeholder groups in this study was expected. It was also hypothesised that a set of variable categories would influence concerns about agricultural issues within and across the two stakeholder groups in this study, including: sociodemographic characteristics; farm characteristics; environmental concerns; engagement, knowledge, and sources of information about the agricultural industry.

Due to differences in the above listed variable categories, the two stakeholder groups of interest in this study were also expected to register differences in their levels of concern about different issues. Evidence of this discordance exists in attitudes toward animal welfare, where public survey respondents have tended to register greater concern and farmers have been more positive or defensive (Te Velde et al., 2002; Vanhonacker et al., 2008). Such results align with research showing a higher willingness to pay for improved farm animal welfare outcomes (Lagerkvist and Hess, 2010). Recent research has also identified a mismatch between the public willingness to pay and farmer willingness to accept for improved animal welfare and provision of ecosystem services. Furthermore, this mismatch diverges at higher levels (Latacz-Lohmann and Schreiner, 2019; Tienhaara et al., 2020). Conversely, Howley et al. (2014) found that their samples of the Irish public and farmers had similar levels of concern about the environment but diverged on specific issues, such as the importance of maintaining wildlife habitat on farms. Following this, similar heterogeneity in concern across issues was expected in this study.

2.2. Issues at the centre of agricultural sustainability and social licence concerns

Recognising differences in public and farmer attitudes across issues such as animal welfare compared to environmental conservation (Section 2.1), we sought to identify the key issues attracting attention in the Australian agricultural industry. Guiding the review was the scope of issues described as threatening the industry's social licence in Williams and Martin (2011) and those across the spectrum of sustainability issues since included in the Australian Agricultural Sustainability Framework (in pre-stages of development at the time of this survey; McRobert et al., 2022). With a focus on issues relevant to the systems operated by the agricultural industries to be surveyed (broadacre crop and livestock), identified issues included on and off-farm issues related to management practices, use of inputs and technologies, land use, and industry governance.

Two key issues stood out for livestock producers in the review: animal welfare and greenhouse gas emissions. The Australian public's attitudes to farm animal welfare have changed through time (Hampton et al., 2020); with increased attention following visible breaches of expected standards in live export supply chains (Bruce and Faunce, 2017). To reflect the nature of responsibility along the supply chain, animal welfare was captured in two dimensions in our study: on-farm and off-farm. The majority of social on-farm animal welfare research has focussed on public attitudes, self-rated knowledge, and expectations (e.g. Coleman et al., 2018; Futureye, 2018). For off-farm animal welfare, there has been more focus on responses to information (Bruce and Faunce, 2017). Additionally, the Australian agricultural industry is responsible for approximately 14% of Australia's greenhouse gas emissions with the majority stemming from animal agriculture (DISER, 2020) and most Australians regard it as important to reduce greenhouse gas emissions (Colvin and Jotzo, 2021). Australian consumers concerned that meat production harms the environment by increasing greenhouse gases or concerned about animal welfare tend to consume less meat compared to others (Malek et al., 2018). Following this, a series of attitudinal and sociodemographic variables linked to concern about these issues in previous studies (Coleman et al., 2018; Malek et al., 2018; Malek and Umberger, 2021) were included in this study with similar associations between environmental attitudes and concerns about animal welfare and greenhouse gas emissions expected.

An additional set of issues identified in the literature, of relevance to

broadacre cropping farmers, relate to the use of chemicals, synthetic fertilisers and genetically modified crops, where the key concerns relate to biosafety externalities affecting human health and the environment (Roth, 2011; Beckie et al., 2020). This concern was evident when Australian public support for genetically modified organisms in food and crops was 38% in 2017 (Cormick and Mercer, 2017). Such concerns have also led to decisions to limit the use of such inputs or technologies in some jurisdictions (Cormick and Mercer, 2017; Beckie et al., 2020). However, farmers are already facing constraints on market access (e.g. Eady, 2017), and anticipate future decisions to prohibit or restrict access to inputs will increase costs of production (e.g. Walsh and Kingwell, 2021). Adding further complexity to attitudes and concerns within the farming community are issues of coexistence between farmers operating different farming systems, for example organic (Wheeler, 2011; Kershen, 2014). Studies that examine these issues independently, and not as a collective set of practices that may exist in organic agriculture were rare and as such, the inclusion of these issues, and others such as concern about soil health were included in the study on an exploratory basis.

A final group of issues relate to the use of socially valuable assets, particularly natural resources, to create private profits (Martin and Shepheard, 2011). The term socially valuable asset is used to describe an asset that may provide non-use values or other socially beneficial services/goods but has formal property rights governing ownership or use (and therefore does not meet the criteria to be defined a public good). In the Australian context, concern about the use of socially valuable assets is highlighted in debates about: (1) limits on land clearing on private properties (Martin and Shepheard, 2011); (2) foreign ownership of agricultural land (Keogh, 2014; Laurenceson et al., 2015); (3) coexistence of rural and urban land uses (Martin and Shepheard, 2011); and (4) the re-negotiation of water sharing between irrigation and environmental and cultural purposes (Shepheard and Martin, 2008; Grafton and Wheeler, 2018). Institutional arrangements governing land clearing and water use in Australia have experienced change which has led to changing and differing expectations (Grafton and Wheeler, 2018; Simmons et al., 2018). Adding to this, there are records of diverse views and preferences among the public and farmers about strategies to achieve goals related to the recovery of water for the environment (Loch et al., 2014) and the optimal level of land clearing (Martin and Shepheard, 2011). Following this, such issues attracting much attention at the time of the survey were included as a focus for this study.

3. Methods

3.1. Survey design and implementation

Two surveys serve as the data source for the analysis. Both surveys and associated survey development and testing activities were approved by The University of Adelaide Human Research Ethics Committee ($H-2020-101$). The first survey was administered by an online panel provider (Pureprofile) and distributed to a representative sample of the public in South Australia and Victoria. The second was a phone survey of farmers (modified slightly from the online questionnaire) that collected data from broadacre cropping and livestock farmer respondents in the same jurisdictions as the public survey. Broadacre cropping and livestock farms were targeted as they are the most common farm types in South Australia and Victoria, and Australia as a whole (ABS, 2018a, 2018b). A third-party telephone survey administrator (Q&A Market Research) was engaged to survey willing participants between October and December 2020. Interviews were conducted with farmers randomly drawn from a list of over 3500 farm businesses (supplied by Impact Lists) and supplemented with 20 additional records of organic farming businesses that were also located in South Australia or Victoria and operating a livestock or broadacre cropping or mixed enterprise business. A focus group with members of the public and interviews conducted with farmers and agricultural industry professionals from July to September 2020 were used to understand key issues, experiences, and concerns to incorporate into the survey as well as to pre-test the survey.

The decision to use an online survey for the public and a telephone survey for the farmer sample was based on an assessment of the research objectives, target populations, timeline, and budget (Dillman et al., 2014). For example, Australian farmers receive multiple surveys every year and report having limited time to respond (ABS, 2015). Given the burden of multiple requests for information and number of mail-out survey requests that farmers report to reject (ABS, 2015), it was considered highly likely that requests to complete a mail-out survey for this project would also be rejected in large numbers. Using the experience of other survey research specifically targeting farmers (e.g., Wheeler et al., 2018), a telephone survey was expected to achieve a higher response rate and lower non-respondent bias. At the same time, the use of an online survey was deemed appropriate for the public given our budget constrained our capacity to use a telephone survey for over 2000 people, and sample selection bias issues previously associated with internet-based surveys have reduced (Dillman et al., 2014).

The survey design was informed by a review of existing literature (including peer reviewed and industry publications) that captured various issues attracting attention in and across the Australian agricultural industry as summarised in Section 2.2. Focus was applied to issues that were more or uniquely associated with agricultural industries, rather than issues or concerns persistent across industries or Australian communities. For example, issues such as adequate pay and conditions for employees were identified as concerns but ultimately excluded from this study as this issue pertained to regulatory compliance and was not more relevant to the surveyed agricultural industries than other industries. Using the outcomes of the literature review, both surveys included questions for respondents to record their level of concern (on a Likert scale from 1 = Strongly disagree that [issue] is a concern to me to 5 = Strongly agree that [issue] is a concern to me, or 'I don't know') about 15 issues that were commonly described as attracting debate or public concern. Respondents were instructed to reply to questions based on how concerned they were about each issue relative to current industry practice and not whether they think the issue is generally important. Identical wording of these questions was used for both surveys to enable comparisons. Responses to these questions by both groups form the basis of the analyses presented in the following sections. Table 1 lists the 15 statements presented in the survey. Questions on socio-demographics and attitudes were also asked, and farmers provided information about their farm and farm business.

3.2. Survey responses

The online public survey received 2032 responses. However, only 1824 responses provided complete sociodemographic information and as such, only these 1824 responses were used in the regression analyses (described in next section). Of the 846 farmers contacted from our list, 351 farmers completed the telephone survey. This represents a response rate of 57%, including farmers that agreed to participate later but were not required once the survey quota for each state was met, or 41% if those non-interviewed farmers are excluded from the calculation. This response rate is on par with other farmer telephone survey research in Australia (e.g., Wheeler et al., 2012, 2021), and higher than the 20 to 35% response rate recorded for most mail-out surveys (Fielke and Bardsley, 2014; Greiner and Gregg, 2011) and some telephone surveys (e.g., Tingey-Holyoak, 2014).

3.3. Comparative, principal component and regression analyses

A Kruskal-Wallis test for one-way analysis of variance by ranks was used to determine whether there were any statistically significant differences between the public and various groups of farmers with respect to concerns recorded across the 15 agricultural issue statements (Hecke, 2012). Anticipating statistically significant differences ($p \leq 0.05$) between respondent groups, Tamhane's T2 tests were selected as

appropriate to determine which respondent groups differed from each other (Tamhane, 1979). Tamhane's T2 tests were selected (rather than Tukey's Honestly Significant Difference tests, or similar) because variances were expected to be unequal between the comparison groups.

Following this, an exploratory principal component analysis (PCA) was conducted using responses from both the public (n = 2032) and farmer respondents (n = 351) to the 15 agricultural issue statements. The PCA was used to determine whether responses to distinct agricultural issue statements would load highly on specific components (Mooi et al., 2018). A PCA analysis was considered appropriate because the Kaiser-Meyer-Olkin statistic was 0.912, a value considered 'marvellous' (Kaiser, 1974) and Bartlett's sphericity test was statistically significant, p-value <0.001 (Bartlett, 1950).

Using an orthogonal varimax rotation PCA, the components were retained if the eigenvalue was >1 (Kaiser, 1960), and component loadings were considered practically meaningful if >0.3. Component scores were determined using the ordinary least squares (OLS) regression method as described by DiStefano et al. (2009). Component scores computed with this method have a mean of 0 and standard deviation of 1. Given these attributes, the component scores were used as dependent variables in seemingly unrelated regression (SUR) analyses. This was done to identify respondents' characteristics associated with different levels of concern regarding components of agricultural industry issues identified in the PCA. A SUR model is a system of linear equations, where for a given individual i, the errors are correlated across equations j (representing an advantage relative to alternative methods where errors are not correlated, e.g., OLS). This is represented in Eq. (1) in vector form where y is the dependent variable (component score for each component equation, j), x is the vector of all independent variables (the same variables were used for each of the component equations j), β the vector of regression coefficients and, u the error terms.

$$y_j = x_j\beta_j + u_j \quad (1)$$

Separate SUR models were estimated for the public and farmer samples. This was done because different explanatory variables were expected to be associated with the component scores for each respondent group (Tables A1 and A2 in the appendix), and because different independent variables were available for both groups.

Findings from the literature detailed in Section 2 and more broadly guided these above-described variable choices (e.g., Howley et al., 2014; Wolf et al., 2016; Coleman et al., 2018; Goddard et al., 2018; Malek et al., 2018; Malek and Umberger, 2021; Latacz-Lohmann and Schreiner, 2019; Tienhaara et al., 2020; Wheeler et al., 2018, 2021). The explanatory variables common in both the public and farmer analyses were: state (South Australia or Victoria); sex (as defined by the Australian Bureau of Statistics); age; education; concerns about environmental issues; and whether respondents lived in an area where agriculture was the main industry of employment. The additional explanatory variables in the public analysis were: whether respondents lived in a metropolitan (urban) or regional area; household income; employment experience; main sources of information about agriculture; diet; membership of environmental or social activist groups; and confidence in government decisions (Table A1 in the appendix). The explanatory variables in the farmer analysis further included farm and farmer characteristics such as off-farm income, farm enterprise and management strategies used (Table A2 in the appendix). All analyses were conducted in StataSE 16.

Other variables and alternative variable forms, e.g., squared forms of continuous explanatory variables, were also tested before the final estimates were computed. Further, additional analyses were undertaken to complement the SUR estimates. The first additional analysis was OLS model estimates using a total concern score as the dependent variable. The total concern score was calculated by summing and rescaling respondents' agreement with the 15 agricultural issue statements that stated [issue] is a concern, on a Likert scale from: 1 = Strongly disagree to 5 = Strongly agree. The second additional analysis explored concerns related to each of the 15 agricultural issues (measured on a Likert scale: 1 = Strongly disagree to 5 = Strongly agree) using ordered probit models. Results from these analyses are included in the supplementary materials. For all analyses, responses of 'I don't know' were recoded to 3.

4. Results

4.1. Summary statistics

The public sample was representative of the adult population of South Australia and Victoria in terms of age and sex (ABS, 2018b, 2020). Likewise, chi-squared statistics revealed no difference between public respondents from South Australia and Victoria and as such the respondents from the two states have been grouped in all results presented (and delineated in the regression analyses by a dummy variable where South Australia = 0 and Victoria = 1; Table A1).

The farmer respondents were considered representative in terms of age and sex of the broadacre farming population in South Australia and Victoria (ABS, 2018b). The mean age of the farmers that completed the survey was 56 years (Table A2). In 2016, 61% of South Australian and 53% of Victorian farmers had a post-school qualification (ABS, 2018b). In this sample, 56% of respondents had a post-school qualification, and 27% had a university qualification (Table A2).

4.2. Stakeholder views on agricultural land use, industry, and management practices

Both public and farmer respondents indicated a high level of concern about the extent of foreign investment in the Australian agricultural industry, relative to other issues presented (Table 1). This was indicated by Kruskal-Wallis test for one-way analysis of variance by ranks. The same test also showed no statistically significant difference between the public and various groups of farmers responses with respect to concerns for irrigation water extraction, culling pest animals, and the extent that lobby groups can advocate for the industry and inform government decisions (Chi square statistic and p-value in Table 1). Where the Kruskal-Wallis test for one-way analysis of variance by ranks indicated statistically significant differences, Tamhane's T2 tests were used to determine which means were statistically significantly different both within respondent groups and across respondent groups. Alongside foreign investment, farmers were also concerned about urban sprawl (bold values in Table 1). The public's second highest level of concern was related to off-farm animal welfare, chemical use, and urban sprawl. Other comparisons of relative concern within respondent groups, rather than across respondent groups are presented in Table S1 in the supplementary materials.

Using comparisons across respondent groups, public respondents indicated significantly ($p \leq 0.05$) higher levels of concern than all farmer groups about the lack of implementation of Indigenous knowledge and rights in agricultural best-practice management and the volume of greenhouse gas emissions produced by the industry (indicated by different superscript letters in relevant rows in Table 1). There were also significant differences ($p \leq 0.05$) in responses across the types of farmers included in the sample. For example, cropping-only farmers registered significantly less concern about using genetically modified (GM) crops than other farmer groups (and the public). Additionally, livestock-only farmers were significantly more concerned than other farmer groups about off-farm animal welfare (Table 1).

4.3. Grouping views on agricultural land use, industry, and management practices

An exploratory PCA using responses from both the public and farmers revealed three components of agricultural issues (Table 2). Three of the 15 agricultural issue statements did not load onto any

Table 1
Mean score for 15 agricultural industry issues, reflecting the relative concern with comparisons of means for each issue across four respondent groups.

	Public (n = 2032)		Crop-livestock farmers (*n* = 131)		Cropping-only farmers (*n* = 37)		Livestock-only farmers (*n* = 183)		Chi square statistic	p-value
Foreign investment: *The extent that farmers and other businesses in the agricultural industry can sell assets (including land) to and/or attract investment from overseas is a concern to me*	**4.14**	**(0.94)**	**4.21**	**(1.16)**	**3.86**	**(1.23)**	**4.05**	**(1.26)**	5.09	0.166
Off-farm animal welfare: *The treatment of animals during transport, sale, or processing,* i.e., *treatment of animals off-farm is a concern to me*	3.93[a]	(1.03)	3.16[b]	(1.42)	3.16[b]	(1.36)	3.50[c]	(1.37)	52.84	<0.001
Chemical use: *The type, timing of application and/or extent of use of chemical weed and pest controls is a concern to me*	3.90[a]	(0.92)	3.14[b]	(1.29)	3.05[b]	(1.54)	3.45[b]	(1.27)	60.64	<0.001
Urban sprawl: *Urban sprawl on agricultural land is a concern to me*	3.89[a]	(0.92)	**4.07[ab]**	**(1.25)**	**3.86[ab]**	**(1.13)**	**4.14[b]**	**(1.14)**	31.54	<0.001
Irrigation water extraction: *The volume of water from common resources (e.g., rivers, groundwater) allocated to and used for irrigation is a concern to me*	3.80	(1.01)	3.66	(1.25)	**3.76**	**(1.21)**	3.64	(1.28)	1.04	0.791
Clearing native vegetation: *Extent and circumstances under which farmers are able to clear land of native vegetation is a concern to me*	3.74[a]	(0.98)	3.38[b]	(1.27)	3.22[b]	(1.46)	3.64[ab]	(1.21)	11.46	0.010
Synthetic fertiliser use: *The type, timing of application and/or extent of use of synthetic fertilisers is a concern to me*	3.72[a]	(0.96)	2.96[bc]	(1.30)	2.54[c]	(1.43)	3.07[b]	(1.40)	94.95	<0.001
Soil health: *The extent that agricultural activities impact soil health is a concern to me*	3.66	(0.97)	3.40	(1.33)	3.32	(1.42)	3.65	(1.22)	4.23	0.237
Use of GM crops: *Use of genetically modified (GM) crops is a concern to me*	3.63[a]	(1.17)	2.90[bc]	(1.45)	2.16[c]	(1.48)	3.12[b]	(1.49)	75.08	<0.001
On-farm animal welfare: *The treatment of animals on farms is a concern to me*	3.63[a]	(1.14)	3.17[bc]	(1.43)	2.84[b]	(1.52)	3.42[ac]	(1.48)	20.15	<0.001
Indigenous knowledge and rights: *The lack of implementation of Indigenous knowledge and rights into best-practice land and water allocation and management is a concern to me*	3.62[a]	(1.10)	2.83[b]	(1.14)	2.78[b]	(1.13)	2.93[b]	(1.31)	106.45	<0.001
Volume of GHG emissions: *The volume of greenhouse gas (GHG) emissions produced by the agricultural industry is a concern to me*	3.56[a]	(1.10)	2.56[b]	(1.26)	2.84[b]	(1.38)	2.71[b]	(1.24)	139.82	<0.001
Culling pest animals: *The extent and circumstances under which farmers are able to cull pest animals, including native species is a concern to me*	3.44	(1.08)	3.18	(1.37)	3.00	(1.45)	3.26	(1.44)	7.20	0.066
Lobby groups: *The extent that agricultural lobby groups have the ability to advocate for the industry and inform government decisions is a concern to me*	3.36[a]	(0.96)	3.58[a]	(1.27)	3.30[a]	(1.31)	3.43[a]	(1.36)	10.46	0.015
Food safety: *Farmers' ability to meet food safety standards is a concern to me*	3.34[a]	(1.06)	3.05[ab]	(1.35)	2.68[b]	(1.36)	3.10[ab]	(1.48)	15.94	0.001

Note: Agreement with statements measured on a 5-point Likert scale where: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree or I don't know, 4 = Agree, 5 = Strongly agree. Standard deviation is in brackets. The Chi square statistic and *p*-value are results of Kruskal-Wallis tests for one-way analysis of variance by ranks for each issue across respondent groups. Where differences were depicted, Tamhane's T2 multiple comparison tests were used to add different superscript letters across rows where means were statistically significantly different between respondent groups ($p \leq 0.05$). Bold values indicate the issues of most concern to each respondent group. Further results for comparisons within respondent groups are in the supplementary materials. Short variable names (listed ahead of statements) are used for the remainder of this document.

Table 2
Estimated weights for three significant components obtained from the PCA ($n = 2383$, which includes $n = 2032$ public, and $n = 351$ farmers).

	Component 1 Animal welfare, GHG emissions and food safety	Component 2 Farm input use	Component 3 Use of socially valuable assets
On-farm animal welfare	0.5003		
Off-farm animal welfare	0.4332		
Volume of GHG emissions	0.3826		
Culling pest animals	0.3821		
Food safety	0.3190		
Use of GM crops		0.6391	
Synthetic fertiliser use		0.5096	
Chemical use		0.4391	
Urban sprawl			0.6219
Irrigation water extraction			0.4867
Foreign investment			0.4302
Clearing native vegetation			0.3697

Notes: Full statements describing issues as used in survey are listed in Table 1. Kaiser-Meyer-Olkin statistic = 0.912, and Bartlett's sphericity test was statistically significant, *p*-value <0.001.

component, these issue statements were related to: the lack of integration of Indigenous knowledge and rights into best-practice agricultural management; the extent that lobby groups can advocate for the industry and inform government decisions; and the impact of agricultural activities on soil health. There could be multiple reasons for this outcome, including the relatively higher number of 'I don't know' responses recorded for these statements. Five issue statements loaded onto Component 1, three issue statements loaded onto Component 2, and four issue statements loaded onto Component 3 (Table 2).

The three components of issues identified reflected concerns about: (1) animal welfare, GHG emissions and food safety; (2) the use of some farming inputs; and (3) the overuse of socially valuable assets for private gain. That is, the issue statements that load onto Component 1 describe issues related to on- and off-farm animal welfare, the volume of GHG emissions produced by agricultural activities, and food safety. The issue statements that load onto Component 2 describe concerns about the use of chemicals, synthetic fertiliser and genetically modified crops. The issue statements that load onto Component 3 describe the use of socially

Table 3
Estimated component scores obtained from the PCA and used as dependent variables in the SUR analysis.

Dependent variables	Public (n = 1824)				Farmers (n = 351)			
	Mean		Min	Max	Mean		Min	Max
C1–Animal welfare, GHG emissions and food safety	0.16[a]	(1.81)	−6.03	4.57	−0.90[b]	(2.11)	−6.55	3.55
C2–Farm input use	0.15[a]	(1.36)	−4.76	2.77	−0.90[b]	(1.80)	−5.19	2.67
C3–Use of socially valuable assets	0.05	(1.43)	−6.65	3.41	−0.14	(1.60)	−5.84	2.91

Notes: Standard deviation is in brackets. Across rows, means with different superscript letters were statistically significantly different ($p \leq 0.05$) based on Tamhane's T2 multiple comparison test.

valuable assets for private profit. In particular, the use and ownership of land and water (i.e., the allocation of property rights), and the extent to which these assets are regulated.

The mean component score for the public was significantly ($p \leq 0.05$) higher than for farmers for Components 1 and 2, and not statistically different for Component 3 (Table 3). This result suggests the public has higher levels of concern about the issues related to animal welfare, GHG emissions, food safety and farm input use. Whereas the public and farmer respondents were equally concerned about the use of socially valuable assets for private profit.

4.4. Linking respondent characteristics and views on agricultural land use, industry, and management practices

The SUR analysis revealed the characteristics associated with the public and farmers' concerns across each of the three components of issues identified above. The maximum correlation coefficient for the explanatory variables included in the public analysis was −0.398, and the mean variance inflation factor was 1.22. The maximum correlation coefficient for the explanatory variables included in the farmer analysis was 0.328, and the mean variance inflation factor was 1.17. These statistics indicate no serious issues with multicollinearity, and robust standard errors were used to in-part control for heteroskedasticity.

For the public analysis (Table 4), males and respondents with higher household incomes had significantly lower levels of concern across every component of issues. Additionally, respondents who self-identified as omnivores were less concerned about issues in each component than those who identified as vegan, vegetarian, or flexitarian. Likewise, respondents that reported being financial members of environmental or social activist groups stated significantly greater concern about the issues mapping onto all components, but particularly animal welfare issues captured in Component 1 (based on ordered probit analysis—results in supplementary materials).

Respondents concerned about climate change harming their household and willing to make pro-environmental trade-offs, were significantly more concerned than others across all components (Table 4). Individuals that stated farmers were one of their main sources of information about the agricultural industry were significantly less concerned about issues mapping onto Components 1 and 2. This result reflects the relatively lower concern recorded by the farmer sample for these components (Table 3). Individuals confident that governments make decisions based on evidence, were significantly less concerned about socially valuable assets for private profit (Component 3), indicating their belief that government interventions will allocate and regulate socially valuable assets such as land and water appropriately. Interestingly, no significant association was found between the level of concern recorded and whether respondents lived in an area where agriculture was the main industry of employment. Likewise, respondents living in urban centres, were only significantly ($p \leq 0.1$) more concerned about animal welfare, GHG emissions and food safety

Table 4
SUR results for the public (n = 1824).

Variable	C1–Animal welfare, GHG emissions & food safety		C2–Farm input use		C3–Use of socially valuable assets	
State (Victoria)	−0.113	(0.071)	0.216***	(0.064)	−0.136**	(0.060)
Agriculture main industry	−0.169	(0.144)	0.005	(0.122)	−0.069	(0.122)
Urban	0.156*	(0.088)	0.003	(0.074)	−0.017	(0.074)
Male	−0.186**	(0.073)	−0.317***	(0.062)	−0.104*	(0.062)
Age	−0.008***	(0.003)	0.011***	(0.002)	0.020***	(0.002)
University educated	−0.049	(0.079)	−0.150**	(0.067)	0.117*	(0.067)
Household income	−0.003***	(0.001)	−0.002***	(0.001)	−0.002***	(0.001)
Unemployed	0.092	(0.155)	0.215	(0.132)	0.110	(0.131)
Omnivore	−0.712***	(0.073)	−0.463***	(0.062)	−0.368***	(0.062)
Activist member	0.983***	(0.157)	0.639***	(0.133)	0.574***	(0.133)
Agriculture experience	−0.754***	(0.103)	−0.172**	(0.087)	0.132	(0.087)
Information–farmers	−0.172**	(0.074)	0.138**	(0.063)	0.103	(0.063)
Information–industry	−0.026	(0.076)	0.044	(0.064)	0.024	(0.064)
Information–friends/family	0.063	(0.076)	0.121*	(0.065)	0.058	(0.065)
Information–government	0.033	(0.072)	−0.031	(0.061)	0.048	(0.061)
Information–research organisations	0.176**	(0.075)	0.019	(0.064)	0.125**	(0.064)
Confidence in government	−0.002	(0.072)	0.033	(0.061)	−0.190**	(0.061)
Climate change (CC) is happening	0.548***	(0.110)	0.143	(0.093)	0.257***	(0.093)
CC is largely human induced	0.474***	(0.093)	0.076	(0.079)	0.129	(0.079)
CC will have negative impact	0.549***	(0.079)	0.300***	(0.067)	0.560***	(0.067)
Pro-environmental trade-offs	0.514***	(0.060)	0.371***	(0.051)	0.524***	(0.051)
Constant	−1.701***	(0.299)	−1.595***	(0.254)	−3.027***	(0.254)
Chi-squared statistic	997.18		399.48		623.04	
p-value	<0.001		<0.001		<0.001	
R squared	0.354		0.180		0.255	

Robust standard errors in brackets.
*** $p \leq 0.01$.
** $p \leq 0.05$.
* $p \leq 0.1$.

Table 5
SUR results for farmers ($n = 351$).

Variable	C1–Animal welfare, GHG emissions & food safety		C2–Farm input use		C3–Use of socially valuable assets	
State (Victoria)	0.019	(0.214)	0.211	(0.186)	−0.428***	(0.158)
Agriculture main industry	−0.377*	(0.207)	−0.077	(0.179)	0.000	(0.153)
Male	0.132	(0.212)	−0.711***	(0.184)	−0.324**	(0.156)
Age	0.012	(0.011)	0.004	(0.009)	0.019**	(0.008)
University educated	−0.277	(0.252)	−0.657***	(0.219)	0.006	(0.186)
Farm area	0.0003	(0.002)	−0.001	(0.002)	−0.003**	(0.002)
Crop-only farm	−0.142	(0.345)	−0.710**	(0.300)	−0.049	(0.255)
Livestock-only farm	0.219	(0.235)	0.072	(0.204)	0.075	(0.174)
Organic	0.582	(0.385)	1.706***	(0.335)	0.076	(0.285)
Irrigator	0.094	(0.266)	0.004	(0.231)	0.185	(0.196)
Off-farm income	0.007**	(0.003)	0.009***	(0.003)	0.001	(0.003)
Farm productivity trend	−0.130	(0.113)	−0.250**	(0.098)	−0.221***	(0.084)
Farm group member	0.290	(0.210)	0.157	(0.182)	0.147	(0.155)
Succession plan	0.150	(0.207)	0.145	(0.180)	0.388**	(0.153)
Climate change (CC) is happening	0.710***	(0.244)	−0.130	(0.212)	0.043	(0.180)
CC is largely human induced	0.144	(0.227)	0.145	(0.197)	0.119	(0.168)
CC will have negative impact	0.251	(0.220)	0.209	(0.191)	0.451***	(0.162)
Pro-environmental trade-offs	0.383**	(0.160)	0.211	(0.139)	0.280**	(0.118)
Constant	−3.570***	(1.025)	−1.056	(0.891)	−1.571**	(0.757)
Chi-squared statistic	51.18		86.05		65.25	
p-value	<0.001		<0.001		<0.001	
R squared	0.127		0.197		0.157	

Robust standard errors in brackets.
*** $p \leq 0.01$.
** $p \leq 0.05$.
* $p \leq 0.1$.

(Component 1) and did not record a significantly different level of concern than respondents from regional communities in response to other issues.

The farmer analysis revealed associations between farm characteristics and concerns related to the three components of issues (Table 5). Farmers that perceived their farm productivity to have increased over the five years preceding the survey recorded less concern about issues related to farm input use (Component 2) and the use of socially valuable assets. Crop-only farmers recorded significantly less concern about genetically modified crops, synthetic fertilisers and chemical pest and weed control use (issues that map onto Component 2). This may be because they are more knowledgeable, or, depend more on these technologies in their business. Farmer responses also reflected awareness about how issues may directly affect them. For example, farmers with greater land area were statistically significantly less concerned about using socially valuable assets than other farmers. This may be because they perceive issues captured in this component, such as urban sprawl and irrigation water extraction, to be less relevant to their situation—the largest farms in this sample tended to be rainfed and located away from urban centres. Irrigators also recorded less concern about irrigation water extraction (based on ordered probit analysis—results in supplementary materials), although this was not statistically significant. However, this result was not distinguishable in the overall positive association between irrigators and concern about the use of socially valuable assets for private profit (Table 5). This result may reflect the sample composition—only 18% of the sample were irrigators, and some reported a small land area under irrigation.

Farmers with succession plans were more concerned about the use of socially valuable assets for private profit (Component 3). This could reflect a perception that issues captured in this component could have long-term or future impacts on their business. For example, urban sprawl or constraints on access to water for irrigation could affect their business at some point in the future. Likewise, certified organic farmers recorded greater concern about the use of genetically modified crops, synthetic fertilisers and chemical pest and weed controls (issues that mapped onto Component 2—detailed ordered probit results showing associations with each issue are in the supplementary materials). This may represent concerns that led to the decision to operate an organic business and/or the threats that leakage or contamination with genetically modified materials or synthetic fertilisers and chemicals present to their business.

5. Discussion

While agriculture makes positive contributions to communities and livelihoods, the sustainability and acceptability of aspects of agricultural operations is attracting increasing attention across the globe (Williams and Martin, 2011). In response to this observation, this study sought to record the concerns of both the public and farmers about a wide set of issues. Using a survey case study in South Australia and Victoria, Australia it was possible to discern three underlying dimensions of issues that are challenging industry sustainability and attracting concern. Across and within stakeholder groups there were differences in concerns that mapped onto each of the three dimensions of issues: (1) animal welfare, GHG emissions and food safety; (2) farm input use and (3) the use of socially valuable assets for private profits.

The public generally indicated greater concern about agricultural issues presented in the survey. This result echoes comparisons of public and farmer attitudes toward more specific issues such as animal welfare (Vanhonacker et al., 2008). But this result contrasts with findings reported by Howley et al. (2014) showing similar levels of concern about environmental issues between the two groups. However, there were also differences in the level of concern within the two stakeholder groups surveyed. For example, public respondents consciously reducing their consumption of animal source foods recorded statistically significantly higher levels of concern about the issues presented to them. The result mirrors those in Malek and Umberger (2021) that found consumers reducing their meat intake were motivated to do so by animal welfare concerns. Further, organic farmers recorded statistically significantly higher levels of concern about using genetically modified crops, synthetic fertilisers and chemical pest and weed controls. Similar differences between organic and conventional farmers have been identified previously (e.g. van Huik and Bock, 2007). There was also no strong evidence for a rural-urban divide in the results, i.e., in most cases public concern levels were not higher in urban communities, or lower in agricultural communities. This, added to similar results reported in Witt et al. (2009), is an important contribution to our understanding as industry (Lush, 2018) and government (House of Representatives

Standing Committee on Agriculture and Water Resources, 2020) continue to frame agricultural perception issues as consequences of a rural-urban divide and lack of understanding of the industry. These findings suggest that greater reliance on evidence-based policy beyond information provision could lead to improved social outcomes.

The public and farmer respondents differed in their concerns regarding animal welfare, GHG emissions, food safety and farm input use but did not differ in concern about using socially valuable assets for private profit. This result could in part be an artefact of our farmer sample. For example, there were few irrigators included in the farmer sample and if this was not the case, there could have been a greater divergence on the level of concern about irrigation water extraction, and consequently the use of socially valuable assets for profit more generally. Further, current concern about the extent and circumstances under which farmers can clear the land of native vegetation in Australia is concentrated in states not surveyed in this study, e.g., Queensland (Simmons et al., 2018). The concerns captured here, from South Australian and Victorian farmers, may reflect that this issue is less relevant to these farmers. Farmer views captured in this research also likely, among other things, reflect the market (and rationale behind the market they operate in) as found by van Huik and Bock (2007). For example, organic farmers recorded greater concerns about using synthetic fertilisers, chemicals, and genetically modified crops. Concerns about the use or overuse of these technologies could have acted as the motivation to adopt an organic production system. The use of these products by neighbours and potential contamination threats posed by this (e.g., Kershen, 2014) have most likely also compounded concerns expressed in the survey.

Caution should be applied when interpreting some results presented in this article, for example, the relatively high level of concern about foreign investment compared to other issues presented. Given the general nature of several statements presented to respondents, it is impossible to draw complete conclusions about why respondents were concerned about certain issues. However, the results could be read with the support of the existing literature on specific issues to provide insights (e.g. Keogh, 2014; Laurenceson et al., 2015 on foreign investment in Australian agriculture). The broader literature should also be drawn on when considering the implications of the findings. For example, the Australian agricultural sector has been heavily dependent on foreign investment for growth and the concerns held by stakeholders may have implications for attracting investment to continue to grow the value of the Australian agricultural industry (Smith et al., 2022).

As the sample composition is likely to have influenced the results in this study, it is important to understand the potential changes to the composition of the surveyed groups through time and how results produced in this study are subject to change with this. Public views can be expected to change through time, dependent on multiple factors including the tone and content of information they are exposed to (Te Velde et al., 2002; Swinnen et al., 2005; Vanhonacker et al., 2008). Whereas Vanhonacker et al. (2008) argued that a change in views or frames of reference for issues may be harder to achieve among farmers, but once established, likely to be more permanent than among the public.

The findings support the argument presented by Dumbrell et al. (2020) that public concerns related to the operations of natural resource dependent industries can be categorised as responses to market and government failures. Classifying issues attracting concern as a response to these market and government failures can be used to frame our understanding of stakeholders' decisions to argue or support the resourcing of agriculture to be conducted differently. This result could encourage the extended use of new and interdisciplinary approaches to analyse the underlying drivers, rather than the symptoms, of concerns potentially driving debates regarding the agricultural industry. In particular, this research could be paired with the growing body of literature that links an industry or activity's social licence to operate to public trust, and perceptions of benefits and fairness (e.g., Walton and McCrea, 2020). By identifying the issues of most concern this research can act as a catalyst for developing practical strategies to overcome them. For example, contextualising challenges confronting the industry and pairing this with other factors associated with social licence outcomes, the industry could be supported to chart a pathway toward achieving their sustainability goals (as outlined in the Australian Agricultural Sustainability Framework; McRobert et al., 2022).

6. Conclusion

Across the globe, the debate is ongoing for how to best respond to sustainability challenges and tensions specific to some issues in the agricultural industry. As these issues tend to be defined as conflicts of interest between interdependent actors, in this case, farmers and the public, policy processes established to frame and overcome these issues can end in stalemates and efforts to shift attention or blame. For example, farmers often call upon consumers to pay more for goods produced in a particular way, and the public often call upon governments and other supply chain actors to create (dis)incentives for farmers to use certain management practices. By identifying issues attracting the most public and farmer concern, this research is a starting point for identifying effective and efficient responses. Our surveyed farmers and the public seem to react very similarly to issues related to foreign investment, irrigation water extraction, culling pest animals, and the extent to which lobby groups can advocate for the industry and inform government decisions. Farmers were more concerned about urban sprawl, while the public were more concerned about issues such as off-farm animal welfare, chemical use, the lack of implementation of Indigenous knowledge and rights in agricultural best-practice management, the use of GM crops, and the volume of greenhouse gas emissions produced by the industry. Further research that can tease out specific motivations or drivers behind why some issues are of greater concern to some groups and any prioritisation needed to address the issues identified as attracting the most concern in this study will also inform potential trade-offs to be navigated. Understanding the influence of information asymmetry on the development of public concerns could also advance efforts to address these issues and discordant views between stakeholder groups. For now, with tensions growing in prominence, policymakers, industry and researchers need to understand the discordance in concerns between the public and farmers plus the diverse influences on concerns when seeking to minimise or overcome issues that ultimately affect future regulatory decisions, market access or the capacity to carry out business.

CRediT authorship contribution statement

Nikki P. Dumbrell: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **Sarah Ann Wheeler:** Conceptualization, Investigation, Methodology, Supervision, Writing – review & editing. **Alec Zuo:** Formal analysis, Methodology, Supervision, Writing – review & editing. **David Adamson:** Conceptualization, Funding acquisition, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Appendix

Table A1
Public sample summary statistics, explanatory variables ($n = 1824$).

Explanatory variables	Definition	Mean	Min	Max
State (Victoria)	1 = Victoria; 0 = South Australia	0.51 (0.50)	0	1
Agriculture main industry†	1 = Agriculture main industry of employment in postcode; 0 = Otherwise	0.08 (0.26)	0	1
Urban	1 = Metropolitan Adelaide/Melbourne; 0 = Regional area	0.72 (0.45)	0	1
Male	1 = Yes; 0 = Otherwise	0.45 (0.50)	0	1
Age‡	Years	46.39 (15.39)	26	65
University educated	1 = University education; 0 = Otherwise	0.40 (0.49)	0	1
Household income‡	Thousands of AUD per year	86.76 (53.68)	24.5	222.3
Unemployed	1 = Yes; 0 = Otherwise	0.05 (0.23)	0	1
Omnivore	1 = Nominated omnivorous diet; 0 = Vegan/ vegetarian/flexitarian	0.60 (0.49)	0	1
Activist member	1 = Current financial member of an environmental or social activist group; 0 = Otherwise	0.05 (0.22)	0	1
Agriculture experience	1 = Employed, formerly employed, or have family employed in agriculture; 0 = Otherwise	0.14 (0.35)	0	1
Information–farmers	1 = Farmers a main source of information about agriculture; 0 = Otherwise	0.40 (0.49)	0	1
Information–industry	1 = Industry organisations a main source of information about agriculture; 0 = Otherwise	0.35 (0.48)	0	1
Information–friends/family	1 = Family/friends a main source of information about agriculture; 0 = Otherwise	0.38 (0.48)	0	1
Information–government	1 = Government a main source of information about agriculture; 0 = Otherwise	0.41 (0.49)	0	1
Information–research organisations	1 = Research organisations a main source of information about agriculture; 0 = Otherwise	0.35 (0.48)	0	1
Confidence in government	1 = Agree or strongly agree Australian governments make policy and regulatory decisions based on scientific and economic evidence; 0 = Otherwise	0.38 (0.49)	0	1
Climate change (CC) is happening	1 = Agree or strongly agree that climate change is happening; 0 = Otherwise	0.83 (0.37)	0	1
CC is largely human induced	1 = Agree or strongly agree climate change is largely human-induced; 0 = Otherwise	0.74 (0.44)	0	1
CC will have negative impact	1 = Agree or strongly agree that climate change will have a negative impact on household; 0 = Otherwise	0.54 (0.50)	0	1
Pro-environmental trade-offs (average index)§	A healthy, well protected environment and a prosperous economy go hand in hand The environment needs to be protected even if it impacts economic prosperity In order to have economic prosperity, the environment is going to suffer a bit (reverse coded)	3.65 (0.63)	1.33	5

Notes: Standard deviation in brackets. †As per the main industry of employment in 2016 Census for nominated postcode (Australian Bureau of Statistics, 2018b); ‡Age and Household income are semi-continuous variables; §Construction variables measured on Likert scale: 1 = Strongly disagree to 5 = Strongly agree.

Table A2
Farmer sample summary statistics, explanatory variables (n = 351).

Explanatory variables	Definition	Mean	Min	Max
State (Victoria)	1 = Victoria; 0 = South Australia	0.57 (0.50)	0	1
Agriculture main industry†	1 = Agriculture main industry of employment in postcode; 0 = Otherwise	0.58 (0.49)	0	1
Male	1 = Yes; 0 = Otherwise	0.61 (0.49)	0	1
Age‡	Years	56.55 (9.97)	26	65
University educated	1 = University education; 0 = Otherwise	0.27 (0.44)	0	1
Farm area	Thousands of hectares	7.05 (5.02)	0.004	600
Crop-only farm	1 = Yes; 0 = Otherwise	0.11 (0.31)	0	1
Livestock-only farm	1 = Yes; 0 = Otherwise	0.52 (0.50)	0	1
Organic	1 = Certified organic operator; 0 = Otherwise	0.08 (0.28)	0	1
Irrigator	1 = Yes; 0 = Otherwise	0.18 (0.38)	0	1
Off-farm income	Percent of household income generated off-farm	25.53 (29.96)	0	100
Farm productivity trend	Last five years: 1 = strongly decreasing, to 5 = strongly increasing	3.54 (0.92)	1	5
Farm group member	1 = Active member of farm group or agricultural organisation; 0 = Otherwise	0.59 (0.49)	0	1
Succession plan	1 = Yes; 0 = Otherwise	0.57 (0.50)	0	1
Climate change (CC) is happening	1 = Agree or strongly agree that climate change is happening; 0 = Otherwise	0.70 (0.46)	0	1
CC is largely human induced	1 = Agree or strongly agree climate change is largely human-induced; 0 = Otherwise	0.52 (0.50)	0	1
CC will have negative impact	1 = Agree or strongly agree that climate change will have a negative impact on household; 0 = Otherwise	0.49 (0.40)	0	1
Pro-environmental trade-offs (average index)§	A healthy, well protected environment and a prosperous economy go hand in hand The environment needs to be protected even if it impacts economic prosperity In order to have economic prosperity, the environment is going to suffer a bit (reverse coded)	3.71 (0.65)	1.67	5

Notes: Standard deviation in brackets. †As per the main industry of employment in 2016 Census for postcode nominated by respondent (Australian Bureau of Statistics, 2018b); ‡Age is a semi-continuous variable; §Construction variables measured on Likert scale: 1 = Strongly disagree to 5 = Strongly agree.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2024.108149.

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