Factors Influencing Agricultural Professionals' Attitudes Towards Organic Agriculture and Biotechnology

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Key Words: Organic agriculture, biotechnology, knowledge, attitudes, agricultural professionals.

Abstract

Organic agriculture and biotechnology are two key innovations that are considered to have beneficial impacts on the future sustainability of agriculture. Although there have been a number of consumer and farmer studies looking at what factors drive acceptance of organics and biotechnology, no studies have considered the factors that influence attitudes of agricultural professionals. Given the key role that agricultural professionals (extension officers, scientists, academics and researchers) play in influencing farmer adoption of agricultural innovations and conducting research, their views on individual innovations may be critical for overall adoption. Traditionally, agricultural professionals have been pessimistic about the future and viability of organic agriculture; while on the other hand indicate strong support for agricultural biotechnology. This study reports the results of a telephone survey conducted in mid 2004, with 185 agricultural professionals surveyed for their views towards organic agriculture and biotechnology. A particular aim was to study how increased knowledge and experience influenced attitudes towards the two innovations. The influence of knowledge on attitudes was considered to be important as the scientific establishment and government often advocate the need for increased public education on biotechnology to improve acceptance. Using an ordered probit regression framework, some of the significant key influences on attitudes towards the two innovations were: knowledge; experience; education; informational effects; attitudes on agricultural sustainability and research issues; and occupational effects. The study finds support for the hypothesis that professionals with increased organic knowledge and experience are more likely to think favourably about organic agriculture, but did not find support for the hypothesis that professionals with increased biotechnology knowledge are more likely to have favourable biotechnology views.

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I would like to thank Professor David Round, Dr Henning Bjornlund, Dr John Wilson, Jeremy Tustin, Dr Els Wynen and Brita Pekarksy for their valuable comments and advice. All errors are of course my responsibility.

1. Introduction

Many writers argue that conventional agriculture is not sustainable and that radical changes will be needed. Although the extent of the necessary changes may be questioned, there is a general consensus about society's desire to internalize some of the externalities of agriculture. Different parties suggest that there are two silver bullets that may provide solutions to the current problems in conventional agriculture: organic agriculture (OA) and biotechnology. Studies show consumers tend to be supportive of organic agriculture but not as supportive of biotechnology. (see Section 3 for further detail). On the other hand, the scientific community generally rejects OA as a high cost and unproductive system, while readily accepting biotechnology as having great future potential. Proponents of organics argue that it has not been given enough research consideration or been fairly considered, while opponents of biotechnology argue that its costs and risks have not been evaluated sufficiently. Given the role that agricultural professionals (namely extension officers, scientists, researchers and academics) play in affecting farmers' adoption of innovations, the purpose of this paper is to identify the key factors that influence attitudes of professionals towards organics and biotechnology. In particular, the aim is to identify the role that increased knowledge and experience in each innovation plays in influencing attitudes.

The goal of OA is to give priority to long-term ecological health, such as biodiversity and soil quality, rather than short-term productivity gains. A question many scholars ask is whether OA is a pre-modern technology or a technology for today's world. Proponents argue that it is both, being an innovation that opposes some forms of modernity, with visions of returning farming to certain pre-modern structures, as well as an innovation that provides solutions to current agricultural problems (ie Pretty 1995). Although authors such as Macilwain and Gewin (2004), Mäder *et al* (2002), Stolze *et al* (2000) and O'Riordan and Cobb (2001) have detailed scientific evidence on the environmental, economic and health benefits of organics, many professionals still question OA's financial viability, environmental credentials and overall efficiency and productivity, and reject it as an alternative farming system (ie Avery 1995).

Increasingly, writers are referring to OA as a "new paradigm" in agriculture (Dimara *et al* 2003, Abaidoo & Dickinson 2002, Wynen 1996, Beus & Dunlap 1990, Dahlberg 1986) challenging the status quo of conventional agriculture.[1] The share of all agricultural land under OA has been

[1] Conventional agriculture is defined here as standard practice utilized by the majority of Australian farmers. The term 'paradigm' derives from Kuhn (1970) and is often used to mean a way of

growing steadily in Australia since the early 90s, from 0.8% in 1990 to 2.5% in 2004 (Willer & Yussefi 2005, Halpin 2005). On the other hand, OA research funds have remained small, with only $401,000 federal funds committed to relevant OA research in 2000-2001 (Wynen 2003).[2]

Biotechnology, in particular genetic modification (GM) techniques, is also not a new concept. Life forms and processes have been modified for thousands of years, using methods such as selective cross-breeding and hybridisation techniques. Genetic engineering (GE) (also known as recombinant-DNA technology) is the modern innovative form of biotechnology, and is what is referred to in this study or whenever the term 'biotechnology' is used.

Many believe that biotechnology will secure growing world food needs as well as deliver a huge range of environmental, health and economic advantages. Opponents counter this and argue that it may have disastrous environmental and health consequences. While these opposing arguments are not explored in depth in this paper, either way biotechnology certainly does represent one of the most important (and controversial) innovations that have occurred in agriculture over the past four decades and adoption of GE crops is growing in Australia. Crops grown commercially in Australia include cotton and carnations, and as at 2001 64% of cotton crops were genetically engineered (Anderson and Jackson 2005). The Federal government believes biotechnology methods have great future potential, and has committed at least $A247 million dollars for its development (Owen *et al* 2001). State governments have also committed considerable funds to biotechnology, with Victoria and Queensland pledging a combined $600 million (Smith 2002).

2. Research Issue

The current conflicts in agriculture between OA and conventional agriculture; between GE and conventional agriculture; and between GE and OA exists at two broad levels, namely the societal and scientific. More specifically, acceptance of an agricultural innovation can occur at different levels, namely research, extension, farmer and community. The premise of this paper is that it is impossible to separate out agricultural practices from the beliefs and values that underlie them.

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looking at things: a set of shared assumptions, beliefs, dogmas, conventions, and theories and is closely linked to 'normal science'.

[2] No historical series of OA research funds exist, although it is likely to have been even less in previous years. Wynen (2003) estimates that the research funding for OA was 40% less than the amount it should been, given organic farming levies and Commonwealth funding. Over the past five decades, private OA farm research in Australia has probably made up at least 90% of all OA research.

The development and acceptance of any innovation is not a purely rational process, but one that involves conflicting beliefs, values, perceptions and social interaction.

So, why do farmers choose to adopt new innovations? Farmers' adoption rates are influenced by: (a) subjective perceptions about profitability and risk; (b) uncertainty and certainty about adoption; (c) the amount of information that needs to be acquired; and (d) attitude to risk and uncertainty.[3] The information available (and the costs of acquisition) is a critical factor in influencing subjective farmer perceptions but, given the difficulty in addressing this issue, it has often been ignored in the innovation adoption literature. Information is provided through sources and channels. Sources (such as extension officers, scientists, academics, private consultants and other farmers) provide the content or expertise of interest to farmers while channels are the methods or vehicles by which information is transferred (such as magazines, radio and internet).

Studies such as Fuglie and Kascak (2001), Marsh *et al* (2000), Kromm and White (1991), Van den Ban and Hawkins (1988) and Feder and Slade (1984) have illustrated quantitatively the positive role that extension officers play in diffusing agricultural innovations. Agricultural research also plays a critical role in creating and further developing new innovations for farmer adoption. As Fisher and Arnold (1996) p.1074 argue, farmers might see innovations only through 'windows' that provide limited vision. Such vision may be affected by the source of information used, and hence influenced by the perceptions of the source themselves. However, the more widely an innovation is adopted, the more effective available information becomes and the less likely that misconception exists. Given that OA and GE products are only beginning to be adopted, it is likely that misconception exists.

Organic farmers have often complained about agricultural professionals' negative attitude about, and lack of knowledge of, OA. They believe professionals actively discourage other farmers from adopting OA practices. For instance, a survey of around 1,200 US organic farmers in 1998 found that the greatest restraint to OA conversion was "uncooperative or uninformed extension" officers. The limited research that has been done into the state of knowledge and attitudes on OA held by agricultural professionals provides some support for these claims (Morgan & Murdoch 2000, Harp & Sachs 1992, Wynen 1988, Busch & Lacy 1983).
In contrast, professionals' attitudes about GE are generally positive. Australian and international surveys of agricultural professionals show that most strongly endorse GE and believe that it will

[3] See Rogers (1995) and Pannell (1999) for further detail on agricultural innovation adoption.

contribute to sustainable agriculture (McNeil & Williams 2002, Aerni 2002, Lawrence *et al* 2001, Foster & Ghonim 1995, Lawrence & Norton 1994). However, professionals have raised concerns about the uncertainty of GE and the involvement of private industry when it funds university or government research (Cronin & Jackson 2004, Lawrence & Norton 1994).

Considerable research has looked at consumers' views and attitudes towards OA and GE (Lyons *et al* 2004, Hossain & Onyango 2004, James & Burton 2003, Burton *et al* 2001). Consumers tend to have more positive attitudes about OA than GE. Proponents of biotechnology argue that the public does not understand it and that their reluctance to accept GE therefore stems from ignorance and not wisdom (Anderson & Jackson 2005, Cronin & Jackson 2004, Marris *et al* 2001, Norton 1998). This has been referred to as the deficit model of risk communication, and is an argument that is often repeated. A greater flow of information from the scientific elite to the public is therefore meant to correct public opinion (Frewer *et al* 2003) and make consumers think more like scientists. Critics of GE agree that the public does not have enough knowledge about GE, but conversely believe that increased knowledge will lead to decreased acceptance.

At the same time, critics of OA argue that the public is too willing to support OA and if they were more scientifically aware they would not see any benefits in the innovation. On the other hand, proponents of OA believe that the public is unaware of all of the benefits of OA and if they were, demand for organic products would be higher.

Studies have sought to explore how knowledge of GE affects consumers' views (see Appendix One for an overview). A number of these have found that consumers who have the highest perceived understanding of biotechnology (rating their knowledge themselves), do tend to be more positive towards GE food (Koivisto *et al* 2003, Bukenya & Wright 2003, Li *et al* 2002, McGarry Wolf and Domegan 2002, Baker & Burnham 2001 and Boccaletti & Moro 2000). However, there is a key difference between 'perceived' and 'actual' knowledge. Authors such as Hossain and Onyango (2004), Koivisto *et al* (2003) and Costa and Mossialos (2003) found that when they assessed actual knowledge of GE (using test GE questions), knowledge was no longer a factor in influencing views.[4] Marris *et al (*2001) also found that the hypothesis, held commonly by policy makers, that the public is ignorant and ill informed is a myth.

[4] Chern & Rickertsen (2003) have been the only study known to show a statistically significant result for positive influences of actual GE knowledge on attitudes. However, their results are questionable as the actual GE knowledge was based on one question only. Their second actual knowledge variable was not significant, and if they had transformed their knowledge variables to

The idea that increasing scientific information from an existing basis will change consumers' views is also not supported by the available empirical evidence. Surveys of 1,400 European consumers by Frewer *et al* (2003) found that providing increased information did not increase acceptance of GE foods. In fact, the reverse was found to be true, in the sense that increased information activated and reinforced previously held opinions. The channel by which information about GE products was provided was not important, but information source characteristics did influence consumer choices. In particular, consumers were more likely to choose GE products if they perceived the source providing information to be honest. Similarly, Williams and Hammitt (2001) found that consumers' level of trust in government agencies and confidence in the safety of the food supply is a significant predictor of food safety risk perceptions.

There have been no studies identifying the link between knowledge and attitudes of agricultural professionals towards OA or GE. This paper attempts to identify that relationship. If professionals look past the dogma and stigma attached to OA and study it in more depth and detail, does that mean, as some alternative farmers suggest, they will be more likely to see its net benefits? Or, will this increased OA knowledge and experience confirm common beliefs about its impracticality and low profitability? Alternatively, will increased knowledge and understanding of GE lead to an affirmation of the common scientific beliefs about its positive net benefits? Do other factors, such as socioeconomic, information sources and occupational factors, influence GE attitudes? In any event, the role that professional knowledge plays in influencing attitudes does not conclusively prove the net benefit of either innovation.

3. Survey Design and Variable Definition

A survey was designed to elucidate agricultural professionals' views and knowledge of OA and GE. For the purposes of this survey, an agricultural professional was defined as either providing agricultural advice to farmers; conducing agricultural specific farm research on agriculture; or teaching agricultural courses at university. The sample was limited to public bodies as the concern was identifying views towards sustainable agricultural issues. Public bodies are more engaged in such activities than private bodies (Marsh and Pannell 2000).[5] A telephone survey

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one variable (as other studies do), it is likely the knowledge variable would have been insignificant.

[5] It is expected that attitudes by private agricultural professionals would probably closely mirror public attitudes. The difficulty of obtaining full personnel lists and details of all private agricultural bodies precluded their inclusion in the survey sample.

method was chosen to: increase the response rate and reduce non-response bias; allow for open-ended questions to be asked; provide additional qualitative comment that would not necessarily have been written down by the respondent; and ensure that all questions were answered. The survey was trialed and piloted prior to commencement in May 2004 and a few questions were eliminated to reduce the length of the survey.[6]

The sample frame for the survey consisted a random group and a targeted group. The random group of agricultural professionals was limited to State and Commonwealth bodies based in South Australia. Respondents were randomly selected from within each body and telephoned, with 119 professionals surveyed.[7]

To supplement the random group surveys, a targeted group of professionals who have actual experience with OA across Australia were specifically sought for additional telephone interviews (66 surveys were conducted). The purpose of this supplementation was to obtain enough records of professionals with OA research/extension experience to be able to compare their attitudes and knowledge with those who do not have such experience (as only a small percentage of professionals do have OA experience).[8] A total of 185 interviews were conducted with professionals around Australia, with an overall response rate of 96%.[9] In general, respondents were very responsive and did not refuse to answer any questions. Demographic characteristics of each group were similar in terms of their age, years in their profession area, area of agriculture and gender. The high response rate and the random sampling of agricultural professionals

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6 Some of the questions that were disregarded included an evaluation of the actual knowledge held by professionals on OA and GE. These questions took up too much respondent time, and hence were substituted for self-perception questions on knowledge instead. In the design stage, the survey was trialed and evaluated by a number of scientists and academics, and it was then piloted on a small sample of randomly selected agricultural professionals.

7 This sample consisted of Rural Solutions SA extension officers, SARDI agricultural researchers, University of Adelaide agricultural academics/researchers, CSIRO Land & Water and CSIRO Plant Industry scientists/researchers and PIRSA agricultural officers. The survey generally took 20 to 25 minutes, with some taking up to 55 minutes. Respondents whom wanted to talk for a long time tended to be those that held very negative or very positive views towards GE and/or OA.

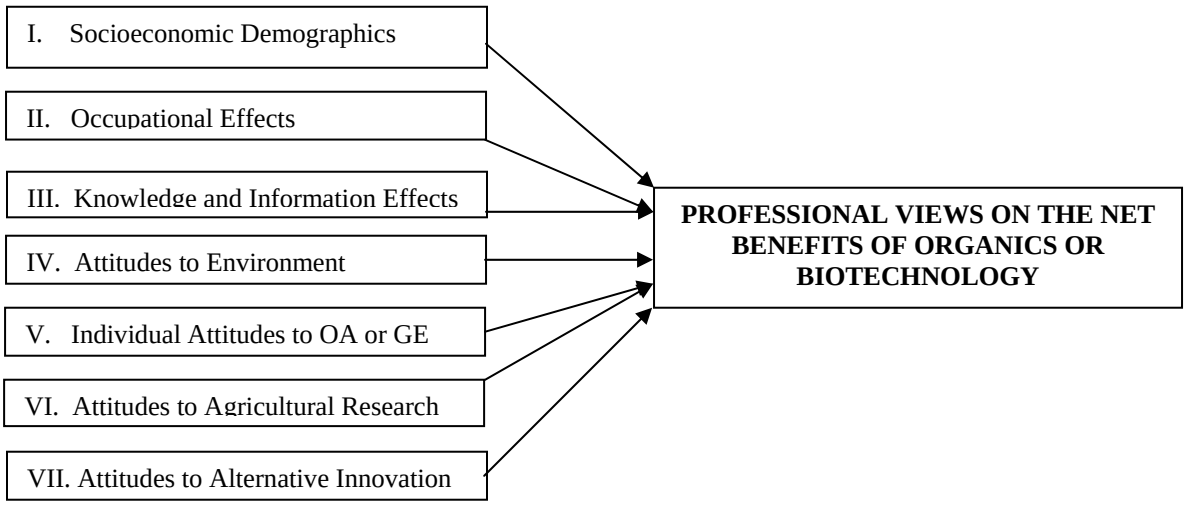
8 A targeted database of over 100 academics, scientists, extension officers and policy makers from 16 Australian organisations was created. Respondents were randomly selected within this targeted database, and were phoned if permission from the head of the organization had been received for ethics clearance purposes. If not, individuals were passed over if selected. The sample sizes for the random and targeted group were both statistically significant at a 7% precision level and a 95% confidence level.

9 The response rates of each population were not statistically different from each other, though the targeted population was slightly higher than the random population (97% vs 96%).

strongly suggest that the surveys represent a statistically significant sample of professionals' opinions on GE and OA.

The purpose of this study was to identify what factors influence overall professionals' attitudes towards the two innovations (our dependent variables are a measure of professionals' perceptions of net benefits of each innovation). During the interview, respondents were asked to discuss the major benefits or costs of each innovation, and then asked whether they thought the innovation's benefits outweighed its costs or risks (answering yes, no or unsure). Using a wide range of literature, such as environmental economics; psychological; sociological; and innovation adoption models, seven groups of explanatory variables were included in an empirical model of professionals' attitudes. Figure One illustrates these seven groups, with discussion of each group following, while Appendix Two contains details of survey questions and variable coding.

Figure One: Influences on Agricultural Professionals OA or GE Views



Socioeconomic Demographics

A range of studies has found that some socioeconomic variables (such as age, gender, income, ethnicity and education) influence consumer attitudes, although these results have been mixed. The most consistent result has been the influence of gender; that is, females tend to be less willing to consume GE products than males, while being more willing to pay for OA products. Age has been positively correlated with views on GE products in some studies, and negatively correlated in others. Age is expected to have a negative influence on OA and GE professional views, as the older the professional is, they more likely they have entrenched views against new innovations.

Income and education have been found to influence GE attitudes, both negatively and positively. Income and education have generally been positive influences in OA consumption. No expectation of influence for agricultural professionals is hypothesized. In the range of OA and GE consumer studies considered, race has never been statistically significant, but it was a positive key influence on pesticide food safety attitudes (Baker & Burnham 2001).

Other socioeconomic variables that were included in the professional attitudinal models were working age (years spent working in a professional area) and farm background. It was hypothesized that working age and having a farm background would be inversely related to acceptance of either GE or OA, as the longer a professional works in an area the less likely they are to accept new innovations. Coming from a farming background was expected to have a negative effect on views towards OA, as it is an innovation that is generally taken up by people who are new to agriculture.

Occupational Influences

No existing consumer studies have considered the influence of occupational factors on attitudes. A variable for leadership (whether the professional was a professor, manager or leader of a program) was entered as a dummy variable. It is hypothesized that leadership will have a positive influence within the OA model as peer influences are expected to be minimized for leaders. If leaders are indeed influenced strongly by their peers, then leadership will have a negative influence in the OA model and a positive influence in the GE model.

A variable for being a scientist was also included.[10] Given the current stance of the scientific community, it was expected that this variable would be positively related with views of GE, and negatively related with OA views. Variables for the type of area worked within agriculture were also created. It was hypothesised that if a professional worked in more production orientated areas they were more likely to support GE and dismiss OA. The final occupational influence was a variable for professionals engaged in extension work. It was hypothesized that this variable would be similar to having a rural background: the more contact with farmers in general, the less likely professionals would feel positive towards either innovation.

[10] Care must be cautioned in such an interpretation however as a professional was only classified as a scientist if that was in his/her job title or main occupation. For example, many academics would consider themselves scientists but if they were engaged in teaching they were classified as academics within the database. Such a variable is simply one of job title only.

Knowledge and Informational Effects

Although knowledge has not been as widely studied as socioeconomic effects, a number of studies have found positive relationships between self-perception of knowledge and GE attitudes but no relationship between actual knowledge and GE attitudes. Here it is hypothesized that knowledge of OA or GE will be correlated positively with acceptance of each innovation.

To test the role of OA experience, a variable for whether the professional was targeted or not was included. It was expected that the more experience professionals have with OA, the more likely it is that they will feel positive towards it.

A count of for the number of major costs of each innovation that the respondent identified was entered. It is expected that the higher the number, the more negative the attitude and vice versa for the number of major benefits identified.

Dummy variables for the first named main information source used for each innovation were created (namely, media, scientific information[11], farmers and other). It was hypothesized that those who relied on the media for GE or OA information would tend to feel more negatively towards them, while those that relied on scientific information would be more positive. Those that rely on organic farmers as their main source of information on OA are expected to have a positive view on organics.

A variable for the influence on how GE and OA views changed over the past five years was included (if they had become more favourable, stayed the same or more negative). Given the growth in information available, it was expected that increasing contact with such information would have positively influenced the views towards either innovation.

Attitudes to Environment and Individual Aspects of the Technology

Variables such as professionals' views on the environmental sustainability of conventional agriculture, yield effects of the innovation, product quality impacts, innovativeness of the innovation, profitability impacts and environmental friendliness were included in the model. It was hypothesised that those who believed that conventional agriculture was unsustainable were more likely to think favorably of OA. No hypothesis is made for GE. Similarly, it was expected

[11] Scientific information included sources such as conferences, journals, academics and scientists.

that the more professionals believe in a particular environmental, health, economic or innovative credential of either OA or GE, the more positive their views would be towards either innovation.

Attitudes to Agricultural Research Issues

Scalar variables for the attitude towards intellectual property rights and the influence of private research funds in agricultural research were included. It was expected that the stronger professional disagreement with the increased use of intellectual property and patenting, the more negative (positive) their views towards GE (OA) because of the prevalence of patenting issues in GE. Similarly, the more professionals agreed with the statement that private funds did not influence research outcomes, the more likely they would be positive towards GE. No expectation was hypothesized for OA.

Attitudes to Alternative Innovation

Finally, the dependent variable for the alternative innovation was entered as an independent variable into each model. Some studies have found that the more consumers view OA as important, the less accepting they are of GE, and vice versa (ie Burton *et al* 2001). It was expected that agricultural professionals would react the same way.

4. Analytical Methodology and Model Specification

An ordered probit model was used to evaluate factors that influenced overall views towards each innovation. A probit model is appropriate when the dependent variable to be evaluated is dichotomous.[12] When the dependent variable takes more than two values and these values have a natural ordering, the use of an ordered probit is indicated (it is estimated using the maximum likelihood method). Most other studies of consumer attitudes towards OA or GE have used probit or logit models, though only a few have utilized the ordered probit specification. The dependent variable used in this study was the respondents' answers to the question on if the benefits of each innovation outweighed their costs or risks. Professionals either responded "no," "unsure," or "yes".[13] The answer "no" indicated that the professional believed there was no net social benefits associated with OA or GE, unsure indicated uncertainty about the net benefits due to unknown

[12] The only difference between probit and logit is that the logit model assumes a logistic distribution for the random error. The ordered probit model is estimated using the econometric software Stata/SE 8.0.

[13] Generally, respondents who answered yes or no responded to the question within seconds. Professionals who took their time answering were those who had not yet made up their minds about the net overall benefits of the innovation and believed it was too hard to make the call at present.

factors, and “yes” indicated that they believed there was net social benefits associated with either OA or GE. Therefore as it stands, the dependent variable represents a psuedo benefit cost ratio. It attempts to assess all the aspects of each innovation and determine whether overall, the innovation is considered worthwhile. The answers were recoded as zero, one and two respectively. (It does not matter which values the variable actually takes in an ordered probit, provided that 2>1>0 in terms of the latent dependent variable).

The discrete dependent variable Y is a rough categorization of a continuous, but unobserved, variable Y* (attitudes to GE or OA). If Y* could be directly observed then standard regression methods would be used (such as assuming that that Y* is a linear function of some independent variables), for example:

$$Y^* = ß1X1i + \ldots\ldots. ßjXji + ui$$

However, Y is used as a proxy for Y*. The relationship between the categories of Y and the values of Y* is:

$$Y = 0 \quad \text{if} \quad 0 < Y^* \leq u1$$
$$Y = 1 \quad \text{if} \quad u1 < Y^* \leq u2$$
$$Y = 2 \quad \text{if} \quad u2 < Y^* \leq u3$$

The u’s are unknown ordered ‘threshold’ parameters to be estimated with the unknown coefficients of the variables. The respondents’ views on the net benefit of each innovation depend on some measurable factors and some unobservable factors. A constant term is not included as a shift in the intercept cannot be distinguished from a shift in the thresholds.

Marginal effects can be interpreted in the following way: a positive coefficient estimate is interpreted as increasing the probability of falling into the highest category (saying yes to positive net benefits from an innovation) for any given dependent variable of Y, and vice versa for a negative coefficient estimate. In general, the marginal effect of a change in the dependent variable on the other categories is ambiguous (Greene 2003). As such, the results must be interpreted with care.

5. Empirical Results

The ordered probit analysis sheds light on the factors that influence professional views of the two innovations. Table One illustrates the results for the OA model[14] and its marginal effects. The larger the marginal effect, the more influence the variable had on attitudes. Although most variables have the expected sign, some do not. The OA model found that the following variables had a positive influence (at 0.1 level of significance or better) on OA attitudes:

- Years of tertiary education;
- Having a non-European background;
- OA knowledge;
- Being part of the targeted sample;
- Identifying major benefits associated with OA;
- Belief in conventional agriculture's lack of environmental sustainability;
- Belief in the environmental friendliness of OA;
- Belief in the financial profitability of OA; and
- Views of OA had become more favourable over the past five years.

The following had a negative influence (at 0.1 level of significance or better) on OA attitudes:

- Salary;
- Having a job title of extension officer or scientist;
- Working at CSIRO;
- Using organic farms as a first main source of information on OA;
- Identifying major costs associated with OA; and
- Belief in the high yield loss associated with OA.

The psuedo R-square statistic is a measure of how well a probit model fits with the observed data. It is analogous to the R^2 statistic common in OLS regresson. The value is 0.48. This prediction result compares very favourably with other consumer studies on attitudes (as described in Appendix One). This goodness of fit value only deserves limited attention however because it maximizes the joint density of the observed dependent variable rather than maximizing a criterion based on prediction of Y, as happens with ordinary least square regression analysis. The log

[14] Note, due to restrictions on the number of variables recommended for a probit model because of sample sizes, not all dummy variables (ie for occupation or informational effects) were included in the final models. In prior tests, none of these dummies were significant and did not affect overall results.

likelihood value of –100.23 was also highly significant ($p < 0.000$). Multicollinearity is thought not to be an issue as pairwise correlation coefficients between all variables were 0.5 and below.

The GE model (illustrated in Table 2) found that the following variables had a statistically significant positive influence (at 0.1 level or better) on GE attitudes:

- Being older;
- Having a non-European background;
- Having a job title of scientist;
- Identifying major benefits associated with GE;
- GE research relevance;
- Using the media as a first main source of information on GE;
- Belief in the environmental friendliness of GE;
- Belief in the product quality of GE;
- Views of GE had become more favourable over the past five years; and
- Belief that intellectual property rights and patenting activity is a good thing for agriculture.

The following had a negative influence (at 0.1 level of significance or better) on GE attitudes:

- Years of tertiary education;
- GE knowledge;
- Identifying major costs associated with GE;
- Belief in the need for long-term GE research; and
- Belief that private research funds can influence research outcomes.

The psuedo R-square value in the GE model is 0.40, slightly less than the OA model. The log likelihood value of –120.77 was also highly significant ($p < 0.000$). Again, multicollinearity is thought not to be an issue.

Table One. Determinants of Organic Agriculture Attitudes (ordered probit)
(dependent variable: Views on OA)

	Model	Marginal Effects (Y = 0)	Marginal Effects (Y = 1)	Marginal Effects (Y = 2)
Socioeconomic effects				
Age	0.009	-0.001	-0.003	0.004
Working Age	-0.024	0.003	0.007	-0.010
Ethnicity (non-European)	1.262**	-0.065***	-0.345***	0.410***
Gender	0.046	-0.001	-0.012	0.018
Farm Background	-0.135	0.017	0.037	-0.054
Tertiary Education Years	0.134**	-0.016**	-0.037**	0.053**
Salary	-0.000***	0.000**	0.000***	-0.000***
Occupational effects				
Scientist	-0.465*	0.067	0.115**	-0.182*
Leader	0.610	-0.055	-0.101	0.236
Extension role	-0.712**	0.099*	0.179**	-0.277**
Natural resource focus	0.087	-0.010	-0.024	0.034
CSIRO	-1.144**	0.265	0.121*	-0.386***
Knowledge/Information effects				
Target	0.742**	-0.079**	-0.209**	0.288**
OA knowledge	0.296*	-0.036*	-0.082*	0.188*
OA research relevance	0.007	-0.001	-0.002	0.003
Media main source information for OA	-0.259	0.035	0.068	-0.103
Scientific info main source for OA	-.0416	0.055	0.109	-0.164
OA farms main source of information	-0.889***	0.127**	0.215***	-0.342***
Number of major OA benefits cited	0.427***	-0.052***	0.07***	0.170***
Number of major OA costs cited	-0.253***	0.030***	-0.118***	-0.101***
Attitudes to Environment				
Views on CA's sustainability	0.598**	-0.073**	-0.166**	0.239**
Attitudes to OA				
Views on OA profitability	-0.155*	0.019	0.043*	-0.062*
Views on OA environmental sustainability	0.476***	-0.058***	-0.132***	0.190***
Views on OA product quality	0.133	-0.016	-0.037	0.053
Views on OA innovativeness	-0.386***	0.047***	0.107***	-0.154***
Views on OA yields	-0.569*	0.090	0.130**	-0.220*
Changes in Views over past 5 Years	0.662***	0.047***	-0.107***	0.264***
Attitudes to Agricultural Research Issues				
Views on agric. intellectual property rights and patents	-0.111	0.014	0.031	-0.040
Attitudes to GE				
GE benefit-cost ratio	0.062	-0.008	-0.017	0.025
Cut1	0.165			
Cut2	1.720			
LL	-100.23			
P>chisq (Wald)	0.000			
Pseudo R^2	0.480			
n	185	185	185	185

1. * significant at p<0.1
2. ** significant at p<0.05
3. *** significant at p<0.001
4. All regressions obtained using Huber-White robust standard errors
5. Discrete change of dummy variable from 0 to 1 in marginal effects column

Table Two. Determinants of Biotechnology Attitudes (ordered probit)
(dependent variable: Views on GE)

	Model	Marginal Effects (Y = 0)	Marginal Effects (Y = 1)	Marginal Effects (Y = 2)
Socio-economic effects				
Age	0.022*	-0.005	-0.002	0.008
Working Age	-0.000	0.000	0.000	-0.000
Ethnicity	1.742***	-0.173***	-0.428***	0.600***
Gender	0.233	-0.060	-0.019	0.078
Farm Background	-0.271	0.067	0.025	-0.092
Tertiary Education Years	-0.121*	0.029*	0.012	-0.041*
Salary	-0.000	0.000	0.000	-0.000
Occupational effects				
Scientist	0.535*	-0.115**	-0.079	0.193*
Leader	-0.088	0.022	0.101	-0.030
Extension role	0.073	-0.018	-0.008	0.025
Natural resource focus	-0.070	0.017	0.007	-0.023
CSIRO	0.470	-0.092	-0.083	0.174
Knowledge/Informational effects				
GE knowledge	-0.273*	0.066*	0.027	-0.094*
GE research relevance	0.014**	-0.003**	-0.001*	0.005**
Media main source information for BT	0.470*	-0.103*	-0.065	0.168*
Scientific info main source for BT	0.193	-0.050	-0.014	0.064
Number of major GE benefits cited	0.318***	-0.077***	-0.032*	0.109***
Number of major GE costs cited	-0.182***	0.044***	-0.018*	-0.063***
Attitudes to Environment				
Views on CA's sustainability	-0.131	0.032	0.013	-0.045
Attitudes to Biotechnology				
Views on GE profitability	0.117	-0.029	-0.012	0.040
Views on GE environmental sustainability	0.239**	-0.058***	-0.024*	0.082***
Views on GE product quality	0.171*	-0.042*	-0.017	0.059*
Views on GE yields	-0.043	0.011	0.004	-0.015
Views on GE long-term research needs	-0.721***	0.175***	0.072*	-0.247***
Changes in Views over past 5 Years	0.757***	-0.047***	-0.076**	0.260***
Attitudes to Agricultural Research Issues				
Views on agric. intellectual property rights and patents	0.144*	-0.035	-0.014	0.050*
Views on influence of private funds on research	-0.214**	0.052**	0.021	-0.074**
Attitudes to Organics				
OA benefit-cost ratio	0.195	-0.048	-0.020	0.025
Cut1	-1.398			
Cut2	0.145			
LL	-120.77			
P>chisq (Wald)	0.000			
Pseudo R^2	0.404			
n	185	185	185	185

1. * significant at p<0.1
2. ** significant at p<0.05
3. *** significant at p<0.001
4. All regressions obtained using Huber-White robust standard errors
5. Discrete change of dummy variable from 0 to 1 in marginal effects columns.

6. Discussion

The knowledge variable plays a very different role in the two models, although it is only weakly significant in both (at a level of 0.1). Increased OA knowledge plays a positive role in influencing OA views, while increased GE knowledge plays a negative role in influencing GE views.[15] This finding is contrary to perceptions held commonly by GE proponents and OA critics, who advocate that increased education will increase consumers' knowledge and positively change their GE views. The finding supports the hypothesis that professionals that have increased OA knowledge and experience are more likely to think favourably of OA. It does not support the hypothesis that professionals with increased GE knowledge are more likely to think favourably towards the innovation.

It will be recalled from previous discussion that some studies have shown a positive link between 'self-perception' knowledge and acceptance. Consumers who believed that they had a strong knowledge of GE are more likely to accept/consumer GE products. Intuitively, this makes sense, as people are highly unlikely to admit that they have no real GE knowledge but are willing to consume such products. Consumers may only do so because they trust government and regulators with their food supply. Other studies show there is no statistically significant link between actual knowledge and acceptance.

This study used professionals' views of their own knowledge as a variable. It was expected that the professionals were more able to correctly judge their knowledge of GE issues than the general public, as generally the issue is much more familiar and prevalent to them.[16] The question therefore arises of why does having an increased knowledge and understanding of GE lead professionals to having more unfavourable GE views? Given the overall acceptance and support of GE by the scientific community, there is the possibility that if an agricultural professional does

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[15] One potential criticism that some may think of the results is that the targeted sample results bias the random sample results. That is, because one would expect that the targeted group have a higher knowledge of OA and more positive views, they therefore influence the overall regressions. However, the hypothesis was to test if increased knowledge did lead to more positive views, and therefore the outcome was not decided a prior. But, to doublecheck the overall results, the regressions were rerun using the random sample data only, and the results were very similar (indeed, the statistical significance of the knowledge variables were increased).

[16] Although it is believed that self-perception of GE knowledge was judged correctly by professionals, it was likely, as mentioned previously, that respondents overestimated their OA knowledge. The test question on OA knowledge (ie identification of OA certification groups) represented a much better fit statistically within the OA model (and had a larger marginal effect). As it was desirable to have the same type of scalar variable measuring knowledge in both models, the measures of self-perception were used in both models.

feel concern about certain aspects of the innovation, they may be more likely to educate themselves about it. Such professionals may feel the need to have increased knowledge about GE in order to be able to effectively argue against it or for the need for additional regulations and/or research.[17] Or, perhaps the more one learns about GE the more uncertain one becomes about its future impacts. Also, professionals who rate their knowledge low may not feel a need to increase their knowledge, as they trust the regulation and science process.

The education variable plays a similar role to the knowledge variable in the two models. Professionals with increased tertiary education are more likely to feel positively about OA and negative about GE. It may be that increased tertiary education plays a role in encouraging professionals to critically assess current scientific thinking, as well as encouraging an inquisitive and skeptical mind. By contrast, professionals that are more accepting of GE may place less importance on self-discovery.

Other variables that highlight the possibility that professionals who are negative towards GE are more skeptical in general are professional attitudes to intellectual property rights, patenting and the influence of private research funds on agricultural research. Professionals who have concerns about these factors are much more likely to be negative towards GE, indicating that they are less likely to accept the scientific consensus on GE as they may believe that it is possible that scientific outcomes may be misrepresented or selectively portrayed through funding outcomes. Professionals who do not believe in this possibility are much more likely to be supportive of GE. On the other hand, the above factors are not statistically significant in the OA model. Possible explanations include the public good aspect of OA research (which makes it difficult to patent) and the fact that public OA research is practically non-existent in Australia (Wynen 2003), making private funding and patenting issues irrelevant as influences on attitudes.

In terms of experience, professionals that were in the targeted group were much more likely to have favourable views about OA. In the GE model, the more that professionals were engaged in

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13 The other issue to be aware of is that knowledge may be endogenous. That is, having a positive attitude towards OA may lead to a desire to gain increased knowledge about it, and as such, the results may be of dubious value. It is believed that such a problem does not exist however, as a regression was run assessing factors of influence on each innovations' knowledge. Overall views on net benefits were not a statistically significant factor in influencing knowledge. Some of the significant variables influencing GE knowledge included education (positive); research relevance (positive); extension occupation (negative); salary (positive); reliance on the media for information (negative); reliance on scientific literature for information (positive).

GE research (in terms of the percentage of their research work relevant to GE), the more likely that they had favourable views of GE.

Information sources also play a prominent role in influencing attitudes. If professionals cited organic farmers as their first main source of information on OA, this had a negative relationship on attitudes in the OA model. Most professionals have had discussions with an organic farmer or visited an OA farm at some stage. Those professionals who have had very little contact with, or knowledge of, any other sources of information on OA presumably use those discussions as their main source. It highlights that perhaps OA farmers are not able to explain their farming methods well enough to convince agricultural professionals of any merit in OA, and professionals may be deterred by what they see as zealous based farming or unscientific reasoning. Contact with OA farmers lead, in some cases, to a reinforcement of negative attitudes. Professionals who are more positive towards OA are much more likely to name a number of sources as important, and do not rely solely on OA farmers (but they are still indicated as an important source).

In the GE model, reliance on the media as the first main source of information has a positive (albeit weak statistically) relationship with attitudes. This is in stark contrast to many scientists' opinions on the media's role in misinforming the public on GE and sensationalizing its issues. Lockie (2001) argues that the media will reflect dominant discourses through which audiences interpret messages. If the media does play such a role in misinforming the public and presenting negative views of GE, one could hypothesize that a reliance on the media may lead to a negative GE attitude. In reality, studies show GE stories in the Australian media have been positive (54 to 70%), 17 to 30% neutral, and only 13 to 16% were negative (White 1998 and Biotechnology Australia 2002). This analysis mirrors other findings in the US and UK regarding positive media portrayal of biotechnology issues. In the GE model, a reliance on the media as a primary source of information does lead to a positive influence on GE attitudes, therefore confirming the hypothesis that the media may influence its audience through its information portrayal (but in an unexpected way). The type of information relied upon can therefore influence views.

As expected, perception of the environmental friendliness, product quality, innovativeness and profitability of OA and GE were significant in influencing attitudes. One interesting result was that a belief in the superiority of GE products had a positive relationship with GE attitudes, but a belief in the superiority of OA's products did not have a significantly statistical effect on OA attitudes. Conversely, consumers' main reasons for buying and supporting OA are product

quality (taste/food safety/health benefits), the environment and ethical concerns (McEachern & McClean 2002).

Factors such as environmental sustainability, innovativeness and profitability of OA were much more likely to influence agricultural professionals' OA attitudes. Professionals therefore responded as information providers to farmers, not as consumers of OA products or evaluators of the health consequences of food. Also, the more professionals believe in the environmental sustainability of current agricultural practices, the more likely they have negative OA views. Those who believe that conventional agriculture is not currently sustainable are more likely to be looking for alternative solutions, but they do not regard GE as an alternative solution. Working in a natural resource management area has no statistically significant influence in either model.

The only occupational effect that was significant in the GE model was being a scientist (positive influence). It had a negative influence in the OA model. Care must be cautioned in interpreting this result due to how being a scientist was coded (refer to footnote 10).

Other occupational variables that were statistically significant in the OA model were being involved in extension and working for CSIRO. That is, the closer professionals are to providing agricultural advice to farmers, the more likely they are negative towards OA. The CSIRO variable is potentially controversial, as one of the reasons cited for the recent failure of an organic Cooperative Research Centre bid was the lack of involvement from CSIRO partners (OFA 2005). Whether this highlights what some in the organic industry claim is the general apathy towards OA within CSIRO and its capture by biotechnology interests is debatable, as the CSIRO variable in the GE model was insignificant.

Unlike many past consumer studies, no statistically significant effects were found for gender. This may suggest an occupational effect, as agricultural professional services are traditionally male dominated, and females that work in such an area may tend to take on more male characteristics (ie Catron 1997). On the other hand, this result may be indicative of a missing variable, that is, the number of children within the household. Some studies illustrate that as a woman has children, her views on GE and environmental issues can change. Such a question was not asked, and it may have played a significant role in influencing attitudes, although the insignificance of the children and gender variables in other previous studies (illustrated in Appendix One) indicates that this was probably not a serious omission.

Another statistically insignificant effect in both models was the view agricultural professionals held towards the alternative innovation. A professional that is pro-OA is not necessarily anti-GE, or those that are pro-GE are not necessarily anti-OA. Such a result would most likely not be true for farmers, given the stance of the OA industry towards banning all GE products. This result also contradicts some studies of consumer views (ie James and Burton 2003). This surprising result may indicated that professional views about one innovation may be driven by separate attitudes and knowledge than their views about another innovation, highlighting the fact that some professionals see benefits in both innovations and believe in the possibility of simultaneous adoption, or at least, coexistence.

There are many ways that this study could be built upon. A much larger, national study of agricultural professionals may provide more statistically significant evidence on the role of knowledge and experience. It would be useful to directly compare self-perception and actual OA/GE professional knowledge, and identify what difference there is, if any, between the two. Some social research work on adoption has shown that personality traits (such as openness, agreeableness, neuroticism, conscientiousness and extraversion), values and objectives can also influence innovation adoption (ie Crase and Maybery 2002).

7. Conclusion

OA and GE represent two innovations in agriculture that are both lauded and deplored. Agricultural innovations are accepted on four broad levels: research, extension, farmer and community (and not necessarily in that order). Agricultural professionals play an important role in helping to create and develop innovations. They also inform and educate farmers (and the public) about innovations through teaching or extension work. Given the importance of their role, it is important to try and understand why most professionals are negative towards OA and positive towards GE. Using a survey of agricultural professionals in Australia, this paper has provided evidence to show that professional acceptance of agricultural innovations is not separate from the beliefs, values and environment that underlie them. Like the public, professionals do not just rely on scientific results to form decisions about new technologies.

Professionals who were older, non-European, had a job title of ‘scientist’, conducted a large amount of GE research work, used the media as a first main source of GE information, had positive views on the environmental friendliness and food quality of GE products, named a large

number of major GE benefits, and had positively changed their views in the past five years were more likely to think that GE conveyed net benefits. Professionals who were more tertiary educated, had a higher knowledge of GE issues, named a large number of major GE costs, believed there was a need for more long-term research on GE, had negative views towards the increasing role of intellectual property rights and patenting in agricultural research, and believed that private funding could influence research results were more likely to think that GE conveyed no net benefits.

Professionals who were more tertiary educated, were non-European, had a higher knowledge of OA issues, were part of the targeted (experienced OA) group, had positive views on the environmental friendliness, innovativeness and profitability of OA, named a large number of major OA benefits, believed that conventional agricultural was not environmentally sustainable, and had positively changed their views in the past five years were more likely to think that OA conveyed positive net benefits. Professionals who had a higher salary, had a job title of 'scientist', worked for CSIRO, worked as an extension officer, named a large number of major OA costs, believed that converting to OA would result in huge yield decreases, and who cited organic farmers as their first main source of information were more likely to think that OA conveyed no net benefits.

The results of this study add to the existing literature on the role that knowledge plays in influencing attitudes towards agricultural innovations. Knowledge played a positive role in influencing agricultural professionals perceptions of OA, but a negative role in influencing their GE perceptions. As such, the results provide a warning to plans to use education as a policy to increase public acceptance of GE. Increased knowledge may not lead to increased acceptance.

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Appendix One. Overview of Studies Showing Influences on Consumer Attitudes to GE and OA Products

Genetically Engineered Products												
Research Study	**Type**	**Country**	**Age**	**Gender (Female)**	**Income**	**Children**	**Ethnicity (White)**	**Educ. Level**	**Knowledge**	**Attitude to GE**	**Attitude to Environ.**	**Risk**
Kaiser *et al* (1992)	BST	US	+	0	NA	0	NA	0	NA	NA	NA	NA
Baker & Burnham (2001)	GE	US	0	0	0	0	0	0	+ (Self)	+	NA	-
Koivisto Hursti & Magnusson (2003)	GE	Sweden	-	-	NA	NA	NA	+	+ (Self) 0 (Actual)	NA	NA	-
James & Burton (2003)	GE	Aus	+	-	0	0	NA	0	NA	NA	NA	NA
Hossain & Onyango (2004)	GE	US	0	0	0	NA	0	0	0 (Actual)	-	NA	-
Donaghy *et al* (2002)	GE	Aus	-	0	0	NA	NA	NA	NA	NA	-	NA
Burton & Pearse (2003)	GE	Aus	+	0	0	NA	NA	0	NA	NA	NA	NA
Bukenya & Wright (2003)	GE	US	0	0	-	NA	0	-	+ (Self)	- (GE)	NA	0
Costa & Mossialos (2003)	GE	UK	0	-	NA	-	NA	0	0 (Actual - GE foods) + (Actual - GE Medical)	NA	NA	-
Boccaletti & Moro (2000)	GE	Italy	+	0	+	0	NA	+	+ (Self)	-	NA	NA
Li *et al* (2002)	GE	China	-	NA	0	0	NA	0	+ (Self)	+	NA	NA
Chern & Rickertsen (2003)	GE	US	-	0	0	0	NA	0	0 (Actual – one question) + (Actual – one question)	NA	NA	NA
Op cit (2003)	GE	Norway	-	-	-	0	NA	+	0 (Actual – one question)	NA	NA	NA
Lusk (2003)	GE	US	0	0	0	0	NA	0	- (Self)	NA	NA	NA
Huffman *et al* (2003)	GE	US	NA	NA	0	NA	NA	NA	- (Self)	NA	NA	NA
Tsay (2003)	GE	Taiwan	0	0	0	NA	NA	-	0 (Self Awareness)	+	NA	-
Organic Products												
Koivisto Hursti & Magnusson (2003)	OA	Sweden	0	+	NA	NA	NA	0	0 (Self) 0 (Actual)	NA	NA	0
Loureiro *et al* (2001)	OA	US	0	+	0	+	0	NA	NA	NA	NA	NA
Donaghy *et al* (2002)	OA	Aus	0	+	+	NA	NA	NA	NA	+ (OA)	+	NA
Millock *et al* (2002)	OA	Denmark	-	+	NA	0	NA	NA	NA	NA	NA	NA
Campiche *et al* (2004)	OA	US	0	0	+	0	NA	0	NA	+ (OA)	NA	NA
Jolly (1988)	OA	US	-	NA	0	NA	NA	0	NA	+ (OA)	NA	NA

Note: Results of all studies are not directly comparable due to differences in the dependent variables, differences in how the independent variables were measured, statistical methods employed, sample size and interpretation of studies results. Studies have not been screened, and results should be interpreted and used with care.
Statistically significant relationships are denoted by a plus (+) for a positive relationship, (-) for a negative relationship, and (0) for no statistically significant relationship.

Appendix Two
Explanatory Variable Table

Variable	Explanation
Age	Actual age in years
Working Age	Years spent working in current agricultural area
Ethnicity	Dummy variable, 1 = non-European, 0 = European
Gender	Dummy variable, 1 = male, 0 = female
Farm Background	Dummy variable, 1 = farm background, 0 = otherwise
Tertiary Education Years	Years of post-secondary education
Salary	Salary of professionals (midpoint of their salary band as indicated by their job classification level)
Scientist	Dummy variable, 1 = scientist, 0 = otherwise
Leader	Dummy variable, 1 = leader, 0 = otherwise
Extension role	Dummy variable, 1 = extension role, 0 = otherwise
Natural resource focus	Dummy variable, 1 = natural resource management focus, 0 = otherwise
Broadacre/Grazing focus	Dummy variable, 1 = broadacre/grazing focus, 0 = otherwise
CSIRO	Dummy variable, 1 = employed at CSIRO, 0 = otherwise
Target	Dummy variable, 1 = targeted sample, 0 = otherwise
OA/GE knowledge	Scalar variable of OA (or GE) knowledge, where 1= no knowledge and 5 = detailed and practical knowledge
OA/GE research relevance	% indicating the research relevance of OA (or GE) in the past 3 years
Media main source information for OA/GE	Dummy variable, 1 = media as main source for OA (or GE) information, 0 = otherwise
Scientific info main source for OA/GE	Dummy variable, 1 = scientific information (journals, peers, conferences etc) as first main source for OA (or GE) information, 0 = otherwise
OA farms main source information	Dummy variable, 1 = organic farms act as first main source for OA information, 0 = otherwise
Views on CA's sustainability	Scalar variable of response to the statement that "CA farming in Australia is generally not environmentally sustainable", where 1= strongly disagree and 5 = strongly agree
Views on OA profitability	Scalar variable of response to the statement that "CA is more financially profitable than OA", where 1= strongly disagree and 5 = strongly agree
Views on OA environmental sustainability	Scalar variable of response to the statement that "OA is more environmentally friendly than CA", where 1= strongly disagree and 5 = strongly agree
Views on OA product quality	Scalar variable of response to the statement that "OA produces better quality of food than CA", where 1= strongly disagree and 5 = strongly agree
Views on OA innovativeness	Scalar variable of response to the statement that "OA farming is a return to pre-1950s agriculture", where 1= strongly disagree and 5 = strongly agree
Views on OA yields	Dummy variable where 1 = belief that conversion from CA to OA results in drops of yield over 30%
No. of major OA costs cited	Number of major OA costs cited
No. of major OA benefits cited	Number of major OA benefits cited
OA benefit-cost ratio	Ordered dependent variable of response to "do you think the benefits of OA are greater than their costs/risks?", where 0 = no, 1 = unsure, 2 = yes
Views on agric. IPR and Patents	Scalar variable of response to the statement that "the increased use of intellectual property rights and patenting activity is a good thing for agricultural research", where 1= strongly disagree and 5 = strongly agree
Views on agric. private funding effects	Scalar variable of response to the statement that "private funding of agricultural research does not influence research outcomes", where 1= strongly disagree and 5 = strongly agree
Views on GE profitability	Scalar variable of response to the statement that "GE is more financially profitable than CA", where 1= strongly disagree and 5 = strongly agree
Views on GE environmental sustainability	Scalar variable of response to the statement that "GE is more environmentally friendly than CA", where 1= strongly disagree and 5 = strongly agree

Views on GE product quality	Scalar variable of response to the statement that "GE produces better quality of food than CA", where 1= strongly disagree and 5 = strongly agree
Views on GE yields	Dummy variable where 1 = belief that conversion from CA to GE results in increases of yields over 30%
Views on GE long-term research needs	Scalar variable of response to the statement that "there needs to be more research on LT consequences of GE products before further general release", where 1= strongly disagree and 5 = strongly agree
No. of major GE costs cited	Number of major GE costs cited
No. of major GE benefits cited	Number of major GE benefits cited
GE benefit-cost ratio	Ordered dependent variable of response to "do you think the benefits of GE are greater than their costs/risks?", where 0 = no, 1 = unsure, 2 = yes