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Rural Farming Community Climate Change Acceptance: Impact of Science and Government Credibility

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Abstract. Independent research of Western Australian rural people's attitudes to climate change and influences on their attitudes offered a preliminary assessment of the WA rural sector's understanding of climate change and insights into potential barriers to communication. Of the farmers surveyed (N=255) only a third (33%) reported to the researchers they agreed climate change was occurring and just 19% believed climate change was human induced. Over half (52%) were uncertain whether human-induced climate change was occurring and only 31% thought climate change represented a major threat to the future of their farm businesses.

Results also showed that only 33% of all respondents (N =411) found climate change information easy to understand. In addition, results indicated that generally respondents had concerns with the credibility of science and low levels of trust in government, which contributed to their attitudes to climate change.

These results suggested the barriers to climate change communication resided with the very structures that sought to communicate with rural people and were embedded in the comprehensibility, relevancy and saliency of climate change information. The results indicated that science and government may need to consider utilising alternative strategies to distribute climate change knowledge within the rural sector. The results suggest that a better approach to distributing climate change information would be to frame the information within the local sociocultural, economic and biophysical environment of the people it was intended to influence.

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Introduction

The need to build Australian farmers' adaptation capabilities and resilience capacities was encapsulated in the National Agriculture and Climate Change Action Plan (NACCAP) 2006–2009 (NRMC, 2006). The NACCAP outlined strategic adaptation options to build resilience into agricultural systems in conjunction with mitigation strategies to reduce greenhouse emissions. Research and development was proposed to support the strategies in enabling the agricultural sector to respond to climate change.

The central element of the strategies was sciences' role in communicating information to farming communities to facilitate informed decision-making processes at business and community levels. NACCAP directed that the rural sectors understanding of climate change should be assessed and barriers to communication identified.

The successful implementation of the strategy was reliant on farmers and other stakeholders in the agricultural sector acknowledgement of the risk climate change could represent and the need to respond. Therefore three questions for science and extension were: 1. Were Australian farming communities accepting the evidence of climate change science was providing? 2. Did farming communities necessarily interpret the scientific evidence as a tangible indication of threat to their businesses and/or life-styles? 3. Were farming communities' attitudes to science and government influencing their attitudes to climate change?

Climate Change Awareness and Threat Perception

The Intergovernmental Panel on Climate Change (IPCC) has since the Second Assessment Report (Watson et al., 1996) consistently reported an increasing level of confidence in evidence of global climate change and outlined potential impacts to regions through the northern and southern hemispheres (McCarthy et al., 2001; Parry et al., 2007). Australia and particularly southern areas of Australia compromising a large proportion of the agriculture sector have been identified as highly susceptible to adverse climate change impacts (Kokic et al., 2005; Hennessy et al., 2007).

Prior to this research a number of international studies gauging public awareness of climate change of threat/risk had been conducted. Two studies in the US indicated that public concern regarding the risk climate change represented was relatively low. One study showed that just a third of people (34%) thought climate change was serious, while another 43% felt it was somewhat important to slow the rate of global warming (Sustainable Energy Coalition in Bord et al, 1998). Later US research conducted in 2008 indicated concern may have decreased with only 18% of respondents indicating a serious concern about climate change (Maibach et al., 2009). Alternatively, a study in the United Kingdom found that over 90% of people who had taken part in climate change surveys believed climate change represented a risk and action needed to be taken (Anable et al., 2006).

Yet when it came to understanding the climate change problem, Bord et al. (1998) found, as Kempton (1993) and Berk and Schulman (1995) had, that people remained largely uncertain about the causes and threats that climate change represented. Uncertainty, flawed or inconsistent knowledge and low threat prioritization remained prominent features of many people's attitudes (Anable et al., 2006)

At the time leading to this research, there had been only a limited study of rural Australians awareness and attitudes to climate change (DAFWA, 2006; Milne et al., 2008). Both were based on qualitative data. After the research was conducted, a further two Australia-wide quantitative studies were published (ABS, 2008; Connections Research, 2010) and many international studies, including multinational studies in the Comparing Climate Change Policy Networks Project starting in 2009 (COMPON, 2011).

Earlier research in Western Australian agricultural and urban regions via seven public forums involving 54 participants found people generally accepted climate change was occurring (Department of Agriculture and Food Western Australia, 2006). Most people in the study had noticed changes in the climate over the last 30 years. The changes included declining rainfall, more extreme weather events and increased seasonal variability.

However, most people were unsure if human activity was a catalyst of the change and thought climate change represented an intangible future-orientated threat that would not affect them. Many considered they had already taken adaptive action and were managing the change.

Other qualitative research suggested further the threat of climate change might not be enough to motivate farmers and rural communities to adapt (Milne et al., 2008). Case-studies of two irrigation and two broad-acre farming communities in the Murray Darling Basin found only 36% of participants believed climate change was occurring. Of the remainder, 11% did not think climate change was happening, 40% were uncertain and 15% thought climate change would not affect their region. This was despite the communities experiencing unprecedented dry conditions for 7–10 years.

Quantitative research of 150 403 agricultural businesses Australia-wide undertaken in 2008 showed two thirds of farmers (66%) had noticed changes in the climate, with 62% indicating that the changes had impacted on their properties (ABS, 2008). The majority (92%) indicated that rainfall had declined, while three quarters (74%) agreed there had been an increase in extreme weather events and half (50%) believed that the climate had become warmer. Almost half (48%) of the farmers surveyed had changed management practices in response to the changes in climate.

While past research had indicated ambiguous levels of acceptance of climate change and high degrees of uncertainty in rural areas, the studies were limited in examining the factors influencing people's attitudes to climate change in depth. For instance, why when people had acknowledged there had been dramatic changes in climate, there remained a low or uncertain perception of risk associated with the changes. Nor did the research qualify if farming communities were responding to permanent change or changes perceived as temporary or cyclical.

Communicating the Threat and Need to Adapt

To get an understanding of what the issues may be in people accepting that climate change is occurring, semi-structured interviews were conducted with a small sample of 12 farmers, agribusiness representatives and indigenous landholders. Responses were used to discover and explore concepts via an iterative grounded research process (Whiteley and Whiteley, 2001). The second stage of the research was to conduct a survey of a larger sample. The following uses the literature reviewed to understand the in-depth interviews based on the grounded research principles.

The in-depth interviews and literature indicated there could be five key elements which could influence people's perceptions of climate change and climate change threat. These key elements involved the processes of transferring information and knowledge from science to the lay person in a way which needed to be comprehensible and would promote motivation and response. The elements included:

1. perceptions of scientific credibility;
2. interaction and conflict between farming community knowledge and scientific results;
3. perceptions of governments/policy-makers credibility;
4. communication, information and knowledge transfer;
5. attitudes and behaviours derived from beliefs and values.

Science Credibility

Garvin (2001) observed the credence and authority of science in society had been gradually eroded since the conclusion of the Second World War. However, Garvin (2001) suggested issues of trust and credibility could be attributed the differences in the rational that the public and scientists apply to risk. Garvin (2001) felt the public tended to be concerned more with what was not known about the risk associated with an activity than what is known. More importantly for the lay person is the risks that they believe are important are the risks that the experts ignore (Margolis, 1996).

The natural investigative mechanism of formal science driven by healthy scepticism and the need to debate, review and retest to validate knowledge as legitimate has also contributed to undermining sciences credibility with the public (Langford, 2002).

It could be expected that science has in the process also lost some credibility with farmers. However, given the historical interdependent relationship between farmers and (agricultural) science it may be argued that farmers are not so much questioning sciences' credibility as contesting sciences' authoritive position, its motivation and contribution to their farm businesses (Holloway, 1999; Cohen, 2009).

As the farmers interviewed for the research observed: 'Nine times out of 10, I bet you that a good idea a scientist has come up with he got from a farmer', and 'My concern is that climate change will be an excuse for some researchers to put out the hand and guarantee themselves a job'. But ultimately there is that acknowledgement that farmers need science: 'R&D has been a key part of agriculture and farming'.

Interaction and Conflict between Farmers' Knowledge and Science

To give scientific information relevancy, Holloway (1999) observed farmers used their own knowledge in a process of modification to adapt scientific knowledge to local context. Both Vanclay (2004) and Holloway (1999) noted the authority of scientific knowledge was being questioned by farmers who did not accord science automatic credibility and legitimacy.

In terms of legitimacy, Australian farmers constructed their own knowledge through what were, in essence, informal scientific processes of experimentation, trials and assessment (Vanclay, 2004). Therefore, Vanclay (2004) noted the validity of the knowledge formed by the informal process was as legitimate to farmers as knowledge formed, reviewed and substantiated by formal scientific process.

Adger et al. (2008) suggested adaptive policies and action could be limited by individual and social constraints. The social factors that determine adaptive limits emanate from within a society. The factors evolve from what is valued and the value is applied to the knowledge and information within cultural contexts to interpret perception of threat and assess social capacity to adapt and minimise the risk.

Thus the communication of risk relies not only on the substance of the threat but the authority of knowledge that validates the threat. The communication is also dependent on socio-cultural relationships with the biophysical environment and the trust of social structures advocating the threat as illustrated in farmers comments drawn from interviews during the research.

> 'Of course the climate's changed… It's always changing. We have had big dries before back in the 1940s and 1970s but then its turned wet again. The old man reckoned the weather was different when he was young to what it was when he finished farming… His dad went through the Federation drought… The old man never went through a drought that bad.'

And, 'Yes, they [climate scientists] are totally right. If the climate keeps changing the way it has there mightn't be farming in this area in 50 years time'.

Perceptions of Governments'/Policy-makers' Credibility

In the communication of information, the credibility of science and government/public bodies is intrinsically linked in the perceptions of the public (Botterill and Mazur, 2004). Earlier models of risk communication tended to view the public as relatively unsophisticated and therefore needing more scientific information to garner support for policies that could have been or were being challenged in the public domain (Gutteling and Kuttschreuter, 2002). However, this approach had a tendency to challenge and at times dismiss peoples' views of risk that were based on their core beliefs and values (Kasperson, 1986).

In relation to climate change adaptation, government faces further challenges in sustaining public trust and credibility. The variability of adaptive needs and options across the social scope become more diverse and exposed to conflict as adaptive policies are applied and decisions are made at the micro (business), meso (local) and macro (national/state) levels (Adger et al., 2008).

Added to this is the public's concern in the governments' capacity to deliver solutions and/or not be influenced by vested interests or use climate change to increase tax in other sectors of the economy (Stoll-Kleemann et al., 2001).

Science therefore needs not only to contend with perceptions of its own social integrity and credibility but also that of governments' credibility to respond to people's concerns. One of the interviewees commended: 'In the old days farmers used to be valued by the government and city people… but not now. I don't think the average city person cares about the farmers… and the governments' the same. As long as we keep paying our taxes they don't care'.

Communication, Information and Knowledge Transfer

When considering the relationships between the recipients of climate change knowledge and those who generate the knowledge, it is important to examine the role the

general media plays in conveying the information. Equally it is necessary to examine the media's perception of the role it plays.

Printed and electronic media representatives maintain that the media's role is to present balanced and unbiased information (Brossard et al., 2004). However, Gore (2006) quotes research of over 700 research science reports that were predominantly consistent in accepting climate change yet found the media had a high proportion of dissenting views reported. Fortner et al. (2000) found the American public generally trusted the media and valued it as a source of unbiased information. However, Krosnick et al. (2000) thought media coverage of climate change had little impact of increasing knowledge among educated people. In turn, Potter and Oster (2008) questioned how climate change as a matter of public concern could be ever fully represented in the mass media. Unlike the depletion the ozone layer, which could be represented as a singular issue backed by a series of facts, climate change is not the fact or issue within the narrative but the story itself (Potter and Oster, 2008). Climate change is a broad diffused future-orientated topic that presents multiples of issues challenging the media to articulate the impending threat (Unger, 2000). As such the complexity of climate change may represent a difficult challenge for the media in transferring information from the science/government sources to the public in a way that is understood.

Attitudes and Behaviours

Vanclay (2004) and Holloway (1999) observed that farming and adaptation were inter-reliant processes enmeshed within a socio-cultural context. To consider farming simply as an application of scientific technologies was to value the technologies adaptive capacity too highly and disregard the socio-cultural influence (Holloway, 1999).

This implied that definition of what are 'right' adaptive options and 'wrong' options and who determines what is 'good' information and what is misinformation may be subjugated by attitudes derived from within the social constructs of farming communities. Wardell-Johnson's (2007) work illustrated the social and economic relationships between rural people and their environments, which in aggregation contribute to defining their 'sense of place'. Sense of place, an intangible sometimes misunderstood concept, is nevertheless a robust and powerful catalyst of the individual's knowledge and identity. It could be proposed acceptance of new knowledge and definition of what is the 'right' option is based less on the logic of the probabilities and rationale of experts and more on how the knowledge and options which conform to sense of place (Wardell-Johnson, 2005). Borgida and Campbell (1982) found that while a consistent transfer of pro-environmental information elicited a positive change in people's explicit environmental values, there was far less change in people's implicit values and their poor environmental behaviours.

Attitudes and behaviours may only begin to change when the distance between implicit and explicit values/beliefs converge (Dengate et al., 2006). Dengate et al. (2006) contended this could only start to occur when information and awareness became knowledge that was incorporated into existing knowledge forms. The process Dengate et al. (2006) favoured to transfer information into knowledge was engagement rather than trying to convince people that a particular view is correct. An example of this approach was landholders who having attended workshops on the value of planting trees in the landscape were more likely to plant trees on their properties than those who attended fewer workshops or did not attend (Cary et al., 2001). Incorporating information and awareness could be best summed up by the maxim, 'Tell me and I forget. Show me and I remember. Involve me and I understand' (Dengate et al., 2006).

Although climate change is an acknowledged, measured certainty (Parry et al., 2007) the problems and threat it poses for rural Western Australians retains a level of intangibility. It may be the rural socio-cultural conceptualization of climate change challenges what is being communicated as a risk, which in turn could be contributing to the intangibility of the threat. If the climate change risk can be translated to tangible events and specific adaptive responses then climate change information may be considered useful and the risk associated with climate change better accepted.

Based on results of the grounded research (interviews interpreted based on literature), it was expected that there may be varying acceptance of climate change in rural communities. It was hypothesized that acceptance may be associated with experience and knowledge of local climate, attitudes to climate change science, attitudes to government policy-makers and perceived usefulness of climate change information. The research method to test these theories follows.

Research Method

Research methodology was post-structural, heuristic and explorative in nature and based on approach of discovery (Kleining and Witt, 2001; Wardell-Johnson, 2007). The application of this post-structural heuristic approach required four key criteria described as the 'Hamburg rules of explorative research' to be met by the researcher (Kleining and Witt., 2001). The rules are defined as: 1. openness of the research person; 2. openness of the research topic; 3. maximum variation of perspectives; and 4. discovering similarities and integrating all data.

The heuristic post-structural approach recognizes that intrinsic attitudes and values are formed through an evaluative, iterative process influenced and conceptualised within personal, socio-cultural and biophysical contexts (Gough and Price, 2004; Wardell-Johnson, 2007). The approach is aimed at discovery through collective exploration that is re-examined through repetitive investigation for similarities that by their distinction define differences (Wardell-Johnson, 2007).

The research was conducted first using semi-structured interviews with 12 participants to identify concepts or substantiate constructs integral to the study based on grounding results in literature (reported above). This was followed by a structured survey of 411 members of Western Australian rural communities that included businesses associated with agriculture (agribusiness) as well as farmers.

As the population of interest were spread across a very wide geographical area (1.2 million square kilometres) (ANRA, 2011), it was decided to use central location intercepts to efficiently collect surveys. The survey was conducted between August and October 2008 at locations across WA agricultural regions. Most information was collected using face-to-face intercepts at three major annual field-day events that take place in WA: Dowerin and Newdegate field-days and the Mingenew Lions Expo. Surveys were also undertaken at additional locations to include representation of smaller diary, horticulture and viticulture industries: the Perth Royal Show, Waroona Agricultural Show, Muresk Agricultural Institute and Katanning Pasture field-day. The locations were chosen because each event took place in a different

agricultural region and locations represented the diversity of farming systems and climatic conditions that comprise WA agricultural industry sector.

People who agreed to take part in the survey were initially asked if they owned, managed or contributed to farming in any capacity. The framing of the question was designed to capture not only farmers but their family members who, while studying or retired, still assisted during key periods in the farming year. It was also designed to identify agribusinesses associated with farming.

There was a 13% refusal rate of the face to face intercepts. Of those refusing to participate, 68% indicated they did not believe climate change was occurring. There was a 41% response rate to mail back responses. A total of 411 surveys were collected and available for analysis. Of the 411 respondents, two thirds (255; 62%) were identified as associated with farming and the remainder as agribusiness and general members of the rural community.

The survey explored four areas of interest, which included:

1. observations, experiences of climatic conditions over the previous 10 years and their responses;
2. attitudes to climate change;
3. opinions of science and science's role in climate change;
4. opinions of government/policy-makers role in climate change.

With the limitations of collecting surveys at central locations, the characteristics of the sample was compared to information about rural communities to see if the sample was representative and the results able to be generalized to the population as a whole. Analysis of individual questions was undertaken using SPSS Statistics 18. To test the theories, participants were clustered and classified using numerical taxonomy analytical software PATN (Wardell-Johnson, 2005; Belbin et al. in Wardell-Johnson, 2007).

Results

The results have been divided into sections the literature and familiarization study had indicated to be contingent with the development of attitudes to climate change.

1. Socio-demographic characteristics of the sample.
2. Personal perceptions of climate change.
3. Attitudes to climate change, which included:
   - perceptions of threat;
   - attitudes and responses to climate change threat;
   - opinions of science and perceptions of climate science credibility;
   - perceptions of governments' (State and Federal) climate response and implications for rural people.
4. Grouping of people with similar socio-demographic characteristics who shared similar attitudes to climate change and determining if they were statistically different to other groups within the survey sample.

Sample Characteristics

The majority of survey participants were males (70%), although researchers observed there appeared to be only slightly more males than females attending the events at which the survey was conducted. When couples were approached, females deferred to males to complete the survey. The representation of females (28%) in the survey was much lower than the WA rural female population (48%) (ABS, 2005) but comparable to that expected working in agriculture, forestry and fishing (30%) (Department of Training and Workforce Development, 2011).

Of the participants surveyed, 62% indicated that they 'owned, managed, or contributed to farming operations' in some capacity. This group was over-represented in the survey population when compared to ABS (2006) data, which indicated people directly involved in farming comprised 15% of Western Australia's rural regional population. The over-representation of this group in the research could be attributed to the nature of the field days, which were highly orientated to people directly involved in farming and the agricultural industry. In this regard, the research results are more appropriately generalized to the rural farming community and not necessarily the broader rural community as a whole.

Most of the participants who contributed to farming, owned or managed farms (73%) which was higher than expected for the farming community (60%) (Department of Training & Workforce Development, 2011). The remaining 17% owned, managed or worked in closely allied industries, such as transport, fuel and oil supply, agricultural consultancy, machinery servicing and agriculture contracting (Table 1).

There was an over-representation in the sample of owners and managers of farms; however, they were of interest to the research. As key decision-makers, their attitudes to climate change may have a bearing on the prioritization of climate change threat as an economic risk factor for the sustainability of their businesses. Other research has proposed farmers viewed sustainability as continuing or improving productivity and profitability within the environment that as a resource could be managed and maximized (Fleming and Vanclay, 2009). The problem Fleming and Vanclay (2009) proposed was climate change was not considered a major threat because change was assumed to be incremental and would allow enough time for systems to adapt.

While farmer participants had on average 36 years experience, with a standard deviation of 18 years this ranged between 18 and 54 years for most (68%) partici-

Table 1. Type of contribution to farming.

Contribution to farming	Frequency	Percentage (%)
Own/manage a farm	225	73.1
Farm employee	30	9.7
Allied farm industry	53	17.2
Total	308	100

Table 2. Farming experience.

Time-frame	Percent	ABS (2006)	Storer (2010)	Langley et al. (2007)
1–10 years	16%	9%		
11–20 years	20%			
21–30 years	18%			
31+ years	46%			
Average	36 years		16 years	22 years
Range 95%	18–54 years		3–28 years	8–36 years

pants. Compared to studies of the same population of interest, ABS data (2006) indicated participants with 1 to 10 years involvement in farming (16%) were relatively over-represented in the survey compared to the overall WA farming population (9%) (Table 2). Similarly, the sample populations' experience of farming was greater than found in rural WA surveys by Storer (2010) (average 16 years) and Langley et al. (2007) (average 22 years).

With differences between the characteristics of the sample and those known of the population as a whole, care is needed to extend the findings of this research to wider groups. It is suggested this should treated as exploratory with follow up work recommended.

Farmers Experience and Knowledge of Local Climate

When farmers were asked if they had experienced poor seasonal conditions during the previous 5–10 years that had resulted in reduced profitability, most (84%) indicated they had. On average, 69% had experienced three and half years of poor seasons, with a standard deviation of 1.7 years during the 10 year time-frame.

The poor seasons were not necessarily concurrent, although many farmers from the Northern Agricultural Region (NAR) did indicate they had experienced two successive dry seasons during 2006 and 2007. These farmers reported the low rainfall during the period had an adverse effect on farm operations and incomes. Several of the farmers had not attempted to sow any crops during this time while others who had undertaken a dry seeding programme or seeded on minimal moisture over the two years did not harvest any grain.

At the same time, North Agricultural Region farmers with stock had almost completely destocked in the latter stages of 2006. The extent of destocking was illustrated in the reduction of sheep present on farms in the Northern and Northeastern areas of the region in 2008. One farmer who had 15 000 sheep shorn on his farm in 2005 had only 300 sheep left by September 2008. In another instance, a farmer who had 12 000 sheep in 2005 did not have a single sheep on the property by May 2007, and despite very favourable seasonal conditions in 2008 had not considered restocking at any level in the foreseeable future.

However, most farmers acknowledged that between two and four poor seasons in 10 years were normal and should be expected. Provision for the occurrence was incorporated into management strategies. Farmers in the NAR, despite having experienced an unprecedented drought event in the previous two to four years, generally concurred with the view that two to four poor seasons in 10 were normal.

Attitudes to Climate Change

Uncertainty concerning climate change occurring and what was causing climate change were the prevailing responses. Only a third (36%) of participants agreed that climate change was occurring, while half (51%) were uncertain. This included those who were very unsure if climate change was occurring and people who were not wholly convinced if it was or was not occurring. The remainder (13%) did not agree climate change was happening.

These responses were comparable to the qualitative research among the Murray Darling Basin (MDB) farming communities where 36% of participants accepted climate change was occurring, 40% were uncertain, and 11% disagreed it was occurring (Milne et al., 2008).

Half (53%) of participants were uncertain if climate change was a part of a natural climatic cycle and not influenced by greenhouse emissions while 21% believed it was due to a natural process. Just a quarter (25%) of respondents disagreed climate change was natural, which again was similar to responses in the MDB study where 26% felt climate change was human induced (Milne et al., 2008).

Of note were the reactions of many participants when asked if climate change was occurring. Quite a number of participants either felt the question was confronting, or expressed a reticence to respond. Other respondents physically drew back from the interviewer. When these respondents were asked if climate change was part of a natural cycle and not influenced by greenhouse emissions most exhibited relief and generally indicated that they thought climate change was natural.

This direct questioning of climate change occurring, elicited some strong feelings among a small number of participants. These participants reacted negatively, stating simply, 'Climate change was not happening!' or 'I don't believe in climate change!', or words to that effect. Some forcibly suggested that the survey was biased towards climate change and was being used by science and/or government to promote climate change acceptance among rural people.

Alternately other respondents easily accepted climate change was occurring. However, many respondents expressed uncertainty and on many occasions spent quite some time in personally assessing if they thought climate change was occurring or not.

Yet despite the low acceptance (36%) of climate change among participants, 42% were concerned it represented a threat to the future of rural communities. However, 39% were uncertain of the threat it represented.

There was less concern for the future of their businesses. A third (33%) believed climate change was a threat to the future of their businesses while 24% did not. Notably levels of uncertainty were higher among this group with 43% unsure of the threat potential to their businesses.

These responses implied tensions between what the people knew at a local level and what they were being told by experts. To explore the potential causes of the tensions, science as the generator of the knowledge and information and as the principal messenger was examined.

Grouping Respondents: Attitudes to Climate Change Clusters

Analysis of Variance (ANOVA) revealed statistically significant differences between responses of groups to climate change being part of a natural cycle and not influenced by greenhouse emissions and the credibility of science and scientific knowledge/information variables ($p < 0.01$).

To further explore attributes of affinities within groups and differences between groups numerical taxonomy using PATN Windows software (Wardell-Johnson, 2005; Belbin in Wardell-Johnson, 2007) was used as it simultaneously puts people into groups and allows the use of ratio and non-ratio scale data to explain the differences between groups. The analysis examined whether people could be clustered into different groups based on their attitudes to science and if the prevailing attitudes were a contributing influence to people's attitudes to climate change.

The numerical taxonomy multivariate analysis revealed three clusters of values derived from respondent's attitudes to science and scientific knowledge/information (Figure 1). The description of the statement and its meaning in the context of the analysis represented by the abbreviated variable label relevant to cluster values is contained in Table 3.

The clusters represented three distinctive sets of attitudinal values to scientific credibility and the perceived usefulness and importance attached to scientific climate change information and knowledge.

The two-way table illustrates the grouping of people and variables defined by cluster analysis (Figure 2). The table describes the results of numerical taxonomy, showing the relationships of familiarity between people within each group correlated with the science variables displayed in Figure 1. The five colours displayed in the two-way table (see the legend) depict the strength of the association between the intrinsic science variables displayed across the top of the table and respondents displayed down the left-hand side of the table (respondent characteristics for each cluster described on the right hand side of the table).

The degrees of correlation range from white to black. White depicts no correlation or affinity between respondents and relevant variables, while black shows the highest degree of correlation of affinity between respondents and variables.

The two-way table shows three clusters of correlations between respondents and variables (Figure 2). The three clusters represented 83% of the survey population.

The first cluster labelled 'Uncertains' represented 50% of the survey sample. The cluster comprised participants uncertain if climate change was part of a natural cycle or not. They generally believed that science had not considered all of the factors in its estimation of climate change and that humans would adapt naturally as the climate changed. Participants in the cluster considered climate change science to be divisive because scientists could not agree about what was causing climate change to accelerate and also questioned the integrity of scientists. There was a perception scientists were exaggerating the potential effects of climate change and were using climate change as source for funding.

The second cluster labelled 'Dissenters' represented 15% of the survey sample. The cluster consisted of participants who agreed climate change was part of natural cycle and not influenced by greenhouse emissions. They thought the climate change problem was beyond science and nothing could be done to solve it. They also displayed unfavourable attitudes to the credibility of science and the integrity of scientists and researchers.

The third cluster 'Acceptors' represented 18% of survey participants. The cluster included participants who thought climate change was influenced by greenhouse emissions. They believed scientific information was useful, valued science's view of climate change and thought scientific publications were a useful source of climate change information. They also thought there should be close co-operation between science and agriculture in finding solutions for climate change. These participants also felt that climate change information was easy to understand.

Additional Characteristics of Attitudes to Climate Change Clusters

Further analysis showed that none of the respondents in the 'Acceptors' cluster agreed climate change was natural and not influenced by greenhouse emissions (Ta-

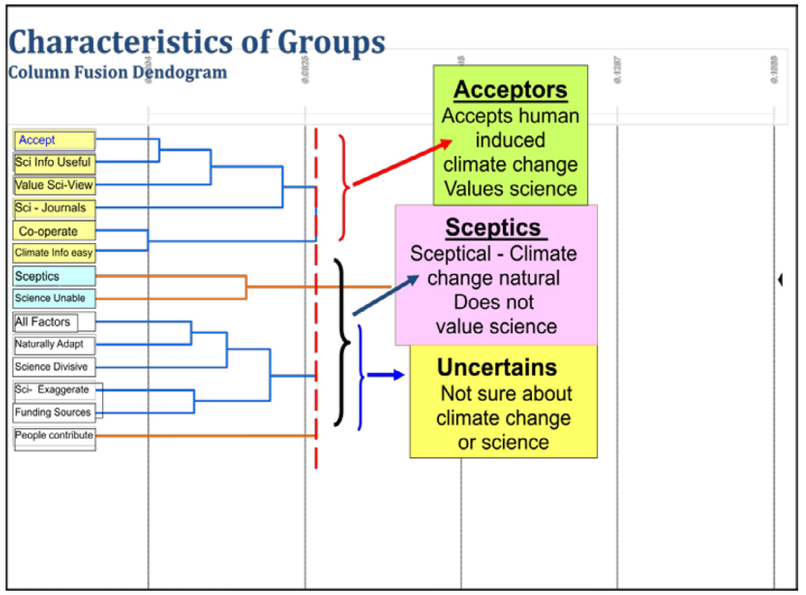

Figure 1. Column fusion dendogram showing value clusters.
Note: Bray-Curtis UPGMA beta –0.5.

Table 3. Cluster values of questionnaire statements.

Statement	Variable label
Disagree that climate change is part of a natural climatic cycle and is not influenced by greenhouse emissions	Accept
Agree that climate change information provided by scientists is useful	Sci info useful
Value science's views about climate change	Value Sci-view
Agree that scientific sources are important as useful sources of climate change information	Sci-publication
Agree that science needs to work closely with businesses associated with agriculture & rural communities in finding climate change solutions	Co-operate
Yes, climate change information is easy to understand	Climate info easy
Agree that climate change is part of a natural climatic cycle and not influenced by greenhouse emissions	Dissent
Agree that the climate change problem is beyond science and nothing can be done to solve it	Science unable
Agree that scientific estimates of climate change have been made without considering all factors involved	All factors
Agree that humans will naturally adapt as the climate changes	Naturally adapt
Agree that scientists cannot agree about what has caused the acceleration of climate change	Science divisive
Agree that scientists are exaggerating the potential effects of climate change	Sci - exaggerate
Agree that climate change is the latest fashionable funding source for scientists and researchers	Fund sources
Agree that the ordinary person will contribute as much to climate change solutions as scientists	People contribute

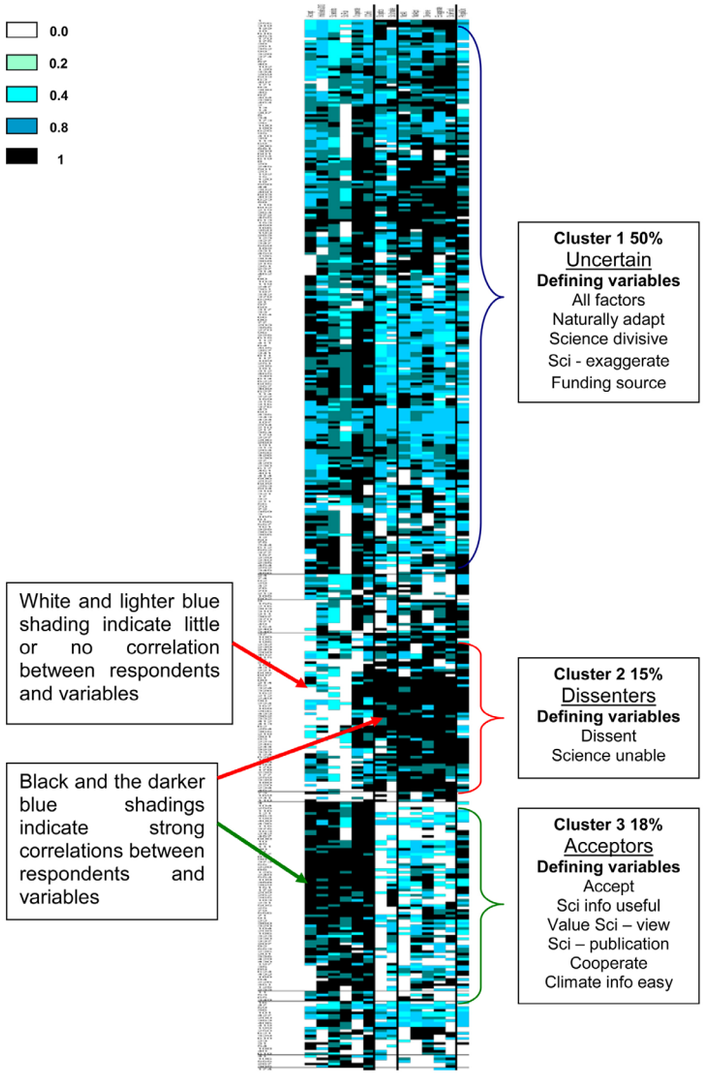

Figure 2. Two-way table of clusters of respondents correlated with credibility of science.
Note: Bray-Curtis UPGMA beta –0.5.

ble 4). In turn most (63%) of the 'Dissenters' cluster agreed climate change was natural while just 19% of the 'Uncertains' cluster shared a similar view.

The scientific credibility variables defined the greatest differences between the three clusters. Respondents in the 'Dissenter' cluster exhibited very unfavourable attitudes to science and scientist's credibility. Essentially, respondents from the 'Dissenter' cluster believed that: scientists had not considered all the factors in their estimates of climate change (74%), science was divisive (79%), scientists were exaggerating the potential impacts of climate change (83%) and were using climate change as a funding source (73%).

Table 4. Clusters – additional attributes of typologies.

Characteristics	Cluster 1 'Uncertains'		Cluster 2 'Dissenters'		Cluster 3 'Acceptors'	
	%	Mean	%	Mean	%	Mean
Climate change is part of a natural cycle	19%	4.0	63%	5.5	0%	2.2
Scientific information is useful	34%	4.8	13%	3.1	72%	6.0
Agriculture and science should cooperate	72%	6.0	45%	4.8	88%	6.4
Science is unable to solve climate change	27%	3.7	66%	5.8	14%	3.0
Scientists have not considered all factors	34%	4.9	74%	5.9	4%	3.2
Humans will naturally adapt to climate change	33%	4.7	76%	5.9	18%	3.3
Science is divisive	54%	5.3	79%	6.2	32%	4.5
Scientist's are exaggerating impacts	26%	4.3	83%	6.2	5%	2.7
Scientists are using climate change as funding sources	47%	4.9	73%	6.2	19%	3.3
People will contribute as much to solutions as science	30%	4.4	58%	5.2	32%	4.1
Science information sources important*	50%	1.3	16%	0.6	78%	2.2
Value sciences view on climate change**	80%	2.1	13%	0.7	97%	2.8
Climate change information is easy to understand***	35%	1.7	27%	1.7	61%	1.4

Notes: On a scale of 1–7, where 1 = strongly disagree and 7 = strongly agree; * on a scale of 0–3 where 0 = not at all important and 3 = most important; ** on a scale of 0–3 where 0 = not at all and 3 = value highly; *** where 1 = yes and 2 = no.

Cluster Values Attributed to Scientific Information and Views

Science's poor credibility with participants in the 'Dissenters' cluster was reflected in the importance placed on the value of scientific information and the scientific views about climate change. Only 16% thought scientific publications were important in providing useful information and just 13% valued science's views on climate change (Table 4).

On the other hand, participants from the 'Uncertains' cluster indicated a relatively high level of support for scientific information sources and climate change views. Half (50%) thought sciences information sources were useful while most (80%) valued science's climate change views.

However, it was the understandability of climate change information that underlined the differences between the clusters. Only 27% of respondents in the 'Dissenters' cluster and 35% of people in the 'Uncertains' cluster found the information easy to understand. Conversely, 61% in the 'Acceptors' cluster found the information easy to understand.

This raised the question of what was influencing people's understanding of the information. Was it caused by the use of technical scientific jargon? Or was it, as Holloway (1999) and Vanclay (2004) proposed, a conflict of validity between the

localized knowledge forms of rural people with the distantly constructed scientific knowledge.

The length of time spent living in area and the development of people's sense of place with an area could influence the development of particular attitudes to their biophysical environment (Stedman, 2003; Wardell-Johnson, 2007).

Results revealed the time people had lived in an area was statistically significant (99% confidence) in regard to the credibility they attributed to science. Results showed participants who had lived in an area longer significantly accorded science less credibility than those who had resided in an area for shorter periods of time. Longer-term residents had greater levels of agreement to: scientific estimates of climate change do not consider all factors; scientists' divisiveness about the causes of climate change; scientists using climate change as a funding source; and do not value scientists and researchers climate change views.

The amount of time farmers had been involved in farming also had significance for four scientific credibility variables. Basically, the longer farmers had been involved in farming the more inclined they were to disagree that science had considered all factors in its estimates of climate change and, essentially, did not value scientists' and researchers' climate change views.

Participants in the 'Dissenters' cluster had lived in an area (4.5 years) longer than people in the other two clusters ('Uncertains' 3.6 years and 'Acceptors' 3.2 years). Farmers in the 'Dissenters' cluster had been involved in farming for longer (5 years; 'Uncertains' 4.4 years and 'Acceptors' 3.7 years) and had more family history in farming than farmers from the other clusters (6.7 years; 'Uncertains' 6.3 years and 'Acceptors' 5.7 years).

This implied possibly an aggregation of knowledge contextualized within a local rural socio-cultural framework could be contributing to attitudes of scientific credibility. While participants' attitudes to climate change appeared to be influenced by their attitudes to science and perceptions of scientific credibility, there was evidence of facets of trust. However, the same could not be said for policy-makers.

Policy-makers' Credibility with Rural People

Just 9% of all survey participants believed government climate change policy would be fair and sensitive to the needs of agriculture and rural communities. Most disagreed (43%) or were uncertain (47%).

Farmers were more pessimistic about how they would be treated by future climate change policy. Half (50%) of them did not anticipate policy-makers would display fairness or sensitivity to the WA rural sector while only 8% thought the rural sector would be treated fairly.

Table 5. Local experience.

Clusters – demographics	Cluster 1 'Uncertains'		Cluster 2 'Dissenters'		Cluster 3 'Accepters'	
	Mean	SD	Mean	SD	Mean	SD
Time lived in an area	3.6	1.9	4.5	2.6	3.2	1.8
Time involved in farming	4.4	1.7	5.0	1.8	3.7	1.8
Family time involved in farming	6.3	1.4	6.7	0.7	5.7	1.9

From that point, trust and credibility in policy-makers diminished. Farmers did not think policy-makers would take all relevant factors into account when forming future climate change policy. Just 2% of farmers thought all factors were being considered while 62% thought this was not occurring.

However, the most damning indictment of lack of trust in government came in the response to the statement 'Politicians will use climate change as an election issue'. Most (85%) of the farmers and 78% of all survey respondents agreed this would be the case.

It may not necessarily follow that trust and credibility issues with policy-makers could influence people's attitudes to climate change. But there remains the potential for sciences' tenuous credibility with farming communities to be further undermined by science's association with government.

Conclusion

The results of this research revealed some fundamental issues in the diffusion of climate change information and knowledge transfer between science and rural Western Australians. There was a high degree of uncertainty regarding climate change occurring, if it was human induced and if it was a major threat to the future of farm businesses and rural communities. It would appear the uncertainty was underpinned by the incomprehensibility of the scientific information and the ambiguous credibility of scientists and researchers.

Most of the participants in the survey had noticed change in the climate, yet only a few had connected what was occurring at a local level with global climate change. Based on these responses, it could be questioned whether science is able to communicate relevant and salient information to farming communities.

Sciences role in developing knowledge and adaptive innovations will be integral to the future of farming and rural communities in Western Australia. Therefore the need to address these shortcomings in climate change communication processes is paramount. The results suggest that a better approach to distributing climate change information would be to frame the information within the local socio-cultural, economic and biophysical environment of the people it was intended to influence. If people can translate the information provided to what they can observe around them, they may be more likely to understand the points being made. However, it is suggested it is not sufficient to make people aware of the risks of climate change. To make a meaningful response they need ideas of what can be done to mitigate the causes or adapt to the risk. The ideas need to be translated to actions appropriate to the local situation.

Further research is needed on how to best communicate with farming and rural communities so that it is understood and can be compared to their existing knowledge. In addition, further research is needed on the factors affecting people's attitudes to climate change across larger geographical areas to see if the results of this study are replicated in other areas.

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