Identifying farming styles to encourage farmer engagement in climate adaptation and mitigation programs

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Abstract. Australian farmers will be greatly impacted by climate change. But farmers' attitudes and actions to climate change vary. Rather than changing attitudes to increase actions this paper considers addressing farmer adaptation and mitigation through understanding farmer decision making drivers. Using two waves of a large-scale climate change survey of Victorian farmers, four distinct farming styles were derived using cluster analysis. Each style had varying propensity to risks, planning, innovation, technology use and farming practice. The farming styles also reflect uncertainty and division in belief about causes of local climatic changes in Australia. However, there were few differences in actions between the groups. Thus, rather than attempt to change farmer beliefs, social drivers can be used to tailor key messages and outreach programs to appeal to each styles goals, experiences, and climate concerns. The findings support the need for segmentation that considers the broader socio-economic drivers of farming.

Keywords: typology, climate change, adaptation, mitigation, attitudes,

Introduction

Climate change will have a significant impact on Australian agriculture more than any other developed country (Garnaut 2011). Predictions indicate Australia will experience more frequent extreme weather events such as heatwaves, floods, and in the study area in Victoria, southern Australia, increased temperature and less rainfall (IPCC 2013). Yet many farmers are sceptical about the reality of climate change (NCCARF 2013) and there is some feeling that there will be time to act later (NCCARF 2013). Farmer uncertainty is not restricted to Australia, farmers across the world are uncertain about climate change (e.g. Hogan et al. 2011; Barnes & Toma 2012; Haden et al. 2012). With this uncertainty, exploring ways to encourage farmers to adopt climate change adaptation and mitigation actions is vital to ensure food security for the world's growing population. This paper argues that a more holistic viewpoint about the main drivers of farming decisions is required.

A key question that policy makers and practitioners will need to understand is farmers' willingness to respond to climate change and to proposed shorter and longer-term strategies. Whilst focusing on the influence of attitudes on actions is often emphasised in climate change research (e.g. Wheeler, Zuo & Bjornlund 2013; Kuehne 2014), attitudes alone do not drive changes in farming practices and adaptations (Niles, Brown & Dynes 2016). Rather, farmer decision making is shaped by a whole myriad of factors including weather, markets, new technologies, individual goals and preferences, risk perception (Haden et al. 2012), farmer health, moral responsibility and other farm characteristics (Hogan et al. 2011). As such, it is important to consider a more contextualised picture of drivers which impact on farmer decision making, such as their farming goals (Pannell et al. 2006) as a basis for encouraging farmer action around climate change. Drivers of farming decision making, or social drivers, are factors that influence farmers' attitudes and decisions. They include lifestyle changes and preferences or goals (Hogan et al. 2011), culture, education, economic status and technological innovation usage and knowledge (Pannell et al. 2006; Björklund et al. 2009). Social drivers are related to the individual rather than societal level and are about the way people think, make decisions and act from day-to-day (Pannell et al. 2006; Björklund et al. 2009). Thus, understanding farmers' social drivers of decision making will help to understand the best ways to help them adapt to climate change and act to mitigate greenhouse gas (GHG) emissions on farm.

Over the last decade, literature has supported policy and program development that acknowledges farmers are not homogenous, and thus there is a need to understand perceptions of individual farmers (Vanclay, Mesiti & Howden 1998; Thomson 2001a; Berry et al. 2008; Barnes & Toma 2012). This paper reports research conducted on behalf of industry, the Victorian based agricultural government agency, DPI (now, Department of Economic Development, Jobs, Transport and Resources (DEDJTR)), to help build programs to encourage farmers to take up climate adaptation and mitigation actions. In so doing, our aim was to move away from a one-size fits all approach to improve understanding of the diversity within their farmer client-base (Hogan et al. 2011). In order to devise better communication and engagement strategies to encourage on-farm climate change actions, DEDJTR practitioners

required information about the different types of farming approaches (called farming styles in this paper) that exist across Victoria based on individual farmer differences in importance of farm decision making drivers. This information would assist DEDJTR practitioners in development of outreach programs tailored to specific farming styles within the Victorian agricultural sector.

A small body of studies have used typology research to examine the views of farmers and climate change (Waters, Thomson & Nettle 2009; Hogan et al. 2011; Barnes & Toma 2012). In particular, farmer typology research by Thomson (2001b) which draws upon farming styles theory (van der Ploeg 1994; Vanclay, Mesiti & Howden 1998; Howden & Vanclay 2000; Mesiti & Vanclay 2006) was adopted as the basis for classifying our Victorian farmer population using farming goals, experiences and beliefs to understand different farming styles. This inductive approach to deriving farming styles using cluster analysis enables emerging styles to arise naturalistically from survey data as opposed to previous attempts to classify farmers into predetermined classes from social constructs (van der Ploeg 1994; Vanclay, Mesiti & Howden 1998). The strength of this approach is that it moves away from grouping farmers based on demographic variables such as age, income, industry sectors, and farm size to classify farmers according to their common worldviews, farming goals and management practices (Vanclay, Mesiti & Howden 1998). This typology research measures individual differences in each person's social values and provides a holistic perspective of each respondent's personal construct of farming. To do this a set of attitude statements, called farming style (FS) statements, measures farmer values in terms of running the farm. Values are related to lifestyle, finances, knowledge, planning/risk, and use of technology and innovation. Thomson (2001a) found that measuring farmers' attitudes on these values predicted how farmers would respond to adoption of a farm innovation. Thus, these values may be considered as underlying farm decision making, and thus, as social drivers for farm decision making. Therefore, the farming styles determined from this typology enables extension practitioners to develop communication and engagement programs tailored to the unique set of decision-making drivers of each farming style to more effectively encourage adoption of adaptive farming practices (Kaine et al. 2005; Emtage, Herbohn & Harrison 2006; Schwarz, McRae-Williams & Park 2009; Waters, Thomson & Nettle 2009).

Thus, this paper presents a typology of farmers based on social drivers, derived from two waves of a longitudinal surveys located in Victoria, Australia on attitude, knowledge and actions towards climate change and variability related issues. The aim of this paper is to present the farming styles uncovered in this study, and discuss how these styles can be used to align farmer climate change action programs with differing farming goals, beliefs and experiences.

Method

This paper examines social data from two survey waves of the Victorian Farmer Survey on Climate Change conducted in 2009 and 2011 (WIDCORP 2009; HCRP 2012). The purpose of these farmer surveys was to examine attitudes, knowledge and actions of Victorian farmers towards climate change, climate variability and greenhouse gas mitigation and track changes across time. In each survey round, a random sample of farm respondents was sourced from DPI customer databases across the main Victorian agricultural sectors including Grains, Mixed, Livestock, Dairy and Horticulture. Representative samples were obtained from each sector in each survey round with the exception of Horticulture. Bias may have occurred as a result of the sampling method as farmers who contact agricultural agencies may possess different traits to those with no contact. Participation in the survey involved completion of a questionnaire via telephone or online. More information of these studies is available elsewhere (see WIDCORP 2009; HCRP 2012). All farmer cases from the above sectors in 2009 (N=1372) were used for baseline farming style classification. Then the 2011 survey sample (N=1206) was assigned to the 2009 styles. In order to fully describe characteristics of the 2011 farming styles, secondary variables from 2011 dataset were compared across styles including differences in attitudes to climate change and adaptation actions. These steps are outlined below.

Derivation of baseline farming styles

The method used to develop farming styles follows Thomson (2001b). This approach has been tested several times (Thomson 2001a; Schwarz, McRae-Williams & Park 2009; Waters, Thomson & Nettle 2009) and has the ability to predict differences in adoption and innovation propensity. Thomson's farming style theory informs the input (primary) variables and cluster analysis procedures of the baseline study. A set of 14 of Thomson's 31 original wide-ranging FS statements were included in the 2009 survey instrument (see Table 1 key), as time and budget constraints limited the use of the full instrument. Since previous research successfully derived a stable four cluster solution (Schwarz, McRae-Williams & Park 2009) using 19 of Thomson's 31

variables, a similar method was employed in this baseline survey. DEDJTR representatives with in-depth knowledge of the farming community selected 14 statements to retain breadth of subject matters related to the broad social drivers of farmer decision making. These subjects included planning and risk, knowledge, business-approach or traditional approach to farming practice, and technology and innovation. The 14 statements chosen for this survey (Table 1 key) were word-crafted to refine and clarify values being measured for the purpose of the survey. A five-point scale measured the respondent's level of agreement with each item. Responses to these statements were then used in clustering. A non-hierarchical K-means cluster analysis, known as the iterate and classify method was performed using SPSS version 13. As there was no prior knowledge of the number of clusters that existed within the sample (Everitt et al. 2011), the cluster analysis was run a number of times specifying two, three, four and five cluster solutions. The order of the data to be classified was randomised and the cluster centres were then compared after multiple runs (five runs) of the K-means algorithm, choosing a solution which had the lowest variance in cluster centres. As such a four cluster solution was chosen for its high stability and provided the most insight into the data. As a result four farming styles (Farming Style (FS) 1, 27% of sample; FS 2, 17%; FS 3, 31%; FS 4, 25%) were derived by cluster analysis using 2009 farmer responses to the 14-item instrument.

Classifying farmer cases from the 2011 Victorian Farmer Survey

Classification of farmers cases from the 2011 Victorian Farmer Survey was performed by assigning 2011 survey data to the 2009 baseline styles. Brevity was the aim of data collection in the 2011 survey for the farming styles data, thus methods to further reduce the number of statements was explored. A statistical reduction method, termed the Brownell Reduction (BR) Method eliminated the least predictive attitudinal and behaviour variables of the 14-item instrument using the 2009 survey data (HCRP 2012; Graymore, Schwarz & Brownell 2015). These statements were then dropped out of the statement set producing an 8-item instrument for the 2011 survey (see Table 1). As many of the attitudinal statements in the 14-item instrument are highly correlated only a few representative statements are required in order to maintain accurate classification of the new 2011 farmer responses. Further information about this method is available in Graymore, Schwarz & Brownell (2015).

Farmer responses to the 8-item instrument from the 2011 data set were assigned to one of the 2009 clusters (i.e. farming styles) with 90% accuracy. A deductive analysis based on proximity to the cluster centres calculated the distances from each farmer's set of responses to all four of the 2009 cluster centres. Farmer respondents were then assigned to the cluster centre they were closest to. This is similar to the way the original K-means algorithm classifies clusters; however in this case, the 2009 centroids are used as the basis of the classification. Of the four styles, FS 3 was the largest with 34% (n=411) of 2011 sample, followed by FS 2 with 22% (n=268), FS 4 with 22% (n=267) and FS 1 with 22% (n=260).

Portrait development of baseline farming styles

Portraits of each farming style were developed by examining results of primary variables involved in the baseline cluster analysis as they are essential to understand the distinct characteristics of each farming style within Victoria (Hogan et al. 2011). A factor analysis was performed on 2009 responses to the 14-item instrument. This identified underlying patterns between statements and showed how statements are related. Four discrete factors emerged, labelled as forward-thinking, risk adverseness, self-reliance and conventionalism which explained 51% of the variance in responses (see Table 1). Comparisons between clusters across factors were calculated using a regression on each respondent's survey responses and these scores provide base portraits of each farming style.

Analysis of secondary variables in the 2011 Victorian Farmer Survey

Factor analysis was performed on a set of statements which describe differences in attitude toward climate change between the 2011 farming styles. Factor analysis of statements revealed three underlying themes which explained 54% of the variance in 2011 responses (Table 2). Comparison across each cluster was made using regression scores.

Tests were performed in order to determine other significant differences on secondary variables of interest (Tables 3, 4 & 5) such as attitude toward future climate impacts, related climate change and GHG policy, knowledge and use of climate information, behaviour (adaptation and mitigation now and likely in the future), and structural and demographic data. These included z-tests to compare proportions across the four farming style groups; and t-tests to analyse the variance in the means of attitudinal questions which included a five-point Likert scale.

Results: Farming styles of Victorian farmers

All 2011 farmer cases were classified into the four baseline farming styles with similar percentage compositions to 2009. Results of two factor analyses performed on primary variables (i.e. farming styles) (Table 1) and climate change attitudinal statements (Table 2) found that each farming styles group has distinct approaches towards their farm business, as well as differences in climate change attitudes. Analysis of secondary variables showed some style differences in: structural characteristics (Table 3); attitudes related to climate change/GHG impacts and policy (Table 4); and knowledge of climate-related information and climate drivers (Table 5); however, less style differences in adaptation/mitigation behaviours (Table 5).

Profiles of each farming style using 2011 data are presented below with reference made to relative differences to the Victorian farmer average (marked as Total 2011 sample column in results tables) and to statistically significant differences to other farming style groups.

FS 1 (22% of sample)

FS 1 farmers (described as autonomous) have a conventional and self-reliant approach to farming and are unlikely to take financial risks. They have a high level of interest in intergenerational farming. FS 1 have small farms, have a high percentage in mixed farming (30%), and are an older group with the least education. Average hours worked per week is higher than the norm (57 hours). Off-farm income is lower than the average. Members of FS 1 are closely aligned with the changing weather factor, and this group is the least likely to believe in anthropogenic climate change. Their climate literacy is low, as is their use of climate-related information. Level of knowledge of farm GHG emissions is similar to the average.

Whilst their current actions to manage climate change and GHG emissions are close to the average, their future likelihood of reducing GHG is significantly low, and they are more likely to consider reducing farm size or exiting farming in the future. This reflects their slightly more pessimistic attitudes towards GHG emissions and farming than the average, in particular they are more likely to disagree that low emission food markets are an opportunity for agriculture in the future. However, their consideration of carbon trading reflects the average.

FS 2 (22%)

FS 2 farmers (described as speculative) are a non-traditional farming group with little interest in developing their farming enterprise for the longer term but are prepared to take some risks to finance growth and/or diversification for short-term gains. As expected, their attitude toward intergenerational farming is low. FS 2 members have large farms, are a younger group, with close to average education levels, off-farm income and weekly hours worked. While climate literacy is average, their use of climate-related information is low. FS 2 is strongly correlated with belief in anthropogenic climate change and has the highest negative correlation relative to other styles for the changing weather factor. This group's knowledge of GHG emissions balance on farm is similar to the average.

FS 2 farmers are about average in every other respect of climate change and GHG knowledge, attitudes and behaviours. Attitudes towards climate change policy issues are similar to the average. FS 2 have similar rates of adoption to the average in terms of actions taken now and in the future to deal with climate change impacts on-farm. Intentions to act on GHG now and in the future also follow average trends. However, attitudes towards GHG emissions are slightly less pessimistic about increased production costs with a price on carbon. Consideration of carbon trading is similar to the average.

FS 3 (34%)

FS 3 farmers (described as ambitious) formed the largest group in this study. They are prepared to take risks to grow or diversify their enterprise, are business minded, profit driven and plan ahead, and thus are more forward thinking than the other farming styles. They are open to and value new ideas and new technology. FS 3 members have a very positive commitment to family farming and strong intergenerational orientation. FS 3 has a higher percentage of grains farmers, and farmers in this cohort have the largest farms. They are the youngest group, exhibit the highest weekly hours worked (59 hours), and have low off-farm income. Educational attainment is average. There is a division in climate change attitudes within the FS 3 group, as there is moderate correlation with both changing weather patterns and belief in anthropogenic climate change. Climate literacy is high with greater knowledge of climate drivers and higher than average use of climate-related information.

Table 1. Farming styles factors from primary variables – 2009 dataset

Factor description	Variables*	FS 1	FS 2	FS 3	FS 4
Forward thinking Has a propensity for use of new technology and innovation, strong planning and risk management, and business-minded attitudes toward farming.	c, d, e, i, j, l, m	Med	Very low	Very high	Med
Risk adverseness* Has an opportunistic attitude toward borrowing finances to expand the farm enterprise.	a, b	Very low	Very high	Very high	Very low
Self-reliance Relies on own knowledge and experience when farming.	g, h (negative correlation), k	Very high	Low	Med	Low
Conventionalism Has a conventional attitude toward farming	f, n	Very high	Low	Med	Low

Key: 14-item instrument (2009 survey). 8-item instrument from 2011 survey are italicised. Subject matter in brackets.

a. *I am unlikely to heavily borrow to finance diversifying my farming activities (Finance)*
b. *I am unlikely to heavily borrow to finance increasing the size of my farm (Finance)*
c. Increasing the profitability or net worth of my farm is very important to me (Farming practice – business)
d. *Farming is a business, just like any other business (Farming practice – business)*
e. I farm because it is my preferred occupation (Farming practice – tradition)
f. *I farm because I am committed to its tradition in our family (Farming practice – tradition)*
g. *I rely on my own knowledge and experience when making farming decisions (Knowledge)*
h. *To manage my farm better I need more knowledge and information (Knowledge)*
i. I like to plan ahead when managing my farm (Planning/Risk)
j. *I take a long term view of farming as an investment (Planning/Risk)*
k. I am happy with my farm as it is (Planning/Risk)
l. I am open to new ideas and alternatives about farming (Technology/Innovation
m. I value knowing about, and using new technology as it becomes available (Technology/Innovation)
n. *I prefer to leave experimenting with new ideas to someone else (Technology/Innovation)*

Note: *Variables significantly correlated with each factor. **For ease of interpretation, the 'Risk adverseness' factor has been inverted. High, Medium (Med) and Low scores are calculated using a regression on each respondent's survey responses. As the measure is somewhat abstract it should be interpreted in a relative rather than an absolute sense.

Table 2. Climate change attitudinal factors from secondary variables - 2011 dataset

Factor and description	Variables*	FS 1	FS 2	FS 3	FS 4
Changing weather patterns Likely to consider growing seasons are changing, believes more wild or extreme weather events are occurring, flowering times of native flora are changing, local rain events are more intense and local average temperatures are increasing.	o, p, q, r, s	High	Low	Med	Med
Belief in anthropogenic climate change Unlikely to consider that drought, floods, frost and heat extremes are part of natural climate variability; is likely to attribute global warming to human activity, believes climate change is serious and likely to have considered climate change in future planning.	t (negative correlation), u, v,w	Low	High	Med	High
Concern and uncertainty in adaptation Concern for water supply security, and uncertain about the farm's ability to adapt to climate change. Do not believe a warmer and drier climate will benefit one's farm.	x, y, z	Med	Med	Med	Med

Key: Secondary variables from 2011 survey

o. More wild or extreme weather events are occurring
p. The growing seasons in my district are changing
q. Flowering time of native trees and other bush plants have changed
r. Rain event in my district are more intense
s. Average temperatures are increasing in my district
t. The drought, floods, frosts and heat extremes over the last decade are due to natural climate variability
u. Greenhouse gas emissions from human activity are responsible for global warming
v. Climate change is a serious problem
w. I do not take climate change into account when thinking about my future
x. A warmer and drier climate in the future will be beneficial to my farm
y. Water supply security for my farm concerns me
z. I am uncertain about the ability of my farm to adapt to climate change

Note: *Variables significantly correlated with each factor. High, medium (Med) and Low scores are calculated using a regression on each respondent's survey responses. As the measure is somewhat abstract it should be interpreted in a relative rather than an absolute sense.

Table 3. Summary of structural characteristics of farming styles 2011

Farming style	FS 1 (a)	FS 2 (b)	FS 3 (c)	FS 4 (d)	Total 2011
Farm sector	30% Mixed[d]	Average	26% Grains[d]	29% Livestock[c]; 13% Horticulture[c]	20% Grains; 21% Mixed; 22% Livestock; 22% Dairy; 8% Horticulture
Farm size Mean ha	906 (Lower)	**1104**[d] (Higher)	**1269**[ad] (Higher)	639 (Lower)	1015
Off-farm income % who earn ≥50% of income off-farm	19%	24%	17% (Lowest)	27% (Highest)	27% earn half or more of income off-farm
Age Mean	**56**[bc] (Older)	52 (Younger)	49 (Younger)	**55**[c] (Older)	52
Tertiary completion (Degree/diploma)	21% (Lowest)	38%	35%	**40%** (Highest)	46%
Hours worked per week Mean h	**57**[d] (Higher)	54 (Lower)	**59**[bd] (Higher)	50 (Lower)	54

Note: Each significant pair (p-value <0.05) is marked with a letter. The letter of the column with a smaller value appears in the row with the larger value (shown in bold).

Table 4. Mean score differences between FS on attitude/value statements 2011*

2011 survey statements	FS 1 (a)	FS 2 (b)	FS 3 (c)	FS 4 (d)	Total 2011
Intergenerational farming					
I want to keep farming to give my children the opportunity to take over the farm	**3.41**[bd]	3.00	**3.82**[abd]	2.75	3.26
Attitude toward future climate impacts on-farm					
Water supply security for my farm concerns me	3.08	2.94	3.08	**3.29**[b]	3.10
I do not take climate change into account when thinking about my future	3.06	2.93	2.90	2.96	2.95
I am uncertain about the ability of my farm to adapt to climate change	2.65	2.47	2.44	2.50	2.51
A warmer and drier climate in the future will be beneficial to my farm	2.20	2.18	2.24	2.39	2.25
Attitudes toward climate change policy issues					
To help farmers adapt to climate variability, government should provide more support and tools	3.71	3.47	3.64	3.61	3.63
Government should provide more support and tools to help farmers adapt to climate change	3.57	3.45	3.59	3.57	3.57
If they existed, insurance products would be an important risk management option for climate variability	3.00	2.92	3.05	2.85	2.95
Farmers should contribute to emission reductions along with other parts of the economy	2.53	2.53	2.58	2.72	2.62
Government listens to the views of rural communities when making policy decisions about climate change	1.85	2.04	1.90	1.91	1.92
Attitudes towards GHG emissions and farming					
My cost of production will increase with a price on carbon	4.50	4.34	**4.55**[b]	4.49	4.46
Reducing greenhouse gas emissions in agriculture will result in lower production levels	3.20	2.09	3.25	3.06	3.14
Markets for food produced with low emissions will provide opportunities for agriculture in the future	2.65	2.76	2.88	**3.00**[a]	2.85
It is possible to reduce greenhouse gas emissions from my farm, and become more profitable	2.56	2.60	2.72	2.81	2.70

Note: Each significant pair (p-value <0.05) is marked with a letter. The letter of the column with a smaller value appears in the row with the larger value (shown in bold). *Based on scaled response from 1 to 5 (strongly disagree to strongly agree).

Table 5. Percentage differences between FS for other secondary variables 2011

2011 survey items	FS 1 n=260 (a)	FS 2 n=268 (b)	FS 3 n=411 (c)	FS 4 n=267 (d)	Total 2011
Use of climate-related information					
Short-term daily or weekly weather data	88	88	90	93	89
Bureau of Meteorology seasonal climate outlooks	57	60	**71[ab]**	**70[a]**	64
Long range climate forecasts	50	54	**60[d]**	49	53
Historical climate information	51	49	56	50	52
Bureau of Meteorology's new 7 day forecast explorer tool	45	46	53	46	47
Sea surface temperature maps	24	30	**36[ad]**	26	29
Knowledge of climate drivers					
The El-nino & Southern Oscillation	92	96	96	96	95
The Indian Ocean Dipole	67	74	75	74	72
Cut-off lows	36	45	**53[ad]**	38	43
The Sub Tropical Ridge	27	**39[a]**	**45[a]**	**38[a]**	37
The Southern Annular Mode	26	28	33	33	30
Actions taken to manage climate change and variability impacts on-farm					
Changed the business structure and management of your operation	40	38	44	44	41
Changed the enterprise mix	36	36	37	34	37
Started a new enterprise	14	18	22	19	19
Leased or bought land to farm in other regions	11	17	17	11	14
Reduced the size of the farm	11	5	6	9	8
Likelihood of future actions towards reduction of cc and cv impacts on-farm (Likely, 4 or 5)					
Change the business structure and management of your operation	19	21	24	22	22
Change the enterprise mix	16	16	16	15	16
Start a new enterprise	8	15	14	9	12
Lease or bought land to farm in other regions	8	10	9	8	9
Reduce the size of the farm	**7[c]**	5	4	**10[c]**	6
Exit farming	**20[bc]**	12	8	**15[bc]**	13
Intentions to mitigate greenhouse gas emissions/store carbon on-farm					
I have insufficient information to make a decision	35	30	35	31	33
When a market exists I will consider making changes	25	25	29	27	27
I've already made changes to my farming operation to manage greenhouse gas emissions or store carbon	27	28	22	31	27
I haven't thought about it	11	14	11	7	11
Other	3	2	3	4	3
Likelihood of future intention to reduce greenhouse gas emissions					
Intend to make changes	39	46	46	**54[a]**	46
Do not intend to make changes	**61[d]**	54	54	46	54

Note: Each significant pair (p-value <0.05) is marked with a letter. The letter of the column with a smaller value appears in the row with the larger value (shown in bold). cc = climate change; cv = climate variability. Base: Total 2011, n=1206

FS 3 farmers have average climate change and GHG knowledge, attitudes and actions except there is higher agreement than other clusters that production costs will increase with a price on carbon. They also show less disinterest in starting a new enterprise and expanding farm size and have least likelihood of exiting farming in the future than other styles. This is logical given the younger age profile of FS 3.

FS 4 (22%)

FS 4 farmers (FS 4) are described as prudent, as they are much more conventional than other farming styles. They will take on new ideas and technologies but are not likely to take financial risks. They are an older, non-traditional farming group with low intergenerational orientation and a high proportion of livestock and horticulture farmers. Farm size is small, and they have high off-farm income and high educational levels. FS 4 climate literacy and use of climate-related information is average. The FS 4 group have a strong alignment with belief in anthropogenic climate change and medium correlation with changing weather patterns. Like FS 1 and 3, attitudes toward climate change policy, actions and future actions to manage the impact of climate change and variability on-farm are near the average. Whilst the likelihood of reducing farm size and exiting farming is low across clusters, this is more likely to be considered by FS 4. As expected for livestock and horticultural farmers, water supply security concern is high. They also have a greater awareness of GHG management with 84% of this group, compared to the average of 75% stating their energy usage on farm emits GHG. Attitudes and intended actions toward GHG emissions and farming are similar to the average; however they are slightly more optimism about the opportunities of low carbon farming and their future likelihood of reducing GHG is significantly higher at 54%. Low participation in carbon trading reflects the norm.

Discussion

This study provides several findings. First, the findings resonate with the spectrum of farming types found in other farmer typology research on climate change (Waters, Thomson & Nettle 2009; Hogan et al. 2011; Barnes & Toma 2012). This study identified four distinct types of farmers within the Victorian farmer population. Each type having differences in the importance of social drivers on which they base their management practices. As such, this typology research demonstrated that "one-size fits-all assessments of farmer vulnerability [to climate change] are inappropriate" (Hogan, Bode & Berry 2011, p. 4065).

The distinct farming styles identified in this study also showed differences in climate change attitudes. This reflects findings of other Australian studies that demonstrate views within rural and regional Australia are divided in beliefs about the causes of local climatic changes (Buys, Miller & van Megen 2012). There are two schools of thought evident within the Victorian farmer population that relate to belief in anthropogenic climate change and belief that local changes in weather are part of natural cycles in climate. Farmers from both FS 2 and 4 feel that the changes they are seeing in climate are related to anthropogenic climate change, while farmers in FS 1 feel that it is related to natural cycles in climate. Farmers in FS 3 are divided in their attitudes. However, all styles are concerned and uncertain about the way to adapt their farms in the face of climate change.

Styles have structural characteristics which differ according to farm sectors, farm size, primary income source, tertiary education completion and hours worked on-farm. There are also some large differences between some styles on climate literacy (that is, knowledge about climate drivers and awareness of climate information sources). There are no significant differences across groups on attitudes towards climate change policy issues in 2011. About 70% of all Victorian farmers disagree that *government listens to views of rural communities when making policy decisions about climate change*; around 60% agree that *government provides more support and tools to help farmers adapt to climate change*; and, *climate variability*); and nearly half (46%) disagree and a further one third agree (30%) that *farmers should contribute to emission reductions along with other parts of the economy* (HCRP 2012).

Similar to climate change policy attitudes, there are few differences in attitudes between farming styles towards GHG emissions and farming. Across the total 2011 sample, views are divided on each statement, except on production costs of carbon increasing with the majority of farmers in agreement. FS 3 believe production costs would increase more so than the other farming styles and this may relate to FS 3 distinctive style characteristics including the larger farm size and high percentage of grain growers in this group. FS 4 are significantly more in agreement about opportunities for a low carbon economy, which may be related to this group having the highest proportion of educated farmers, having smaller farms and greater off-farm income.

There are no significant differences between groups in terms of their intentions to act to reduce climate change impacts or mitigate greenhouse gases. Similar results were presented by Barnes and Toma (2012), in which five of six farmer types stated no intention to take-up emission actions. In Victoria, the level of actions across the farmer styles are similar to that of the whole sample, with around 40% of the sample having changed farm business structure/management to manage climate change/climate variability and about one quarter of the total having changed farm business to manage GHG emissions and/or carbon storage (HCRP 2012). Differences in *future climate change actions* among styles are evident although small (i.e. less than 10 percentage points difference between styles). *Future intentions* to mitigate are however significantly different between styles, with FS 4 significantly more likely to make intended changes than FS 1. This might be due to a combination of demographic differences: FS 4 having higher off-farm income, higher education levels, greater belief in anthropogenic climate change, and higher percentage of livestock graziers and therefore greater need to consider emission management from methane-producing livestock.

Implications for farmer climate change programs

How do we use the styles to encourage different farmers to take up action? In recent research, Nicholson and Long (2015) discuss enhancing engagement with farmers based on temperament typing and the different ways that farmers learn and make decisions. The farming styles are similar, as the styles are created from clustered groups with similar preferences to social drivers which are a basis on which farm decisions are made, and help us to determine what is important to groups of farmers in their decision making. Classification of farmers based on key social drivers led to the discovery of four farming styles with varying predispositions to risks, planning, innovation and technology use, and farming practice approach. We can use this knowledge to develop climate change adaptation and mitigation programs tailored to each farming style's distinct combination of social drivers so they appeal to each group's values and encourage them to take-up adaptations. Therefore, these findings support the need for typology research and program delivery that considers the broader socio-economic drivers of farming to develop climate adaptation programs for the Victorian farming community.

Related literature on climate change and farmers suggest the ways that farmers experience, think and talk about problems is important in engaging with farmers on climate change (Fleming & Vanclay 2010), including immediate shorter term factors like intergenerational issues (Waters, Thomson & Nettle 2009) and farmer and financial health (Hogan et al. 2011). Haden et al. (2012, p. 6) concludes that what is needed is:

> outreach programs that allow farmers to examine the pros and cons of individual agricultural practices by framing each in a global and local context may help facilitate agricultural decisions that are well-aligned with farmers' economic goals, their past experience, and their beliefs and concerns regarding climate change.

Thus, the use of a typology approach to extension practices, which encapsulates an understanding of climate change attitudes as well as social drivers impacting on farmer decision making, provides a more holistic understanding of the types of farmers in the community for practitioners. This will enable them to better engage with their differing values and goals. Hence, program messaging needs to appeal to the different combinations of farmers' decision making drivers, such as profitability, productivity, viability, risk involved, cost-benefits of actions and innovation and leadership in relation to adaptation and mitigation practices. They should provide information based on the unique combination of each farming style's values, allowing farmers to examine the pros and cons of the adaptation or mitigation practices in both global and local contexts in view of their own values and goals. Programs may focus on aspirational characteristics of styles. That is, for FS 3 (Ambitious), a focus on the farm business, profitability and planning, or for FS 2 (Speculative) a focus on how the practices will provide short-term gains. Moreover, programs could focus on concerns of climate change such as targeting water security for FS 4 farmers. Thus, messages and content targeted at each style should be based on the set of drivers that influence each style's decision making, as this is more likely to appeal to farmers in each group, rather than 'one-size-fits-all' messaging and content. Consequently, this approach to extension programs is more likely to be effective in helping farmers understand how adaptation and mitigation practices relate to their farming values and goals, and give them the information they need to make a decision about adopting such practices.

Nevertheless, our study shows that despite distinctive climate change attitudes, there are few differences between styles in terms of actions to address climate variability, climate change and mitigation of GHGs emissions. These results suggest attitudes towards climate change have little bearing on actions taken to assist farms to adapt to or mitigate the effects of climate

change now or in the future. Similarly, Niles, Brown & Dynes (2016) found that New Zealand farmers' attitudes towards climate change were not related to their actions; however, they were related to their intentions to act. Thus, this finding has implications for the way climate change programs are designed, as it suggests that changing attitudes will do little to increase adaptation and mitigation action amongst farmers. Further research is needed to inform program development to better understand why farmers take up adaptation and mitigation actions and what stops them. At the same time, further research is required to clarify the relationships, if any, between farmers' social drivers, attitudes and behaviour. In addition, future typology research needs to determine if clustering variables can be further refined to enable detection of differences between styles in the reasons actions are taken. Furthermore, researchers could work closely with extension practitioners to help determine how typologies, such as the farming styles, can be best used in extension. Such research will enable further insight into how farming styles can be used to develop effective extension programs.

In summary, this study has identified four distinct groups of Victorian farmers based on attitudes towards farming, primarily forward thinking, risk-taking, self-reliance and conventionalism, with each having distinct attitudes towards climate change. Our findings suggests programs that provide farmers with skills, knowledge and options to continue to adapt their farms and farm practices, be framed to appeal to their different combinations of values and ways of thinking (moral responsibility, economic rationale, business, profitability, intergenerational orientation) as shown here and in related research (Waters, Thomson & Nettle 2009; Hogan et al. 2011; Haden et al. 2012; NCCARF 2013).

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