Invited paper: Achieving rapid adoption: information value and the role of grower groups

Rick Llewellyn

CSIRO Sustainable Ecosystems, Urrbrae, SA 5064 Email rick.llewellyn@csiro.au

Abstract

The slow adoption rates for many agricultural practices are often a source of frustration for researchers and extension agents. This paper uses an information and learning-based approach to explain why some innovations are adopted quickly and why others, even if apparently profitable, may not be widely adopted. Recent studies of the adoption (or non-adoption) of agronomic innovations in Australia are used to demonstrate steps that can be used to identify specific factors in the adoption decision that are both influential, and can be targeted to accelerate learning of the likely value of an innovation. However, it is also recognised that adoption and the adoption decision consume two limited on-farm resources: time and the capacity to integrate new information. Readily available quality information with high reliability and relevance to the decision-maker reduces these information seeking and learning costs. The rapid rise of grower groups in the Australian research and extension network is considered in this context. Although the participative research processes at the core of grower group activity is most important, the majority of growers engage with groups through relatively traditional modes of communication. Results of a study categorising grower group research projects are presented together with a study of the perceived economic value (willingness to pay) for agronomic research information from grower group and other research sources. The high value placed on localised information is demonstrated and opportunities to achieve more rapid adoption by reducing information and learning-related costs are discussed.

Key Words

Adoption, extension, information, grower groups, economics, research

Introduction

Researchers and extension agents are often frustrated by slower than expected adoption levels for agricultural innovations. When a new technology or farming practice offers genuine benefit to growers, slow rates of adoption cause a loss of potential benefit to growers and industry, and in some cases, the public. This is a major reason why so much attention across a wide range of disciplines has been given to trying to understand what drives adoption of new technology among farmers (see Feder and Umali 1993; Pannell et al 2006; Rogers 1995; Vanclay 1992).

This paper takes an information and learning-based approach to explaining why some agronomic innovations are adopted widely and why others, even if apparently offering major benefits, are slow to be adopted. It is argued that giving adequate attention to the range of factors that can determine whether an innovation offers real or perceived relative advantage compared to the status quo can do more than just reduce frustration levels among those keen to see rapid uptake of a particular new technology. It can reveal new opportunities to target extension and research at factors in the adoption decision that can a) be influenced, and b) be influential in the adoption decision.

The primary aim of the approach used in this paper is not to explain individual adoption behaviour in all its complex psychological and sociological glory, but to identify effective strategies that can be implemented within the scope of a typical agronomy project to improve the decision-making of a substantial number of growers. As information is a major output of most research projects, and learning a major outcome, overlooking potential opportunities for these standard products of research activity can limit potential impact.

For example, it can be constructive to recognise when slow adoption of a new technology may be the result of a rational wait for more high-quality information about its value to become readily available

(Pannell 1999), rather than some intractable attitudinal or social barrier to change. Waiting for more information to reduce uncertainty (and the risk of making a costly wrong decision) can be of more economic value than early adoption; sometimes even when the grower already considers it more likely than not that the new innovation will be profitable (Dong and Saha 1998). Occasionally closer attention to economic and information-related factors in adoption decisions can reveal learning-related constraints to adoption that may have otherwise have been attributed to sociological or psychological factors deemed to be beyond the potential influence of most agronomy research projects (see Baerenklau 2005).

Information with quality characteristics that can more readily reduce uncertainty can reduce the potentially costly waiting time and/or the risk of making a costly wrong decision. Information that requires less investment to seek out, analyse and integrate into existing farm-specific knowledge reduces the overall information-seeking and learning costs associated with this adoption decision (Fischer et al 1996; Marra et al 2003; Abadi Ghadim et al 2005). Different types of information can therefore have different economic value; and a perceived value that is only sometimes made transparent e.g. through subscription fees for an information service.

The rapid rise of grower groups in the Australian R, D & E network is considered in this paper in the context of information value. Investment by the Grains Research and Development Corporation (GRDC) in grower group projects is now $6.5m p.a. (Kearns 2006). While the important role of groups in facilitating action learning, participative research, social networks, capacity building, informing researchers etc is well recognised, the relative value of the information they generate and deliver has received less attention. Beyond the participative research and capacity building activity undertaken at the core of grower groups, most engagement between growers and groups is through the simpler and less personal methods most commonly associated with traditional communication e.g. field days, seminars, newsletter, publications etc. It is this less powerful, but more common and widely distributed form of extension that is a major focus of this paper.

Results of a study showing differences in growers' willingness to pay for agronomic research information from local and non-local grower groups, and other research organisations is presented. The study demonstrates the premium growers place on information that is seen to already be adapted (relevant) to the local farming environment and therefore less demanding in terms of information processing. Looking at the relative perceived value of grower group-derived research information at distances away from the local area also offers some insight into the relevance versus rigour arguments that can arise in assessments of grower group research and extension activity (e.g. Carberry 2001).

In the next section, concepts behind the information, learning and uncertainty approach to information quality and adoption are illustrated. Case studies of the adoption (or non-adoption) of new crops, tillage systems and weed management practices are then used to demonstrate how key factors for a particular innovation can be identified and then targeted with information with the qualities that most rapidly lead to reduction in uncertainty and learning of the likely profitability (or lack thereof). Examples are also given where the impact of extension will be very limited because existing perceptions of key variables held by non-adopting growers are generally consistent with current knowledge, or the information being generated by current users is increasing uncertainty and/or reducing the perceived profitability among non-adopters. Finally, results of a study of grower group R, D & E activity in Australia is presented with results from an economic assessment of the perceived value of the information that is generated.

Delivering research information with impact: learning and adoption

Initially decision-makers do not know everything that matters (Hiebert 1974). The stages that follow the discovery that an innovation exists where information is acquired and processed is central to the information and learning approach to adoption. Another central proposition is that innovations that offer greater relative advantage to growers are more likely to generate more positive messages about the desirability of adopting and therefore are likely to be adopted sooner (Lindner 1987). This information contributes to the learning process through which farmers adjust their perceptions. Except in cases where it can be assumed that all growers are close to being fully informed about an innovation, a lot of the difference in how soon growers adopt a potentially profitable innovation can be due to different overall perceptions of its relative advantage and different levels of knowledge at the time. It's worth noting that overall relative advantage is something broader than just 'profit' and can accommodate farmer and farm-specific factors such as risk, human capital and personal preferences. However, it is unlikely that adoption can be adequately explained unless factors contributing to perceived profitability are recognised.

A range of factors can at least partly be seen in the context of incentives for, or cost of information acquisition and learning. These include managerial education (ability to make better use of information), farm size (ability to gain a greater return on an investment in information seeking and adoption) and spatial issues such as distance to nearest adopter and other information sources (access to information that does not require as much 'translation' to local conditions). It has been observed that these factors can often influence speed of adoption, particularly in the early stages of diffusion of an innovation . Consistent with the central role of information quality and learning, the impact of extension and remote information sources has been shown to reduce in the later stages of diffusion when a larger percentage of all potential adopters have adopted (e.g. the case of lupin adoption in Western Australia described by Marsh et al 2000). As the diffusion process progresses, quality information on an innovation becomes more prevalent and easier to access. For example, there is a greater likelihood that highly relevant information will be available at little or no cost via contact with neighbours.

Considering the perceived quality of research information. The purpose of the example here is to demonstrate how some basic elements of information and information quality can be related to research and extension information. To consider the overall adoption learning process it is useful to unbundle the range of factors that may lead to perceptions of the overall relative value of an innovation that is new to the farmer. So for simplicity, the example here simply refers to 'yield'. Applying Bayesian-based learning principles (e.g. Lindner and Gibbs, 1990), it can be assumed that the actual yield achievable by adopting the practice is a distribution with mean yield and an associated variance due to risk factors such as seasonal conditions (for example, the thick line in Figure 1). The grower is assumed to be imperfectly informed about the yield resulting from the use of the practice, and therefore holds their own prior perception about likely yield, with its own mean and variance (e.g. the thin line in Figure 1). Another grower may have a different current perception of potential yield (e.g. the dashed line). The variance in each case is likely to include a component relating to risk such as seasonal conditions, and a component reflecting the subjective uncertainty resulting from a lack of information (Tsur et al. 1990). It is uncertainty that can be influenced by information and learning. The 'effectiveness' of information can be considered in terms of its ability to shift perceptions towards the yield distribution that would actually be experienced if adopted (e.g. towards the heavy line on Figure 1).

Information gained by the grower about the yield is assumed to have its own mean and variance. Low variance due to low uncertainty can be interpreted as a measure of the quality of the information. This influences the effectiveness in terms of its potential to influence prior perceptions (e.g. information with the characteristics of the dashed line is the least informative about the actual distribution in Figure 1). In reference to rigour and relevance (Carberry 2001), experimental rigour can lead to more certainty (low variance) that what happened in the experiment will happen again under the same conditions. However, when growers also consider the experimental information in terms of 'relevance' and what might happen when the same treatments are applied under their own conditions, extra uncertainty is introduced and the variance increases (e.g. rigour alone can lead to a distribution shown by the thick line but when a grower processes this to include relevance to their own application, the distribution may end up resembling the other distributions in Figure 1). An example later in this paper suggests that perceived 'relevance' may have greater influence than perceived 'rigour' in determining growers' perception of overall information quality.

Perceived information quality and effectiveness can also be influenced by factors such as perceived validity (Leathers and Smale 1991) and location (Marra et al 2001; Lindner et al. 1982). Because uncertainty surrounding the relevance to the decision-maker's own farm is removed, information produced by use of an innovation or a trial, is likely to have lower uncertainty (variance) and therefore have higher 'quality' (Abadi Ghadim 2005). In contrast, you would expect that growers would attach a high uncertainty to the output of a 'blackbox' computer model (see Walker 2002) or an unknown source. Further, each new piece of information derived under similar conditions (e.g. season, location) is likely to have diminishing effectiveness (Fischer et al. 1996). And obviously, even the highest quality information can't be effective at all if the perceived distribution is already the same as the actual distribution.

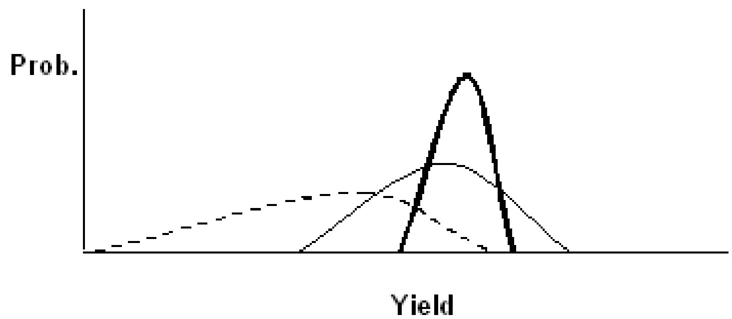

Figure 1. Representation of probability distributions for perceptions and information (actual distribution depicted by heavy line).

Of course, it is not suggested here that information is formally processed in this way by farmers to calculate optimal solutions (see Lindner and Gibbs, 1990). It is likely that 'short-cuts' such as heuristics (or rules of thumb) are often used, and that 'satisfactory' decisions are settled upon rather than the pursuit of the very best profit-optimising solution (see McCown 2002). It is suggested here though that considering perceived information quality and effectiveness as discussed above is useful for considering research and extension information and its potential impact in improving decision making. Where growers are applying simple decision rules, it is possible that the characteristics of information quality contribute to whether particular extension information is considered or dismissed. The next section looks at identifying key factors that are influential in growers' assessment of the relative advantage of an innovation.

Applying the approach to adoption in Australian agronomy: some examples

The basic principles discussed in the previous section can be readily applied to better understand agronomic adoption decisions and to identify opportunities for more effective extension and research needs. In this section three examples of adoption of agronomic practices are presented. In each case the following steps have been applied:

1. With consultation, develop a list of factors that may influence the likely value of the innovation for an individual grower on their farm relative to the original practice e.g. produce an outline of variables that would be needed in a full systems model to evaluate the innovation (including economic and information variables contributing to expected utility). In the case of no-till adoption for example, it is particularly important to recognize the complexity and changing nature of the adoption environment (see Ekboir 2003).

2. Collect data from a representative sample of growers that includes some adopters, using a fully-specified questionnaire that quantifies as many variables as practicable from step 1; including farmers' current perceptions of the factors that may influence overall perceived value of the innovation. Ideally, quantification of key perceptions would also include some measure or proxy for the perceived variance or certainty.

3. Identify variables where there are possible inconsistencies between farmers' current knowledge and field experience and/or research knowledge, including differences between perceptions of growers who have had experience using the innovation and those who haven't.

4. Conduct regression-based analyses to identify variables that have the biggest influence on the likelihood of adoption.

5. Identify those significant variables from step 3 that are also shown to be influential in the management decision in step 4.

6. Where quality information exists or can be generated through R,D&E, place emphasis on those variables from step 5 i.e. the factors found to be both influential and most likely to be able to be influenced.

Example 1. No-till adoption in southern Australian cropping regions

D'Emden et al (2006) used the steps outlined above to identify opportunities for more effective no-till extension strategies. The study involved interviews with 384 grain growers across various agro-ecological regions within the broadacre cropping zone of South Australia Western Australia, Victoria and southern New South Wales. Trends in sowing system use were identified along with grower perceptions of the relative effects of no-till on a range of agronomic and land management factors thought to have a possible role in the overall assessment of the relative advantage of a seeding system for an individual grower.

Results from logit and duration analyses of this data (see D'Emden et al 2006) showing significant factors found to be associated with the adoption of no-till on some area of the farm are summarized in Table 1. The real and perceived cost-effectiveness of key herbicides such as glyphosate and trifluralin are shown to be influential in the decision to adopt no-till. For example, the results show that research and extension able to increase the perceived effectiveness of pre-emergence herbicides in no-till systems among non-adopters is likely to be much more effective than any efforts to demonstrate the erosion-prevention benefits of no-till. Erosion and soil conservation benefits were equally well-recognised by adopters and non-adopters. Other perceptions associated with shorter-term crop production benefits under no-till, such as the ability to sow crops earlier on less rainfall were also important.

The location-specific and information/learning-intensive nature of the no-till adoption process was demonstrated by the importance of variables associated with use of various sources of information and the availability of opportunities for localised field observation and information on no-till use and benefits. Higher participation in extension and use of an agronomy consultant was significantly associated with adoption. However, because almost all no-till association?members were no-till adopters, no-till association membership could not be used as a variable in the econometric models.

Table 1. Factors significantly associated with earlier no-till adoption in Southern cropping regions

- Years since first awareness of nearby no-till adopter
- Higher education
- Use of directly paid consultant
- Higher participation in extension
- Perceived effectiveness of pre-emergent herbicide (trifluralin) in a no-till system
- Perceived soil moisture conserving benefits and improved seeding timeliness of no-till relative to conventional (i.e. full-cut) tillage
- Location (region/state)
- Fall in price of glyphosate herbicide
- Occurrence of a year much drier than average
- Higher average annual rainfall (i.e. adoption generally slower in very low rainfall regions)

82% of adoption decisions correctly predicted by logit model (86% adopters;76% non-adopters). Only statistically significant factors listed. Source: D' Emden et al 2006.

Example 2. Durum wheat adoption in Western Australia

Despite considerable efforts at development and extension, the durum wheat industry in Western Australia remains very small with no growth in recent years. A study by Nguyen et al (2006) used data from a 2004 survey of 60 Western Australian grain growers who had expressed an interest in durum wheat in a logistic regression analysis. The study found that perceptions of the yield potential of durum relative to bread wheat was most influential in the decision to adopt durum, with perceptions of the relative rust resistance of durum also significantly associated with the adoption decision (Table 2). There appeared to be some potential for extension to influence perceptions of rust resistance advantages among non-adopters. However, the most salient result was that growers who had recently grown durum, on average, had no higher expectations of the relative gross margins (and yield) of durum on their farm than non-adopters. Critically, growing of durum in the past was not a significant predictor of future use. When adopters do not generate clear positive information about the innovation, programs aimed at increasing uptake using information-based diffusion methods are likely to be inappropriate and more emphasis on research (e.g. variety development) and/or development (e.g. focused development of agronomic practices) becomes justified.

Table 2. Factors significantly associated with adoption of durum wheat in Western Australia

- Higher expected durum: bread wheat yield ratio
- Perception of higher rust resistance of durum relative to bread wheat
- Involvement in cropping/durum-related extension events
- Larger farm size

Correct predictions of adoption status by model: 84% (91% of adopters; 78% of non-adopters). Only statistically significant factors listed. Source: Nguyen et al 2006.

Example 3. Adoption of integrated weed management practices

Several perceptions were found to be influential in the adoption of integrated weed management practices among WA grain growers (Llewellyn et al 2006) (Table 3). One of the factors in the regression analyses most strongly associated with adoption was the mean percentage ryegrass control expected to be achieved if the practices were used on the respondent’s farm. However, for most practices in the study there were no significant differences between the average perceptions of practice efficacy (weed kill) held by users and non-users (Llewellyn et al 2004). This suggests that research and extension aimed at generating information on practice efficacy was unlikely to be able to make a major contribution to adoption decisions. Extension aimed at raising awareness of the risk and rate of common forms of herbicide resistance development was also found to be unlikely to be worthwhile. It was not a significant factor in influencing IWM adoption and non-adopters (and those with no resistance) were equally well aware of the likely rate of resistance development. Non-adopters did not perceive the risk of resistance to be any lower than those who had already observed resistance on their own farm.

An evaluated extension effort based on a series of interactive workshops was later found to be generally unable to influence perceptions of efficacy for the IWM practices (Llewellyn et al 2005). As indicated by the measured perceptions, learning had already taken place between users and non-users (most growers had a known user of each practice in their local district). The ability to influence the perceived likelihood of a new herbicide able to control existing resistant ryegrass populations was found to be difficult, most likely because of the difficulty in delivering ‘quality’ information about the likely future development of new herbicides by generally secretive agri-chemical companies.

The study found that unless more costly forms of resistance become more threatening to growers (as is happening now with glyphosate and trifluralin), one of the best strategies for increasing the adoption of integrated weed management practices is likely to involve more emphasis on the broader value of the practices in the farming system beyond just weed kill efficacy. A simple application of this recommendation involving higher crop seeding rates demonstrated how this strategy can lead to significant perception shifts and subsequent acceleration of adoption decisions (Llewellyn et al 2005)

Table 3: Factors significantly associated with adoption of integrated weed management practices in Western Australian cropping regions

- Perception of higher economic value of practices for weed control in the farming system.
- Perception of higher ryegrass control (efficacy) provided by practices.

- Perception of a longer time until a new post-emergence, selective herbicide will become available.
- Level of uncertainty of when a new herbicide will become available
- Higher use of information/extension to which the grower is exposed.
- Higher education.
- Higher proportion of the farm cropped.
- Lower discount rate for future returns
- The resistance status of the farm.

86% of adoption decisions (80% adopters; 90% non-adopters) correctly predicted. Only statistically significant factors listed. Source: Llewellyn et al (2006).

In the three examples presented above, the ability to predict a high proportion of adoption decisions and identify specific perceptions of variables that contribute to the likelihood of adoption was demonstrated. Just as importantly, many possibly important variables were found to be not significant or not likely to be able to substantially influenced by additional information. For the two more complex adoption cases (no-till systems and integrated weed management) information-related variables were particularly important. Education had some level of significance in both, and the no-till results in particular demonstrated a very important role for locally-derived (e.g. number of years of being able to observe a nearby adopter) and farm-specific information (paid advisor/agronomist). The following section looks at the perceived value of localised information sources.

The value of information from grower groups

Information that allows a decision maker to more rapidly reach a state where they can cease investing in the evaluation stage and arrive at a decision to adopt or not adopt has an economic value. For example, the investment an individual grower makes in conducting an on-farm trial gives some indication of the expected value of the information to be generated (see Abadi Ghadim and Pannell, 1999). In most cases, pre-trialing decisions are based on a wide range of information sources external to the farm. Grower group organisations are an increasingly important source of this form of research information.

Group to Grower extension: Grower groups as sources of quality agronomic information

Grower-led groups commonly have an objective to bring agronomic and farming systems research to their local area for the purpose of generating practical and locally-adapted solutions (Hassall and Associates 2004; Gianatti & Llewellyn 2003). The activities of groups' are usually seen as belonging to the suite of participatory extension methodologies that feature prominently in the extension literature (Black 2000). However, the forefront of the grower group movement in Australia has in many ways gone beyond the range of international participative research and extension models (see McCown 2002) and has redefined 'participation'. It has also made the information value considerations discussed above increasingly relevant to grower groups.

Reflecting their origins in international agricultural projects in developing countries (e.g. Collinson 2000), the 'participation' in many extension models usually refers to growers becoming participants in a R, D & E process where the objectives and leadership are set by a traditional R, D & E organisation. For the highly organised grower-led organisations that now employ their own researchers and directly receive major R & D funding, the concept of 'participation' becomes very different. In some cases it is traditional research organisations and researchers that are now encouraged to become 'participants' – at the invitation of growers. In the context of traditional research and extension models this is a remarkable demonstration of the development of social capital, capacity building and empowerment. It has also seen grower groups rapidly become major information providers to other growers (see Figure 2).

For a majority of growers, the level of engagement with one of the grower-led R, D & E groups is usually not through hands-on participation in research trials but as recipients of the information that is generated. Actual participation in group research by farmers is generally not high when expressed as a proportion of growers in the group's target region. A study by Hassall & Associates (2004) of nine groups receiving GRDC-funding found a range of 10 to 139 growers actively participating in some R&D within major groups. In the case of grower groups with memberships over 1000 such as the no-till associations of South Australian and Western Australia, the relative importance of information delivery to scale-out to “non-participating” members becomes particularly obvious.

It is this aspect of the role of grower groups, as deliverers of agronomic research information, where similarities with traditional extension’s linear or “top-down” information delivery model are apparent. In the modern case of grower group-generated information, it may be best described as “group to grower” information (see Figure 2). Given the limits to the proportion of growers feasibly able to actively participate in the research process, it is likely that the overall economic benefits of grower group funded R&D projects will be substantially determined by the influence of these information-based modes.

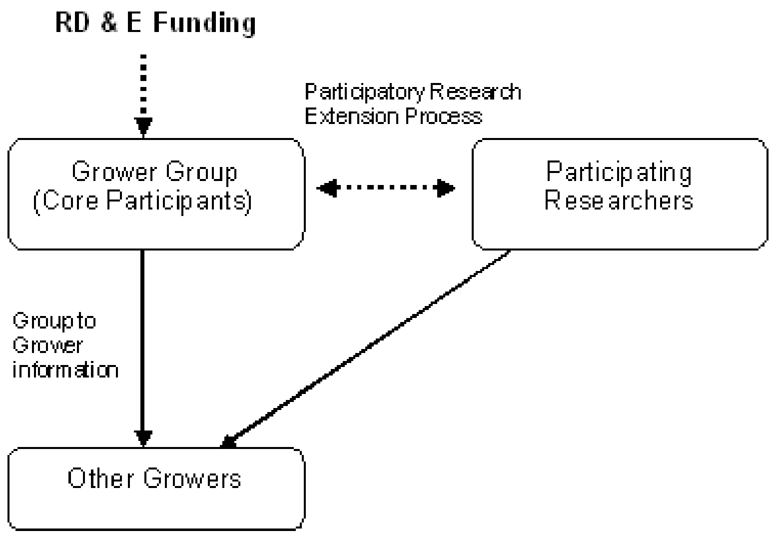

Figure 2. An emerging research-extension model in Australian agronomy and farming systems.

It has been suggested that most grower group projects and activities remain based on ‘traditional’ agricultural trial work (Carberry 2001; Ridley 2005). A desktop study of grower group activity over the period 1999 to 2004 by D’Emden & Llewellyn (2005) supports this observation. Approximately 1300 projects carried out by 11 grower groups between 1999 and 2003 were reviewed. Project information was obtained through trial results booklets and websites published by the grower groups, the GRDC and other information made available by the groups. Results of a categorization of the reported grower group projects are presented in Table 4.

Table 4. R & D projects reported by Australian grower groups 1999-2003 classified by research focus. Several projects were placed in more than one category. (D’ Emden and Llewellyn 2005).

Research focus	Proportion of all projects (%)
Varieties (548)	40
Fertiliser and nutrition (336)	25
Soil amendment and assessment (216)	16

Seeding method (215)	16
Pests and disease (186)	14
Herbicide tolerance/efficacy (175)	13
Precision agriculture (174)	12
Farming systems (137)	10
Pastures and livestock (137)	10
IWM projects (95)	7
Catchment and sustainability (58)	4
Economics and marketing (42)	3

Most commonly projects were in the traditional areas of variety evaluation and fertilizers etc (Table 4) and the vast majority of projects were based on single-year small-plot trials. However, it should be noted that this study of reported grower group projects does not take into account the relative level of investment into different projects. The most common research partners in the projects were from state agriculture departments and retail agronomists (Table 5).

Table 5. Research partners in grower group projects (D' Emden and Llewellyn, 2005).

Research partners	Proportion of project (%)
State Ag. Departments	46
Retail agronomists	20
Universities/CSIRO	8
Independent consultant	5

Valuation of agronomic research information by growers by source and location

To examine the value that growers place on information from local grower group sources compared to other sources, a contingent valuation study (see Bateman et al 2002 for a guide to this methodology) was conducted by Walker (2005). Based on analysis of stated willingness to pay for a publication containing new agronomic trial information, the economic value growers attribute to information based on distance from the source and research organisation was determined. Data came from a questionnaire that was mailed out 7 Western Australian grain growing regions each comprising 2 shires. The centres of each region were approximately 100 km apart. The regions run approximately linearly and included Geraldton in the north-west to Gnowangerup in the south-east. Of the 700 questionnaire mailed out there were 120 responses used in the analysis.

Growers were asked to state their willingness to pay (WTP) for a hypothetical 20- page new publication on new weed control options for crops and pastures based on new results from weed management trials. WTP was elicited for trials conducted by different organisations and, in a second case, the results were from hypothetical trials at a range of distances from their own farm. The analyses took into account a range of other farm and farmer characteristics including grower group membership, education, relative importance of weed management as a problem on the farm, use of other information sources such as consultants. The results presented in Figures 3 and 4 below are expected values of WTP based on the regression coefficients and confidence intervals from double-bounded (lower limit zero; upper limit set by highest available category choice of >$30) tobit regression. Attention should be focused on relative differences rather than actual dollar amounts.

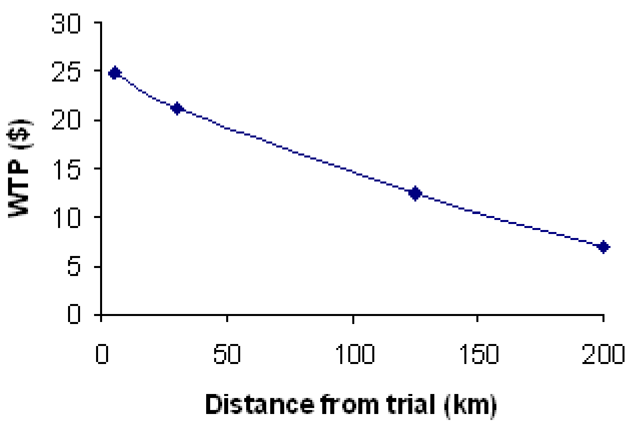

Figure 3. Change in growers' willingness to pay for research information at increasing distances from the trial location. The middle of the 4 distance ranges are plotted. Based on Walker (2005).

The high premium attributed to proximity to the source of the trial information is shown in Figure 3. The revealed willingness to pay is halved beyond 150km from the trial location. Figure 4 shows valuations based on different research organisations conducting the trial with no other reference to trial location. A likely premium for proximity is evident again, with the highest willingness to pay being for information from a 'local farmer group'. Information from trials conducted by other non-local grower groups within the state is valued significantly higher than that from a specified interstate grower group, but slightly less than the information derived from state department or university conducted trials.

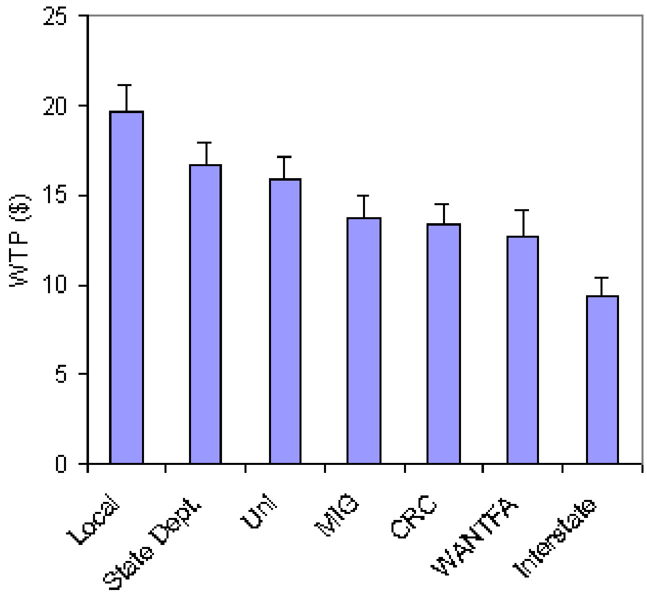

Figure 4. Effect of organisation conducting the research on growers' willingness to pay (WTP) for weed management research information. (stated WTP of Western Australian grain growers and standard error for a publication based on trial information conducted by a local grower-led group (Local); Department of Agriculture WA (State Dept.); University of Western Australia (Uni); Mingenew-Irwin Group (MIG); CRC Australian Weed Management (CRC); WA No-Tillage Farmers Association (WANTFA) and a specified interstate grower-led group (Interstate). Based on Walker (2005).

The results presented in Figure 4 have excluded the effect of membership of the named groups. It is worth noting though that analysis of the Mingenew-Irwin Group (MIG) members showed that in comparison to the results in Figure 2 they valued information from their local group (i.e. MIG) significantly higher ($25) than growers in other shires valued their 'local group'. MIG members on average valued no other source above $13. A further set of valuations showed that willingness to pay did not significantly differ according to who published the information i.e. it was the organisation that conducted the trials and the proximity of the trials that influenced the perceived value not the publisher.

The main reasons elicited from growers for differentiating between the trial information in terms of economic value can be categorised and summarised as 1. Local content & understanding (30%) 2. Credibility and professionalism (24%) 3. Applicability to my farming system (23%). Reasons 1 & 3 can be attributed to relevance, while reason 2 can be more loosely attributed to perceived rigour. The results of the contingent valuation also suggest that 'local relevance' has more influence on perceived value than perceived 'rigour'. The results support the argument that information from a closer source is perceived to be more valuable as interpretation suffers from less variance about the application and relevance of the information (Fischer et al 1996; Lindner et al 1982). Overall, the results demonstrate the high value placed on local grower-group generated information.

While information from local grower information was clearly valued the highest; there was no premium for grower group-derived information if the group was not local. Information from a high-profile interstate group was valued significantly lower ($P<0.05$) than other sources and information from the state department of agriculture was valued slightly higher ($P<0.1$) than information from non-local grower groups (Figure 4). It is worth noting that, grower group research is often being done in partnership with research organisations and vice versa (Table 5). Nonetheless, the results indicate that some grower-led groups are now established in the research and extension network to the extent that the information they produce can be perceived by growers to have state-wide value comparable to that produced by major research organisations.

Final Remarks

The ability and resources required to pay 'attention' to and process information can be a major bottleneck in adoption decisions. The issue is increasingly relevant here as managing the farming system becomes become more complex and the demands on farm decision-makers increase. In addition, many research and extension programs have the objective of promoting even more complex and information-intensive farming systems e.g. salinity management strategies, more intensive production systems and precision agriculture. The information and learning demands of even just evaluating these innovations need special consideration (see Pannell 1999). According to the Nobel Prize-winning economist Herbert Simon:

"...in an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it is that information consumes. What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it" (Simon 1971, p. 40-41).

Farmers are becoming better educated and have greater access to information technology. Yet the results from the studies of adoption and the information valuation in this paper show that the value placed on highly localised agronomic information remains particularly strong, and there appears to be a growing demand for 'in my backyard' research information. This is likely to reflect an increasing need for information to be well targeted and have high quality characteristics if it is to be influential in adoption decisions. The suggested pathways to more rapid adoption presented in this paper are intended to recognise both the essential rationality and address the increasing scarcity of the 'attention' of farmers when it comes adoption decision-making.

Steps can be taken to identify ways to more effectively target research and extension to influence adoption decisions for specific innovations. The approach to considering adoption and communication here is relatively narrow and simple, but it is focused on the role of an output common to all agronomy research projects: information. It is also consistent with the fact that, although less powerful than true participative research processes, the most common direct contact most growers have with a typical research project is through relatively simple forms of extension. The case studies of adoption of agronomic innovations in this paper demonstrate how perception variables in the adoption decision that are both 1. influential and; 2. able to be influenced by information and learning, can be identified. This is done within a broader process that can successfully predict a high percentage of adoption decisions by incorporating a range of factors that influence adoption, many of which probably can't be influenced. Equally importantly, the steps can identify when existing efforts may be being directed towards factors that are either not influential or cannot be significantly influenced, such as where growers are found to be already well-informed of key characteristics of an innovation. The same steps can help to identify when existing adopters are not generating positive information (or are generating high quality negative information) about an innovation. Such local on-farm information is likely to have an effectiveness that is likely to make most extension information irrelevant and point to the need for greater emphasis on research.

Research information generated through local grower group activity is perceived to have the 'relevance' that increases effectiveness and value. While local relevance appears to be the major factor influencing the high perceived value of grower group-generated information, many grower groups have also reached a level in Australia where 'group to grower' information can have considerable value at distances beyond local membership areas. In addition to the multi-dimensional benefits of engaging in a participative research processes (which have not been considered in any detail in this paper), there is good justification for engagement with grower groups as a path to generating more effective information for more rapid adoption decisions. Greater integration of farm advisors and information service providers into technology development and delivery is another possible approach to addressing information-related demands of technology adoption. In the cases of some more complex information-intensive technologies, widespread adoption will be significantly less likely unless local advisory services are available to overcome information and learning-related constraints.

Finally, information and learning-related factors are likely to become increasingly important in adoption decisions. Opportunities exist within agronomic research and extension projects to address this through greater recognition of information-related factors in the adoption process for specific innovations, and by considering how information quality and effectiveness can be increased to achieve more rapid adoption decisions.

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