Development of quick tool for farmer segmentation: Practical uses for extension work

Michelle Graymore[1, 2], Imogen Schwarz[1] & Briana Brownell[3]

[1] Wimmera Research Group, Federation University Australia, Baillie St, Horsham, Victoria, 3400
[2]Centre for eResearch and Digital Innovation, Federation University Australia, University Drive, Mt Helen, Victoria, 3350
[3] Insightrix Research Inc, Millar Ave, Saskatoon, Saskatchewan, S7K 5Y3
Email: m.graymore@federation.edu.au

Abstract. Farming styles research uses farm decision-making drivers to classify farmers into a farming styles typology. Understanding farming styles enables the development of extension strategies that target the diversity of farmers. We classified Victorian farmers into four distinct styles that measured differences in attitudes to risk/planning, technology use, knowledge, farming practice (business or tradition) and finance. However, the large number of variables required to classify farmers, increases time, costs and respondent fatigue in data collection processes. Thus, we developed a quick tool using the Brownell Reduction method to produce a reduced set of attitudinal variables without loss of important information, enabling classification of new responses into the four farming styles, with 90% accuracy. Thus, this BR method is a significant innovation for large repeated surveys and enables farmer style comparisons across data collection years. Quick-tool applications include evaluation of targeted communication and programs, monitoring audience attendance and mobile device usage.

Keywords: Farmer segmentation, typology, practical use, extension

Introduction

Extension has moved beyond finding the best approach to farm, to discover the best approaches to work with a diversity of farmers (Haug 1999). Thus, to work with the diversity of farmers and help improve their practices for farm viability, profitability and sustainability, extension providers need to understand what drives farm decision making. Once this is known, extension strategies can be developed that target the diversity of farmer decision-making drivers, called farming styles. Typology research helps extension providers uncover the range of farmer styles groups in the population they are working with. Specifically, farming styles research is a segmentation method that identifies different farmer types based on farmer's social values and their approach to farming. These social variables are better predictors of farmer behaviour than traditional market segmentation using structural and demographic information (Schwarz, McRae-Williams, Park 2009; Waters Thomson & Nettle 2009). Farming styles research underpins a targeted approach to a wide range of technology and practice changes as each farming style defines distinctive characteristics that impact upon farm decision making, and their likely adoption responses. Thus understanding farmer styles in the farming community enables programs to be designed which appeal to each particular farming style resulting in a likely wider uptake of the targeted program (Schwarz, McRae-Williams, Park 2009; Waters, Thomson & Nettle 2009).

Thomson's (2001) approach to typology research acknowledges diversity among farmers and understands that differences in farming styles can predict differences in adoption of technologies and participation in industry developments (Thomson 2002; Waters, Thomson & Nettle 2009). Now that we accept farmer diversity and the role that social drivers play in farm decision making, the next challenge is to find practical uses for the farming styles method in extension work. Whilst typology research has been conducted, for example, to increase adoption of irrigation systems (Kaine et al. 2005), to inform natural resource management policy and programs (Emtage, Herbohn & Harrison 2007), and to work with different dairy farmer groups (Waters, Thomson & Nettle 2009) evidence of typology application in extension literature is lacking (Emtage Herbohn & Harrison 2007).

Authors point to a lack of an evidence-base in the general underpinning of extension activities (Haug 1999). Particularly, in the current environment where research, development and extension is not well integrated given diminishing resources and public funding in government agricultural extension services (Hunt et al. 2012; Murphy, Nettle & Pain 2013). It is important that extension makes greater use of research knowledge available and to draw upon this evidence-base to maximise efforts (Emtage, Herbohn & Harrison 2007). With less capability and skills in public sector and new development of private sector (Hunt et al. 2012) it is now more than ever that extension providers need to know who they are working with. The farming styles typology provides this knowledge.

Farming styles can be used for the development of targeted extension activities, communication products and monitoring and evaluation processes (Thomson 2002; Waters, Thomson & Nettle 2009). Thomson's (2001) work endeavoured to provide 'tools necessary' to put the farming styles theory into practice. Yet the uptake of farming styles as a useful tool for extension is less understood. Emtage, Herbohn and Harrison (2007) highlight a number of challenges in using typology research for practitioners. The main issues they identified are the lack of expertise to understand and utilise insights offered by typology studies and ensuring that typologies are both scientifically rigorous and useful for the 'real world'. That is, extension officers can use the classification system and it appeals to their way of working. In addition, Emtage, Herbohn & Harrison (2007) note that issues of time, costs and respondent fatigue in using typologies in surveys may impinge on using this approach in extension.

Thus, the aim of this research was to develop a tool that could overcome some of the issues of using farming styles in extension work. Based on Thomson's (2001) farming styles method we developed a 'quick tool' that classifies each farmer respondent into one of the farming style groups. This tool provides a way to alleviate some of the problems of preventing uptake of typology research in extension by maximising current research use, increasing efficiency of classifying farmers and making it more compatible for use in monitoring, evaluation and ongoing data collection processes (Waters, Thomson & Nettle 2009). This paper describes and validates the effectiveness of the quick tool to accurately classify farmers into styles. It then discusses the application of the quick tool for extension providers to enable farmer segmentation and to aid further monitoring, evaluation and other data collection processes.

Method

Our typology method was developed using social drivers of farmer decision making adapted from Thomson (2001), rather than narrowly defined demographic variables. The farming styles method was first used by our research team to understand farmer types in the Wimmera Mallee (Schwarz, McRae-Williams & Park 2009). We were then able to classify farmers into four distinct styles and measure differences in attitudes to risk/planning, technology use, knowledge, farming practice (business or tradition) and finance which predict differences in key variables like adoption of new farming practices. From this initial work, the Department of Primary Industries (DPI) in Victoria saw some promise in using the typology to enable them to develop targeted farming programs.

Consequently, in June-August 2009, our typology method was included in a telephone and online survey about farmer attitudes and adaptation to climate change which was conducted with 1503 Victorian farmers, over 18 years from Grains (n = 246), Mixed (n = 229) (i.e. grains and livestock farmers), Dairy (n = 260), Livestock (n = 322) and Horticulture (n = 297). Forestry and peri-urban landholders were also included in the 2009 sample but removed from this typology analysis as these were not the focus of the study. In July-September 2011, a second-wave survey was conducted with a smaller but adequate sample of 1306 Victorian farmers including Grains (n = 256), Mixed (n = 274), Dairy (n = 287), Livestock (n = 281) and Horticulture (n = 108). Peri-urban landholders were part of the total 2011 sample but again were omitted from this analysis. A degree of accuracy greater than plus or minus 6.5 percentage points was achieved for each sector in both data collection years, with the exception of Horticulture in 2011 (9.2% sampling error). Sampling for both surveys was randomised from customer databases provided by DPI. Therefore 2009 and 2011 contain independent samples. However, in the 2011 survey, time and cost constraints meant that we needed to adapt our typology method so that it could be administered quickly, yet still provide enough information to enable classification of farmers into farming styles.

Both the 2009 and 2011 surveys were part of a longitudinal study to understand Victorian farmer knowledge and attitudes to climate change, climate variability and greenhouse gas emissions to inform DPI farming climate adaptation programs (WIDCORP 2009; HCRP 2012). Surveys were designed with major input from DPI agriculture practitioners in the climate change team and those with previous experience in related typology research. The main topics of the survey were farm characteristics, participant demographics, knowledge, and attitudes to Victoria's climate and related matters, such as climate change policy issues, greenhouse gas emissions in farming systems and climate adaptation and mitigation behaviour. The farming styles research was a component of that longitudinal study to determine if a broad-based multiple industry typology exists, and whether groups have distinctive attitudes or adaptation and/or mitigation practices towards climate change.

Variables used for typology classification of the 2009 baseline survey were a set of 14 statements, based on Thomson's (2001) research, that asked respondents about their landholder values and approach to farming across a range of subjects (see Table 1). Strength of

respondents' agreement with each item was scored on a Likert scale from one to five (strongly disagree to strongly agree). Following Thomson's (2001) approach, these responses from 2009 survey data were input variables in the K-means clustering procedure to derive four mutually exclusive groups termed farming styles. The advantage of this approach was that emerging styles are grounded in survey data, and showed how patterns in data fell into natural groupings. This quantitative method for grouping farmers means differences in 'patterns of beliefs and attitudes about farming' (Thomson 2002 p. 281) can be measured. The main disadvantage of typology research is the large number of variables required to classify farmers. Due to limitations on survey time, length, cost and respondent fatigue it was decided to reduce Thomson's full set of 31 to 14 by only including the statements that were most relevant to the Victorian population and that covered subject matters related to the study. We determined the most relevant statements for this population with the assistance of extension practitioners who had in-depth knowledge of farmer groups and the topic of interest. In effect these practitioners were part of the research process, helping them to gain ownership of the results (Emtage, Herbohn & Harrison 2007). This smaller set of statements was the first stage in making the typology method more user-friendly for extension research, as it allowed space in the survey to ask other important questions on the themes related to the extension program the survey was to inform.

A K-means cluster analysis was performed on 2009 survey data across five main farming sectors to determine baseline farming styles (i.e. clusters). Data was loaded onto SPSS (Statistical Package for the Social Sciences) software. The cluster analysis used the ranked responses of each individual to the 14-item instrument to perform the cluster analysis. This analytical technique discovers mutually exclusive subgroups by splitting the data into a number of groups to maximise the variation between clusters and minimise the variation within a cluster (Everitt et al. 2011). The analysis was run a number of times specifying various cluster solutions. A four cluster solution was stable and provided most insight into the data. All eligible respondents across the five sectors were assigned to one of the clusters (n=1354). According to Hogan et al. (2011), the cluster solution provided meaningful and scientifically useful analysis of the dataset. In our case, the method reduced a dataset of 1354 Victorian farmers into four relatively similar sized groups, with similar characteristics to that found in related farmer typology research on climate change (Hogan et al. 2011).

For the 2011 survey, we wanted to develop the typology instrument further so that it would be quick and easy to administer to a population where we already had a baseline typology. This was in part due to budget and time constraints but also to make the tool more user-friendly for extension. Thus, the 2009 14-item instrument, or statement set, was reduced using the Brownell Reduction (BR) method (published here for the first time). As a result, eight farming style statements (see Table 1) were validated for classification of 2011 farmer respondents into the 2009 farming style groups. To distinguish between the 'survey products', each is labelled according to the year of data collection and the number of statements used to derive the farming styles groups. The full-set of statements from the 2009 survey data is termed the '2009 14-item instrument' (the 14 survey items), and '2009 14-item model' (the farming styles groups developed). The reduced set of statements used in 2011 is termed the 'quick tool' (the 8 survey items). The farmers surveyed in 2011 were assigned to the 2009 farming styles and this is termed the '2011 assigned model.' Solutions to cluster analysis using the 8-item instrument from 2009 and 2011 datasets, are the '2009 8-item model' and '2011 8-item model' respectively. Outlined below is the development of the quick tool using the BR method. Following this is the method used for evaluation of the developed quick tool, and its use in the 2011 survey for subsequent farming style classification of the 2011 dataset.

Development of quick tool using Brownell Reduction method

In order to develop a quick tool for extension, the statement set for farmer typology surveys was shortened using the newly devised Brownell Reduction Method. This reduction method removes statements with the least relevant information thereby retaining only the most important statements to enable classifying farmers into farming groups.

The BR method assumes there is a high level of correlation between attitudinal statements that measure the same factor or underlying issue. It must also use an already segmented dataset in order to test the predictive ability of a new set of reduced statements. For these reasons the 2009 14-item instrument is suitable for this procedure. This iterative procedure removes each statement in turn and then attempts to reclassify cases using a deductive analysis (see procedure in *Validation Test 2* below) into one of the four farming styles (i.e. 2009 14-item model) using only the remaining statements. The percentage of cases that are correctly reclassified is then calculated. This determines the statements' order of importance in correctly

assigning cases to the 2009 14-item model. Statements with the greatest percentage loss were then deemed most important. Statements which yield the smallest decrease in ability to predict the correct cluster classification were dropped. The procedure was repeated with the remaining statements until removing the next statement decreases the accuracy beyond that desired by the research team. In this case,it was set as 90% accuracy to continue to provide a high degree of accuracy in classification. Thus, we found that we could remove six statements without reducing the accuracy of classification below 90%. The eight remaining statements (Table 1) were then used in the 2011 survey.

Table 1. Farming style (FS) statements adapted from Thomson's (2001) original farming attitudinal statements used in 2009 typology and 2011 follow-up study

Subject	Selected attitudinal statements from previous research (Schwarz, McRae-Williams & Park 2009)	14-items	8-items
Finance	I am unlikely to heavily borrow to finance diversifying my farming activities (b)	✓	✓
	I am unlikely to heavily borrow to finance increasing the size of my farm(g)	✓	✓
Farming practice-business	Increasing the profitability or net worth of my farm is very important to me	✓	×
	Farming is a business, just like any other business (e)	✓	✓
Farming practice - tradition	I farm because it is my preferred occupation	✓	×
	I farm because I am committed to its tradition in our family (f)	✓	✓
Knowledge	I rely on my own knowledge and experience when making farming decisions (d)	✓	✓
	To manage my farm better I need more knowledge and information (h)	✓	✓
Labour*	I feel there is a shortage of reliable labour when you need it	×	×
	I think farm labour it too expensive	×	×
Planning/ Risk	I like to plan ahead when managing my farm	✓	×
	I take a long-term view of farming as an investment (a)	✓	✓
	I am happy with my farm as it is	✓	×
	I don't like to make high risk decisions about the farm	×	×
Technology/ Innovation	I am open to new ideas and alternatives about farming	✓	×
	I am willing to try new things	×	×
	I value knowing about, and using new technology as it becomes available	✓	×
	I prefer to leave experimenting with new ideas to someone else (c)	✓	✓
	I believe I am more innovative than other farmers	×	×

Note: Letters provide key for Table 2 and Figure 1. 14-items column 'x' means statement excluded based on professional judgement. 8-items column '×' means statement was not within 90% cut off point of BR method. The subject areas of 'labour' and 'land', as in Thomson's original research (2001) were not included in baseline research due to survey design constraints, however are likely to add further important dimensions to the primary attitudinal characteristics of each style. Statements are word-crafted from the original statements (Thomson, 2001) to refine and clarify the values being measured in the surveys.

Evaluation of 'quick tool' for classification of 2011 sample

To evaluate the use of BR method to reduce statements in longitudinal research and to determine predictive validity of the typology quick tool, three validation tests were carried out to answer the following questions:

1. Does the quick tool, in comparison to the 14-item instrument, produce both stable and similar farming style groups using the 2009 dataset?
2. Can the 2011 dataset using the quick tool be assigned to the 2009 14-item model (baseline farming groups)?
3. Have changes occurred to farming social drivers between 2009 and 2011 surveys that render the 2009 classification and farming styles groups no longer relevant?

Validation Test 1

The first test determined whether a cluster solution using the 2009 8-item model is both stable and congruent with the 2009 14-item model. This would demonstrate that the quick tool has similar predictive ability to the 2009 14-item instrument, that it is not missing essential information to enable a stable cluster solution, and can produce comparable farming style groups to the 2009 14-item instrument. Firstly, multiple runs of K-means cluster analysis were performed on the 2009 data set using random case ordering with the responses to eight variables making up the quick tool. Cluster centroids of the 2009 8-item model were compared across the five runs to determine the level of variation and whether the cluster solution met our

test for cluster solution stability set at 70%, as currently there is no standard value used (Rakhlin & Caponnetto 2007). This means that on average 70% of cases were classified together upon multiple runs of the K-means algorithm.

The second step was to determine if the cluster centroids of two K-means segmentations (2009 8-item model and 2009 14-item model) matched. That is, mean scores of statements from 8-item instrument closely matched across each model. Consistency in cluster centres would demonstrate the quick tool can accurately classify farmers into farming style groups despite a reduction of statements.

Validation Test 2

The second test indicated whether the quick tool could accurately classify the new 2011 sample into the baseline groups. Furthermore, it determined how well the cluster centres and sizes of clusters matched across the years. Firstly, data from the 2011 sample were assigned to the 2009 14-item model. This is similar to the way the original K-means algorithm classifies the clusters; however, in this case the 2009 cluster centroids are used as the basis for classification. Thus this analysis is deductive and so for each 2011 farmer respondent, the distance to each centroid is calculated and then the respondent assigned to the closest cluster.

The second step compared the similarity of cluster sizes across the models (i.e. 2011 assigned model and 2009 14-item model). Cluster centres were also compared using mean scores across the eight attitudinal statements. Because of the nature of the clustering procedure it was expected cluster centres would be close, that is, ±0.3 of the comparable mean scores for the 2009 14-item model, however the analysis verified if this was the case. If cluster sizes and cluster centres across models closely matched, it would validate classification of 2011 sample into 2009 14-item model, and in turn use of the 2009 farming style profiles to describe farming styles of 2011.

Validation Test 3

The third test determined if a cluster analysis of 2011 farmer responses to the quick tool was stable and how well it matched the original 2009 14-item model. Firstly, a K-means cluster analysis was performed on the quick tool specifying 3, 4, and 5 cluster solutions to determine the most appropriate solution. The stability of the four cluster solution was checked by conducting five runs and comparing the mean scores of farming style statements of each cluster across the runs. The stability of the 2011 8-item model would show that relevant differences between farming style groups are still fully captured with the reduced number of statements. The second step compared cluster centres of the two models using means scores from farming style statements across the groups. Similarity in mean scores (again ±0.3) would indicate little attitudinal shift in farming styles over time.

Results

Results of the three validation tests and assessment of BR method and quick tool are provided below followed by the results of 2011 classification of farmer cases using the quick tool.

Results of validation tests of quick tool

Validation Test 1 showed that re-segmentation via K-means clusters analysis of the 2009 dataset with the quick tool produced a stable cluster solution (2009 8-item model), that is 70% of responses in each cluster remained grouped together, on average, meeting the criterion for cluster stability. Furthermore the cluster solution was congruent to baseline farming style groups (i.e. the 2009 14-item model). Models matched closely as indicated by minimal differences in mean scores between 2009 8-item model (i.e. average across five runs) and the 2009 14-item model (Table 2). This demonstrates that the quick tool is effective in classifying respondents into farming style groups similar to that of the 14-item instrument, showing there is little predictive ability lost due to the statement reduction. Therefore this test shows the BR method is a valid approach to reduce farming attitudinal statements.

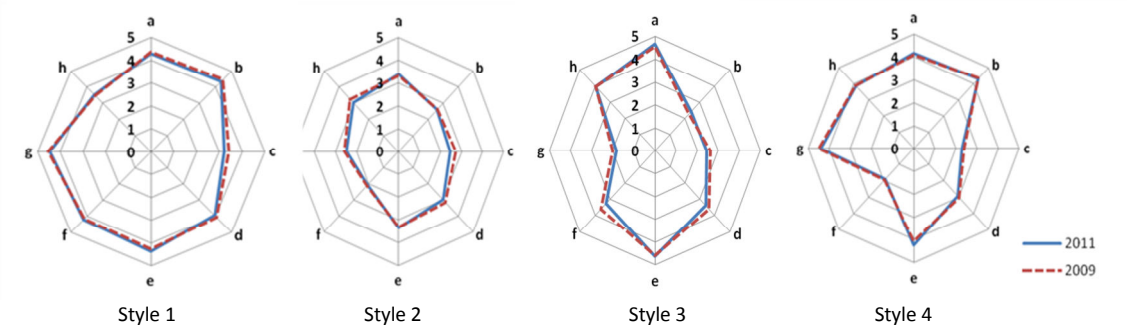
Validation Test 2 showed that all of the 2011 sample, using the quick tool, can be assigned to the 2009 farming style groups. Cluster centres were congruent as indicated by closeness in means scores across farming style attitude (measured on Likert scale from 1 to 5) in both models (see Figure 1). Differences in means scores were only -0.17 to 0.31, and 50% had difference of less than 0.1. The relative sizes of clusters were also similar; with the range of differences in clusters sizes between only 3% and 6% (see Figure 2). This demonstrates that 2011 assigned model had similar cluster groups to 2009 sample, and thus validates using the 2009 farming styles cluster centres to classify the 2011 sample, thereby enabling the linking of the two datasets.

Table 2. Comparison of 2009 8-item model to 2009 14-item model across four farming styles (Mean scores)

Farming style groups:	Style 1		Style 2		Style 3		Style 4	
Statements:	**8-item model**	**14-item model**	**8-item model**	**14-item model**	**8-item model**	**14-item model**	**8-item model**	**14-item model**
a	4.4	4.4	3.6	3.3	4.5	4.6	3.9	4.1
b	4.2	4.5	2.6	2.6	2.3	2.3	4.5	4.3
c	3.2	3.4	2.6	2.7	2.6	2.6	2.7	2.4
d	3.9	4.1	3.1	3.2	3.6	3.6	3.3	3.1
e	4.4	4.3	3.4	3.3	4.5	4.6	3.9	4.1
f	4.3	4.2	2.0	2.2	3.6	3.6	2.0	2.0
g	4.2	4.5	2.6	2.5	1.9	2.0	4.6	4.5
h	3.7	3.5	3.4	3.2	3.9	4.0	3.7	3.9

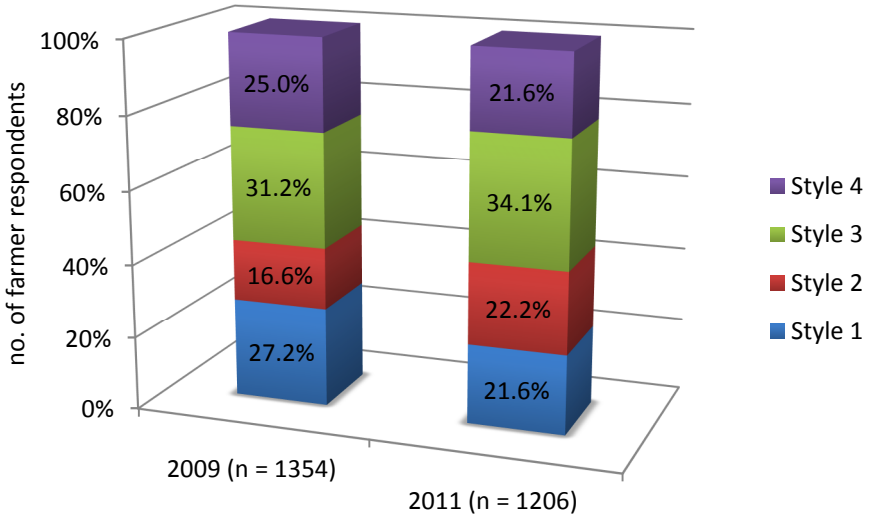
Note: '8-item model' mean score = average across five runs of the stability test.

Figure 1. Farming style attitudes mean scores for the 2009 14-item model and the 2011 assigned model



Note: letters correspond to statements in Appendix 1. Farming style items are measured using a 5-point Likert scale where 1 = Strongly disagree, 2 = Agree, 3 = Neutral, 4 = Agree, and 5 = Strongly agree.

Figure 2. Cluster composition and profiles of 2009 and 2011 farming styles



Key: *Style 1* – These farmers have a traditional and self-reliant approach to farming and are unlikely to take financial risks. This style of farming may be described as *autonomous*. *Style 2* – These farmers have little interest in developing their farming enterprise for the longer term but are prepared to take some risks to finance growth/diversification for short term gains. This style of farming may be described as *speculative*. *Style 3* – These farmers are prepared to take risks to grow or diversify their enterprise, are business minded, profit driven and plan ahead. They are open to and value new ideas and new technology. This style of farming may be described as *ambitious*. *Style 4* – These farmers will take on new ideas and technologies but are not likely to take financial risks. This style of farming may be described as *prudent*.

Validation Test 3 indicated that when the 2011 sample is classified into clusters from an independent cluster analysis using the quick tool, results are similar to the 2009 14-item model. That is, it produces a four cluster solution with a high degree of stability, and relatively similar cluster centres to the original 2009 14-item model (determined by comparison of mean scores). The small changes in the size of clusters (shown in Validation Test 2) is not as a result of a shift in farmer attitudes and thus development of different farming style types to 2009. This justifies the use of the 2009 farmer typology to classify the 2011 sample.

Thus the quick tool produced was able to be used to classify respondents into farming style groups developed from the baseline survey data. This enables a direct link between the independent sample in second-wave survey data and the baseline data, so that comparisons within these groups can be made over time between attitudes, knowledge and actions. Therefore the quick tool can be used to develop 2011 farming style profiles from the baseline typology. Profiles are described below.

Results of 2011 Victorian farmer typology

As the 2011 sample was categorised into the four 2009 farming styles groups (as outlined in Validation Test 2), profiles from 2009 are therefore used as the base profiles for the 2011 farming styles. These profiles were developed from analysis of *t*-tests to mean responses of 14-item instrument in 2009 dataset which contains information about one's approach to farming. A factor analysis, independent of the segmentation process, was performed on the 14-item instrument in 2009 sample and allowed grouping of variables to gain a better understanding of key differences between clusters. Four discrete factors emerged which explain the majority (51%) of variance in responses. These are: forward-thinking, risk-taking, self-reliance and conventionalism. Both analyses were used to develop a profile of each style, as summarised in Figure 2, alongside cluster size comparisons.

Discussion

Typology research can provide extension practitioners with information to understand and interpret the range of farmer values and socioeconomic characteristics within their target group (Emtage, Herbohn & Harrison 2007). Use of social drivers to develop a descriptive typology and then examine structural and behavioural characteristics of each typology enables broad-ranging applications of the research (Emtage, Herbohn & Harrison 2007, p. 485).

However in carrying out typology research care variables need to be chosen carefully as this determines the quality of the emerging typology (Emtage, Herbohn & Harrison 2007, p. 485). As a general rule a large number of variables are required in determining farming styles, as having more data helps to maximise the potential utility of typologies (Emtage, Herbohn & Harrison 2007, p. 489). Yet this longitudinal study, along with others (e.g. Emtage, Herbohn & Harrison 2007; Waters, Thomson & Nettle 2009), identified challenges in survey design due to the large number of variables required to determine farming styles. This is due to the cost of including a long list of statements for the farmer to answer along with other questions which may be of more interest to the extension officer. Further, the longer the survey the more difficult it is to obtain complete survey responses with survey fatigue impacting upon completions. Thus, as Waters, Thomson & Nettle (2009) point out, typology research needs to

> improve[e] the efficiency of identifying/classifying farmers into groups… [by reducing the attitude statements] to eight or ten statements that can be used as indicators for each area of perception/motivation [as this would] … enable it to be incorporated in other data collection processes (such as [national] surveys, project reviews, monitoring and evaluation processes) (p. 56).

In addition, Waters, Thomson & Nettle (2009) state that having a reduced, consistent set of attitudinal statements in longitudinal surveys 'would enable time-series data to be collected and the capacity to see how stable the segments are over time, within and between regions, and how individuals might shift between regions' (p.56).

The need to have a reduced set of statements led to the methodological innovation, termed the BR method, used to develop a quick and easy 8-item tool to classify farmers into previously determined farming styles groups from the baseline dataset. Advantages of this reduced statement set in survey research are reduced time and cost constraints, reduced respondent fatigue, inclusion of other key priority subject areas in the survey, and of most interest it enables a way to link new survey responses back to the baseline farming styles without having to go back to the same respondents each time. Thus, this innovation in typology research lessens the need to re-survey farmers, reduces toll on farmer respondents and addresses limitations of scarce research funding.

Thus the quick tool enables the farming styles typology to be more fully utilised by extension providers (see Figure 3). The quick tool provides an efficient way to classify new farmer cases from the target population (i.e. Victorian farmers from one of five sectors) into one of the farming style groups, for example from subsequent follow-up surveys. The quick tool may be used to classify the target population in surveys on other topics of interest, as the farming styles are not topic specific, instead they are specific to a given population. In other words, once a baseline survey has been conducted for the target population then the quick tool can be used to survey on other topics and effectively value-add. Evaluations of extension programs designed for farmers from a specific farming style group may utilise the quick tool to identify engagement of particular farming styles. For example the quick tool may be used as an evaluation tool to assess the effectiveness of any communication product designed to target different farming styles; or to understand the make-up of audience members in workshops or forums to evaluate whether the event targeted a certain farming group, or farmers from other groups. As well, the quick tool can be used to monitor changes within target population across the farming styles. For example, practitioners could monitor changes over time in attitudes, knowledge and behaviours towards climate change and adaptation by using the quick tool to classify farmers into types, then assessing whether types display significant changes in these characteristics. The improved efficiency of this classification method using the quick tool increases the potential use of on-line communication platforms (i.e. web-pages, mobile devices, mobile phone applications) which is ideal for practitioner use in monitoring landholder make-up at forums and in other data collection processes.

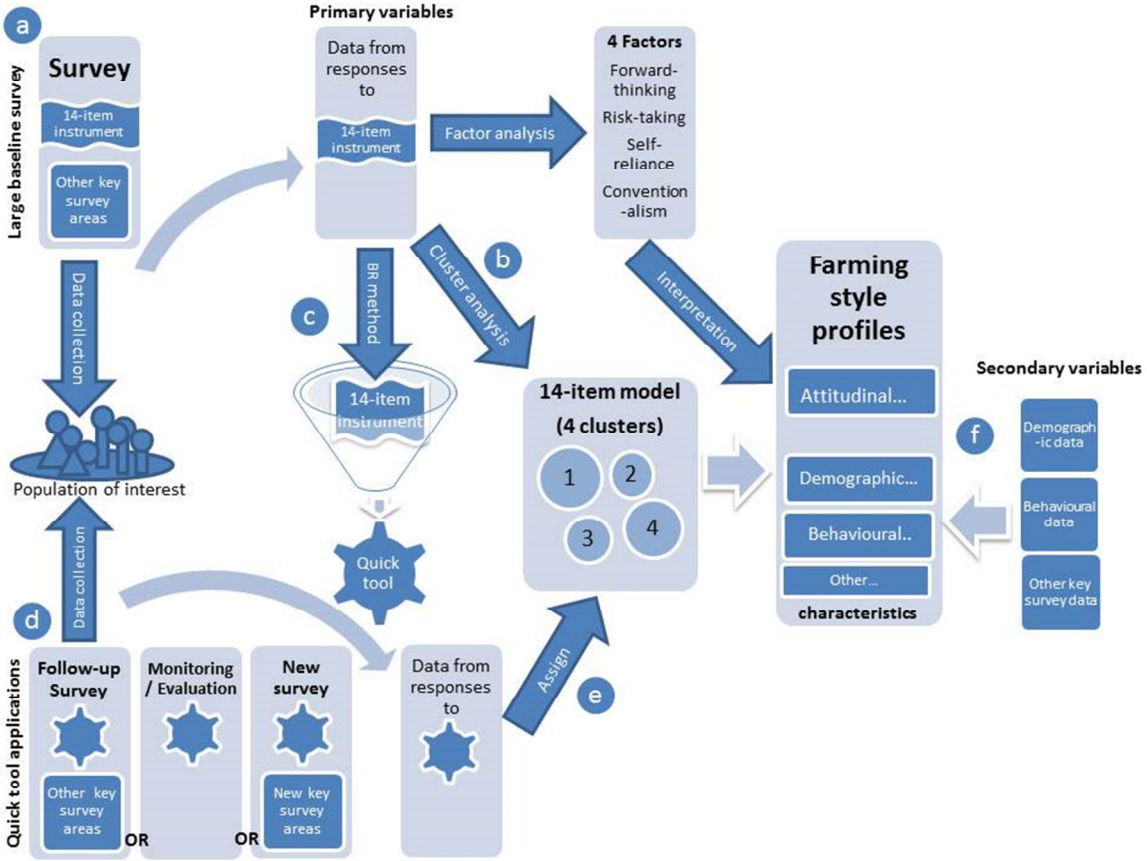
The BR method could be utilised in other longitudinal studies as detailed in this study to develop a quick tool from a larger set of statements that are the primary variables in the baseline cluster analysis. A follow-up survey round with an independent sample could collect responses to the reduced statement set and use these to classify the new data into the original groups. Thus this new innovative method also provides an efficient tool for other research practitioners interested in tracking changes across data collection years.

Emtage, Herbohn & Harrison (2007) highlighted issues in typology research in particular scales of time and space, and whether to focus on single or multiple industries, or single or multiple management practices. The issues of time and space form the parameters of our research. Firstly, our typology is broad-based across multiple industries and single management practices. The primary variables to determine our typology are social drivers of farmer decision-making which are shown to predict differences in the secondary variables, that is, other farming practices and characteristics, such as management practices. Typically this typology would therefore be useful for regionally-based strategic planning and program development as it spans across five different industries Victoria-wide, and concentrates on management practices of interest. These practices can be surveyed in one or a number of data collection rounds, as the strength of our typology is that it is based on landholder values rather than practices. Secondly few typology studies involve repeated survey research and therefore there are few insights into how typologies change over time (Emtage, Herbohn & Harrison 2007). Thus, this study provides some valuable insights. We found the Victorian farmer typology to be relatively stable within a two year time frame. All 2011 farmer cases were reassigned to the 2009 baseline styles with 90% accuracy. Whilst the number of clusters and sizes also roughly matched across the two survey years, the movement of individuals between groups is unknown as different samples were used across years. However, the movement of individuals is not an issue for using farming styles for extension, as it is the societal level of farming styles that are important not who the individuals are in each group.

There are several essential underlying assumptions and thus limitations of using this BR method. Firstly, it assumes that true cluster centres are static – that is, if certain clusters exist in the population that these clusters are not shifting through time and the correlation between the different statements does not change over time. Given the embedded nature of values it is unlikely that social drivers within a farmer population will shift quickly over time, and therefore the typology will remain true to the real world context. Previous research using Thomson's method (Waters, Thomson & Nettle 2009) indicates that groups remain relatively stable across the population (i.e. the number of groups and relative size of groups are consistent) even if individuals over time shift between groups. Consequently, this method can deal with individual farmers changing attitudes such that individuals who were in one cluster change their attitudes so that they most closely match those in other clusters. However any changes in the population that effect the farming styles groups (i.e. changes in correlations between statements) will not be captured using this method. This type of change may signify that attitudes of the entire population are shifting, and thus the original typology is no longer relevant.

Future typology research needs to evaluate the practical use of the quick tool for extension work and in ICT applications. Research is also needed to understand if the quick tool could be used instead of the full statement list to determine farming styles, given that it was able to accurately classify 90% of the sample. Since the main point of typology research for extension is to understand what the styles are and what their common characteristics are to enable targeting of programs to these styles. Thus, it is possible that this level of accuracy is all that is needed for extension, and hence, these eight statements are adequate. Further work is needed to check if a reduced-item tool would work in other populations. In addition, further longitudinal work is required to determine: how, if at all, farming styles drift or change through time within a population; and whether farmers' social drivers remain the same through time and if they do not, how fast they change and what triggers changes in drivers.

Figure 3. Process for use of typology and quick tool by extension officers



Key: a. Large survey with the full list of statements (14-item instrument or full set of variables from Thomson (2001)) of the population of interest. **b.** Perform cluster analysis on primary variables to determine the farming styles of this population. **c.** Using BR method determine what are the most important statements out of the set used for the large study to develop quick tool. **d.** Use quick tool (8-item instrument) in subsequent follow up surveys, monitoring/evaluation surveys of programs based on these farming styles, or for new surveys on other topics as the farming styles determined are not topic specific, instead they are unique to farming population of interest. **e.** Classify from these surveys/data collection processes to determine which farming styles groups they fit into. **f.** Determine what differences there are between the different farming styles groups based on secondary variables such as adoption of innovations and technology use and other behavioural, demographic or key variables.

Conclusion

Farming styles research provides an effective approach for extension providers and researchers to better understand the diversity of farmers using social drivers which influence farm decision making. However, one of the hurdles of typology research is how to increase adoption by extension officers and this may be improved through increasing the potential utility of typologies. Yet there are a number of challenges of engaging with extension practitioners that will need to be overcome. This includes the move to privatising extension, the disconnection between research and extension, the lack of continuity in extension services due to short-term contracts reducing human capital, increasing issues with recruitment and retention of skilled staff and impacting upon the ability to build trust-relationships with farmers (Hunt et al. 2012).

Our farming styles research assists agricultural extension services to manage some of these ongoing structural changes which has seen the knowledge base of practitioners decline as well as reduced research-practitioner links and research funding. This research has made significant progress to remove these particular barriers in extension through development of the farmer typology quick tool. This quick tool, along with the BR method reduces statements to only keep the most necessary variables and thus retains accurate classification of farmers into farming styles that have already been determined for the population of interest. This reduces respondent fatigue, shortens the time required to include farming styles as part of repeated surveys, and thereby addresses research budget constraints. Furthermore, the quick tool makes typology research a more practical tool for extension officers as it restores the research-extension divide because of its wide-ranging applications. Quick tool applications include evaluation of targeted communication and programs, monitoring audience attendance, for use with ICT products like mobile devices, and enables year-by-year farmer style comparisons in large repeated surveys. This is a significant innovation in usage of farmer typologies for both extension and research. With further validation of the quick tool, this innovation may have the potential to be used as a reduced, consistent set of attitudinal statements (Waters, Thomson & Nettle 2009) as part of a common typology segmentation procedure across public and privately run extension agencies.

Understanding farming styles enables the development of extension work with a targeted approach to engage a wide-range of landholder perspectives. The quick tool together with the BR method takes typology research beyond its conceptual application (i.e. raising awareness of farmer diversity) (Nutley, Walter & Davies 2007; Thomson 2001) to offer a more practical use of typology research for extension work. It provides a solution for data collection issues, greater utility of typologies in extension work and addresses some of the current challenges of agricultural extension in Australia.

Acknowledgements

The authors would like to acknowledge funding and support from Department of Primary Industry Victoria for survey and research development; and landholders in Victoria who participated in the two survey rounds of the *Victorian Farmer Survey on Climate Change* in 2009 and 2011.

References

Emtage, N, Herbohn, J & Harrison, S 2007, 'Landholder profiling and typologies for natural resource-management policy and program support: potential and constraints', *Environmental Management* vol.40, no. 3, pp.481-492.

Everitt, BS, Landau, S, Leese, M & Stah, D 2011, *Cluster analysis*, 5th edn, Wiley, West Sussex.

Haug, R 1999, 'Some leading issues in international extension, a literature review', The *Journal of Agricultural Education and Extension,* vol. 5, no. 4, pp. 263-264.

HCRP 2012, *The Victorian farmer survey on climate change 2011*, May 2012, Horsham Campus Research Precinct (HCRP), University of Ballarat, Horsham, Vic.

Hogan, A, Berry, HL, Peng, Ng S & Bode, A 2011, *Decisions made by farmers that relate to climate change* RIRDC Publication no. 10/208, Rural Industries Research and Development Corporation, Canberra, ACT.

Hunt, W, Birch, C, Coutts, J & Vanclay, F 2012, 'The many turnings of agricultural extension in Australia', *Journal of Agricultural Education and Extension,* vol. 18, pp. 9-26.

Kaine G, Bewsell D, Boland A, and Linehan C 2005, 'Using market research to understand the adoption of irrigation management strategies in the stone and pome fruit industry', *Australian Journal of Experimental Agriculture* vol. 45, pp. 1181-1187.

Murphy, C, Nettle, R, & Paine, M 2013, 'The evolving extension environment: implications for dairy scientists', *Animal Production Science*, vol. 53, pp. 917-923. http://dx/doi.org/10.1071/AN12347.

Nutley, SM, Walter, I & Davies, HTO 2007, *Using evidence: how research can inform public services,* Policy Press, Bristol.

Rakhlin, A, Caponnetto, A 2007, 'Stability of *k*-means clustering', in *Advances in Neural Information Processing Systems 19*, ed. B Schölkopf, J Platt, T Hoffman, MIT Press, Cambridge, MA.

Schwarz I, McRae-Williams, P & Park, D 2009, 'Identifying and utilising a farmer typology for targeted practice change programs: A case study of changing water supply in the Wimmera Mallee', *Extension Farming Systems Journal* vol. 5, no. 1, pp. 33-42.

Thomson, D 2001, *As if the landscape matters: the social space of 'farming styles' in the Loddon catchment of Victoria*, unpublished PhD Thesis, The University of Melbourne, Melbourne, Vic.

Thomson, D 2002, 'Understanding diversity in farming behaviour using 'farming styles', *Wool Technology and Sheep Breeding*, vol. 50, no. 3, pp. 280-286.

WIDCORP 2009, *Understanding farmer knowledge and attitudes to climate change, climate variability and greenhouse gas emissions*, December 2009, Water in Drylands Collaborative Research Program, University of Ballarat, Horsham, Vic.

Waters, W, Thomson, D & Nettle, R 2009, 'Derived attitudinal farmer segments: A method for understanding and working with the diversity of Australian dairy farmers', *Extension Farming Systems Journal* vol. 5, no. 2, pp. 47-57.