ENCOURAGING THE ADOPTION OF DECISION SUPPORT SYSTEMS BY IRRIGATORS

Mark Morrison

Abstract

The adoption of decision support systems (DSS) by irrigators and other farmers has been surprisingly slow. Various explanations have been given for the slow uptake including poor system design and inadequate marketing of the programs. Much of the work done to understand the adoption of technologies such as DSS amongst farmers is based on the diffusion model developed by Rogers. If the model holds, the optimal strategy for encouraging adoption is to develop a marketing strategy that will encourage innovators and early adopters to begin using the product, who will then influence others to imitate them. However, the diffusion model was originally developed to explain the adoption of the technologies such as hybrid corn, where adoption is relatively straightforward. Many modern technologies can be quite different, involving sizeable expenditures in equipment, infrastructure or human capital, and/or large additional commitments of time. In this study, the ability of the diffusion model to predict the adoption of a DSS known as Irrigator Pro is investigated. This DSS has the capacity to increase yields, reduce fungicide use and reduce the amount of water used for irrigation. A qualitative methodology involving in-depth interviews with irrigators in Georgia, USA is used to investigate farmers’ attitudes to Irrigator Pro. The results indicate that several variables suggested by the diffusion model do predict adoption, including age and attitude to risk. However, other variables not predicted by the diffusion model, including computer literacy and ownership of a mid-sized farm were found to be important predictors of adoption. This implies that more rapid and widespread adoption can be achieved by not just targeting those who are traditionally considered to be innovators or early adopters.

Keywords

Decision support systems, Diffusion theory, Irrigation, Water conservation

Introduction

Despite their potential, the uptake of many decision support systems (DSS) by farmers has been surprisingly slow (Lynch, Gregor & Midmore, 2000; McCown, 2002, Stephens & Middleton, 2002; Hayman, 2004; Stone & Hochman, 2004). Various reasons have been suggested to explain why uptake has been limited. Lynch, Gregor and Midmore (2000) suggested that the main problem is poor design. They contend that many DSS have not been designed using participatory approaches and as a result have not been tailored to farmers’ decision making processes. McMaster et al. (2002) similarly suggest that many DSS are too difficult for farmers to use and suffer from a poor understanding of how farmers process information. Stone and Hochman (2004) suggest that there are reasons other than poor design that explain the low uptake of DSS. They argue that the primary reason for the poor rate of adoption is that, most DSS are developed and released without much, if any, reference to the basic precepts of marketing, (p.7). They advocate understanding the groups or segments of farmers within the market, what their needs and preferences are, and how to price and distribute DSS to the targeted segments. The usefulness of identifying market segments amongst farmers for the purpose of encouraging adoption of new technologies or practices has been suggested in

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previous studies (e.g., Kaine & Lees 1994; Darbyshire 1999; Watson & Pryor 2002), nonetheless there is limited evidence in the literature regarding the use of marketing approaches in the design and delivery of DSS.

Rather, models developed in the sociological and economic literatures have primarily been used to explain the diffusion of new technologies, and based on these models recommendations for improving rates of adoption have been developed. One of the first models in the sociology literature to explain the diffusion process was developed by Rogers (1962) who drew on insights from Ryan and Gross (1943). Ryan and Gross (1943) first observed that awareness and adoption of agricultural innovations (e.g., hybrid corn) followed bell-type (or normal) distributions. Ryan and Gross, who were sociologists, explained this process of diffusion by what they described as an interaction effect. According to Rogers (1962), this is a process through which farmers who have already adopted a new technology influence those who have not yet adopted. Using data from a number of independent studies of new product adoption by farmers, Rogers (1962) divided different farmers into groups according to how quickly they adopted new technologies. Innovators are the first to adopt, and comprise about 2.5% of the farmer population. These are followed by early adopters (13.5% of the farmer population), the early majority (34%), the late majority (34%), and laggards (16%). Earlier adopters tend to be wealthier, more educated, more established, more risk preferring, more immune to social pressure, and have a greater range of contacts where they can acquire new information. Empirical evidence does support the importance of these variables in explaining adoption (e.g., Ervin & Ervin, 1982; Rahm & Huffman, 1984; Lynne, Shonkwiler & Rola 1988; Caffey & Kazmierczak, 1994; Zepeda & Castillo, 1997; Soule, Tegene & Wiebe, 2000; Khanna Epouhe & Hornbaker, 2001; Soule, 2001). However, other studies have demonstrated that the characteristics are not always related to early adoption (Wilkening, Tully & Presser, 1962; Goss, 1979).

An implication of the diffusion model is that more widespread adoption of new technologies can be encouraged by directly targeting and promoting to innovators and early adopters. These groups are central to encouraging diffusion amongst the majority of farmers. If these groups adopt a new technology and find it satisfactory, they will effectively market the technology to other farmers through their interaction with them. This implies that when developing a strategy for encouraging diffusion effort should be given to tailoring the product to the preferences of earlier adopters. This contrasts with the perspective within the economics literature where the focus has been on identifying the preferences of all farmers rather than just earlier adopters. For example, when Purvis, Hoehn, Sorenson and Pierce (1989) and Cooper and Keim (1996) examined incentives needed to encourage adoption of best management practices, the focus was on examining willingness to accept of all farmers not just the earlier adopters.

However, it is possible that targeting those who might normally be considered to be innovators or early adopters may not always be an effective strategy for rapidly reaching the wider market. This is because various non-sociological variables may also influence product uptake. For instance where the adoption of new technologies requires the acquisition of new skills, such as for the use of GPS positioning tools, having the existing competencies in this area may explain adoption behaviour (Khanna et al., 2001). Because of the heterogeneous nature of farms and farmers, very often it is not rational for certain farmers to adopt a new technology. They do not adopt because they are a laggard or part of the late majority; rather it is not in their interest to do so (Röling, 1988; Chambers, 1990; Vanclay & Lawrence, 1995; Rogers 2003; Pannell et al., 2005). For example, a farmer with a smaller property may simply have the scale to financially justify the use of conservation tillage, though they may aware of the technology and willing to use it if they had a larger farm size. Given this, there is reason to believe that the adoption of new technologies may not always follow the bell-shaped curve across all farmers predicted by the diffusion model. Rather, some technologies may only be adopted by certain farming groups. If correct, this has important implications for marketing strategy, especially if those likely to adopt have different characteristics from those generally considered to be innovators and early adopters.
Apart from potentially not being able to explain adoption processes for all technologies, other limitations of the diffusion model have been noted in the sociology literature. Röling (1988) noted the potential for the diffusion model to reinforce privilege (see also Goss, 1979). This occurs because extension workers and progressive farmers attract each other like magnets, (p.66). Progressive farmers generally receive information first, technologies tend to be designed so that they suit the operations of progressive farmers rather than farmers more generally, and progressive farmers generally receive super-normal profits associated with the early use of new technologies that later adopters do not typically receive (Röling, 1988). Consequently, some new technologies may be inappropriate for farmers who have lower levels of education, smaller farm sizes or do not have the appropriate equipment available. Moreover, if they are not early users of new technologies they are unlikely to receive the financial gain received by early adopters, which may also retard the rate of adoption. For these reasons, other extension strategies involving participatory approaches have been recommended by rural sociologists, particularly in developing country contexts (Chambers, 1990; Röling & Pretty, 1997). This involves using a more pluralistic approach that targets a wider range of farmers.

Given the slow uptake of DSS, we investigate whether a specific DSS Irrigator Pro is likely to be adopted most frequently by farmers generally considered to be innovators and early adopters within the standard diffusion model or whether there are other segments that ought to be targeted. Irrigator Pro, is an irrigation scheduling software developed by the US Department of Agriculture and is described in Section 2. This research builds on other studies conducted in Australia and New Zealand about the slow uptake of DSS, including Kaine and Lees (1994), Wilde and Watman (1997), Stone and Hochman (1997), Stone and Hochman (2004) and Botha and Atkins (2006). A qualitative methodology involving semi-structured in-depth interviews is used to identify and understand farmer attitudes towards Irrigator Pro, which is described in Section 3. The qualitative results are then presented in Section 4, and implications for the marketing of DSS are discussed in Section 5.

**A modern technology: Irrigator Pro**

Irrigator Pro is a computerized decision support system designed to help farmers make better irrigation and pest management decisions. Through the use of statistical or process-based analysis, computerized decision support systems equip farmers with an understanding of the factors affecting crop outcomes (Stone & Hochman, 2004). The specific aim of the Irrigator Pro system is to deliver to farmers increased economic returns via improved yields and reduction in the risk of plant disease, reduced use of chemicals and environmental impact through reduced water use. It is currently available for peanuts, and versions are currently being developed for cotton and corn. It is provided free of charge to irrigators, and is the main DSS available to irrigators of these crops.

Irrigator Pro is used primarily to help schedule irrigation and herbicide applications. It uses information from USDA trials and other scientific studies about optimal irrigation practices. Irrigation is scheduled so that soil moisture is maintained at levels which promote optimum crop growth rates, pests are controlled and the need for fungicides is reduced.

In terms of what is required from farmers, Irrigator Pro initially requires the farmer to supply initial data on crop variety, soil type, irrigation capacity, yield potential and growing region. In addition, it requires up-to-date information on rainfall, soil temperature, weather and past irrigation or fungicides applications will need to be entered. Irrigator Pro requires that rain gauges and stem thermometers be used in each field to collect this data. Irrigator Pro works by asking the user a series of questions concerning their crop and the weather conditions. Once these questions have been answered the program produces a report outlining when and how much irrigation is needed, as well as advice on pest control and the use of fungicides (see Figure 1). Irrigator Pro can be used before planting up until the end of the harvest. Information should be regularly entered into the system for more precise recommendations.

A feature of Irrigator Pro is that farmers can generate decisions for future dates, which allows for better-planned irrigation. Once a decision has been generated Irrigator Pro will advise the user on whether to irrigate or not; when to re-run Irrigator Pro, the
amount of irrigation needed; the fungicide application that is recommended and a warning of possible problems with high or low temperature pests.

Irrigator Pro also uses water and temperature graphs to show farmers how well their irrigation schedule has been at keeping soil temperatures and watering at the optimum level. These graphs display minimum and optimum water and temperature ranges while providing a cumulative history of past irrigation (see Figure 2).

**Methodology and sample description**

In-depth personal interviews were conducted with 30 irrigation farmers in the Flint River Basin between May and August 2002. A qualitative approach was used to enable more careful understanding and probing of farmers’ attitudes towards Irrigator Pro, and because many farmers were unaware of the product and needed to be introduced to it through a product demonstration that was conducted during the interview. The use of a qualitative methodology is consistent with other research seeking to understand farmer attitudes in agricultural sociology (eg. Millar & Curtis, 1999). All interviews were conducted by an interviewer who has a background in farming and is from southern Georgia. Recruitment of farmers was based on a non-probability sampling procedure. Lists provided by the USDA and the Flint River Water Planning and Policy Center were used to recruit farmers. Respondents were selected so that farmers with a variety of farm sizes and crop types were sampled which is consistent with the maximum variation method described by Patton (1990). Interviews were conducted on farmers’ properties. Interviews lasted about 1.5 to 2 hours, and respondents were given several incentives to participate. All interviews were tape recorded and transcribed.
A series of 24 open-ended questions were asked, followed by questions about farmers’ socio-demographics and the characteristics of their properties. The same set of questions was asked of all participants. After each question various probing questions were included. In the interview participants were initially asked several questions about their thoughts on irrigation management in general, to understand what they thought were the benefits of improved irrigation management and how they go about this on their property. They were then asked whether they had heard of Irrigator Pro and what they knew about it. They were then provided with some information about the program and given a demonstration. After the demonstration they were asked about the strengths and weaknesses of the program, whether they thought people would find it difficult to use, the benefits they thought it would have for yield and irrigation management, and how other farmers would be likely to respond to their use of the program. They were also asked about what other things they might do to improve irrigation management, and whether they would in fact consider using the program and how much they’d be prepared to pay for the program. In addition to being questioned about their own use, participants were asked whom they thought was most likely to use the program and whom they thought was least likely to use the program. Lastly, five questions were asked to assist in identifying early adopters and innovators. This involved questioning respondents about the last new technology they adopted and how long they knew about it before they adopted it, and what it was that stopped them from adopting it earlier. In addition, farmers were asked directly whether they considered themselves to be an early user of new management techniques.
Regarding the socio-demographics of respondents, the average age of farmers was 47.6 years, which is somewhat younger than the average age of farmers in Georgia, which is 55.9 years (University of Georgia, 2007). Over half of the farmers in the sample were college educated (18 out of 30). For the majority of farmers (26 out of 30), farming was their main source of income, which is higher than the state average with only 60% of farmers having farming as the main source of income (University of Georgia, 2007). The average farm size was 1895 acres (median 1300 acres) which is larger than the average for the Middle Flint River for both irrigated and non-irrigated farms of 492 acres (Southwest Georgia Regional Development Center, 2005). The main crops grown were peanuts (92.9% of farmers), cotton (82.1% of farmers), corn (60.7% of farmers), pecans (25% of farmers), cattle (14.3% of farmers) and wheat and other small grains (14.3% of farmers) which is consistent with the main crops grown by farmers identified by the Georgia Cooperative Extension Service (University of Georgia, 2007). All of the farmers surveyed used groundwater for irrigation, and 18% of farmers also used surface water. On average farmers irrigated 81.5% of their cropland. During the period in which the survey was conducted Georgia was in the middle of a four year drought. In 1999 the State of Georgia had issue a moratorium limiting the release of new agricultural water permits, while those with permits had the right to continue to irrigate. At the time of the survey farmers did not pay for the water that they used (Gonzalez-Alvarez, Keeler & Mullen, 2006).

Qualitative results

In analysing the qualitative data, the methods that respondents currently use to make irrigation decisions are first explored to provide background information about the level of sophistication currently used in these decisions. Respondents’ awareness of and attitudes to Irrigator Pro are next assessed, including what they consider to be the perceived advantages and disadvantages, their certainty regarding the benefits from using Irrigator Pro, and the likelihood of them using Irrigator Pro. Given the goal of understanding how different groups might be interested in this new technology, particular attention is paid to identifying the differences between those who are more or less likely to use Irrigator Pro.

When presenting the results, a mixed-methods approach to the analysis of the data is used (Bazeley 2004, 2008). In addition to the use of thematic analysis, content analysis is used to assess which responses are more prominent in the data. This approach is common in the mixed methods literature (eg Vitale, Armenakis & Field, 2007).

Methods used to make irrigation decisions

In the survey, before any questions were asked about Irrigator Pro, farmers were asked about what methods they currently use to make irrigation decisions on their farm. Several different methods are used that differ in their level of sophistication (see Table 1). About two-thirds of the farmers surveyed relied on personal judgment and past experience when making irrigation management decisions. They would consider the type of crop they had, the soil type, the stage of the crop, whether the crop is stressed, and weather patterns. The use of personal judgment was more concentrated amongst those with smaller farms, with all those owning farms less than 1000 acres indicating that they used this form of decision making.

<table>
<thead>
<tr>
<th>Methods used to make irrigation decisions</th>
<th>Number of times mentioned</th>
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<tr>
<td>DSS (Irrigator Pro/X Nut)</td>
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</tr>
<tr>
<td>Consultants</td>
<td>2</td>
</tr>
<tr>
<td>Extension</td>
<td>3</td>
</tr>
<tr>
<td>Experience/Judgement</td>
<td>22</td>
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Just the past history of the field and just the knowledge of working with irrigation in the past... I just look at it and if I think it needs it, I go by sight, I guess

Not really a policy, it’s just using judgments from past history. We do try to water heavy and less often.

Weather patterns, conditions at the time, what kind of past conditions... looking at the weather reports, conditions of the crop and the different stages of crop development.
If it’s hot and dry, crank it up. If it wilts, crank it up. I try to wait as long as I can.

Looking at the crop . . . it’s always been if you thought you needed to water, you needed to water.

We go out and check the soil and check the plant and try to start irrigating before the plant goes into stress. Whatever – corn, cotton, peanuts – we try to get a day or two ahead of the water because if we get a day or two behind the plant’s going to get into stress and it’s going to cost.

About a fifth of the farmers surveyed rely on advice from either extension officers or consultants to make irrigation decisions, as shown in the following comments:

Extension gives us some pretty good guidelines to go by as far as how much water a week a crop needs at that stage

I usually go mainly by the Extension Service and dates they use as the crop requires the most water . . .

We use university data regarding water requirements on a per week basis for the crops that we grow. They have scale models to tell us how much water we need for each of these crops to achieve optimum yield at each stage of growth.

Well we just pretty much utilise the condition of the crop and of course I don’t use the scientific methods of what kind of moisture we got in the soil, we just rely on past experience and a lot of looking in the crop. I use a crop consultant and he tells us a lot about how much and when to water, together with what we learned from experience.

Three farmers use or have used Irrigator Pro, and a fourth farmer had trialed an irrigation scheduling program (different to Irrigator Pro) but didn’t like it and now relies solely on experience. Three out of four of the farmers that have used a DSS for irrigation own farms larger than 2500 acres.

**Awareness**

After asking farmers about the current methods that they use to make irrigation decisions, farmers were asked whether they had heard of Irrigator Pro. This question was asked because awareness is one of the first stages in the adoption process. About half of the sample had heard of the program, but only about half of those who had heard of the program knew anything about it. Awareness did not increase with either farm size or education, though the average age of those who had heard of the program was several years lower than those who were not aware.

**Perceived advantages of Irrigator Pro**

After asking farmers about their awareness of the program, they were shown a demonstration of Irrigator Pro. They were then asked what they considered to be the advantages of the program. From a sociological perspective, this is important for understanding relative advantage, which is an important part of the adoption and diffusion of new technologies (Rogers, 2003). From a marketing perspective, understanding perceived benefits is important for the development of promotional messages. While it would be more ideal to ask actual users of the program rather than those who have just been introduced to the program, some insights about potential benefits can be gained. The benefits mentioned included reduced water usage and fungicides, and increased yields, as well as assisting with record keeping and monitoring of crops (see Table 2). Several farmers commented that they thought it would take the, guesswork out of irrigating and improve decision making, especially relating to the timing of irrigation. Others suggested that there may be cost reductions:

When to irrigate at the right time, and when to spray and not to spray

Probably the biggest strength is to help you head off waiting too late to start irrigating, especially if you got a big field, we have a tendency to wait and see the peanut stressing before we begin to water.

. . . it would help me or someone monitor my crop data, rainfall, temperature, keeping a record of when I irrigate, when I used fungicide treatments

It helps you take a lot of the guesswork out of making decisions that concern your profit line and yield potential. We’re so used to watering all the time out here that we might be watering more than we should.

For one thing you’ll keep a daily record of what’s going on in the field, and it will tell you when to water when not to . . . keeps you from over irrigating or under irrigating.

I can see how it would save water if it worked like it was supposed to work.
Perceived disadvantages of *Irrigator Pro*

As well as advantages, the farmers interviewed noted a number of disadvantages of using the program. Understanding perceived disadvantages is also important from a marketing perspective. Identifying disadvantages can lead to modification in design, and promotional messages focusing on conveying information can be developed to counter attitudes that may not be based on fact. One of the most commonly cited disadvantages, particularly amongst larger farmers, was the time required to use the program. A couple of farmers indicated that given the time required it would be a better tool for consultants to use than the farmers themselves:

*Taking the extra time to enter the information...*

... in my situation I don't have a whole lot of time and I definitely am not one on doing any kind of paper work. I'd rather take a whipping than sit down at a desk and write something out or try to put something on a computer... I don't doubt that it wouldn't probably help me out, but... in my situation with limited labor and limited time...

*Having to get and record those temperature readings daily takes a lot of time...*

*Taking time to do it...* just being dedicated enough to take the data down and to do what it says. Use your consultants; I think that's the best way to go.

*Time to learn it correctly...* I hire a consultant now to help me with cotton and peanuts and... I think it would be a management tool that would work into a consultant's operation a lot better than an individual farmers.

*Taking time to do it, because most of the time you ain't got time to do what you normally got to do.*

Amongst the small to medium sized farms, the main disadvantage cited was the possibility of making mistakes and the challenge of learning to use the program correctly:

... maybe not getting the data in correctly

... not taking the time to put the inputs in and do it in a proper manner

My weakness would be making sure I put all the data into it...
I think the weaknesses of it would be in the man operating it like any other thing.

The longer it has been in use the more efficient you'll get with it, and I would say right now that my biggest problem would be learning how to use it.

Other disadvantages mentioned included that it is a radical change from the way I thought and that it may give incorrect advice and the challenge of learning how to use the program.

After considering disadvantages, farmers were also asked whether they thought most people would find Irrigator Pro difficult to use. A third person technique was used for this question to encourage respondents to be honest when answering this question. Over half of the farmers thought that it would not be difficult to use and several commented that they could incorporate the extra work required into their existing farming practices. However other farmers again voiced concern about the time required and noted the difficulty attached to having to use the program every day. A few farmers, particularly older farmers, were concerned about the computer skills that would be required.

Farmers are going to be out in the field checking everything almost daily anyway. It's not going to take just a little time to take a reading or look at the temperature and all that.

You just get to take the time to read the instruments and keep up with the data and enter in the information.

It looks fairly simple

Not difficult to use, maybe difficult to discipline themselves to use it.

I don't think it would be hard to use. The daily thing might be hard, to check it daily.

I think it's just a matter of deciding that you want to do it

Certainty about the benefits of Irrigator Pro

To further clarify farmers’ assessment of the advantages of Irrigator Pro, farmers were next asked about how certain they were that Irrigator Pro would improve irrigation water management and lead to increased yields. The purpose of this questioning was to determine how risky they thought it would be to use Irrigator Pro. About half the farmers interviewed thought there was certainty about the benefits of using the program:

A better job is being done. There's no doubt.

No doubt

I am certain, the software tells you what is going on and what you need to do.

However, the remaining farmers most were more circumspect, with several indicating a need to trial the program first. Some noted that the outcomes would also depend on whether the program was used correctly and on exogenous factors such as the weather. Interestingly, about half of the farmers owning properties larger than 2500 acres indicated that they were uncertain about the benefits of Irrigator Pro and these farmers all suggested the need to trial the program. There was also greater uncertainty amongst those with smaller farms (less than 1000 acres), but these farmers did not suggest the need to trial the program.

I think you have to go back and look at it as a trial and error thing. I have to learn how to use it . . . It's all a big step. I think over a year or two, maybe three years when you get used to working with it.

I think it could, you know, if it was used right

I do not know if I could say for certain whether it would lead to increased yields because I have not seen it compared to the way I've been doing it normally

I don't know, I am not sure

I would be uncertain, we don't know for sure when the water would come and we can't control the temperatures and they have the most influence of anything . . .

However, almost all of the farmers with mid sized farms (1000–2500 acres) indicated that they were certain about the benefits of Irrigator Pro.

Likelihood of using Irrigator Pro

Farmers were also asked whether they would consider using Irrigator Pro within the next year. Only five farmers indicated that they would definitely not use Irrigator Pro, and six farmers indicated that they may consider using it, with the remainder indicating that they would use the program. The main reasons given for not using the program were the difficulty of collecting data for the program, age, inadequate farm size and computer literacy.
No. Just the process of going and collecting the data and putting it in the computer. The time involved... and the fact that I don’t like fooling with stuff like that. Now you know, if it was [farmer’s name]... he’s a computer guru and I think he’d enjoy playing on the computer putting all that stuff in, but that’s just not me.

No... things change with the generations. When I started farming, chemicals were coming in and daddy turned that right over to me. He said you look after it, he wasn’t keeping up with it. Well computers and all that are coming in and that’s his project [his son], not mine.

I just don’t have the acres.

Hell, we’ve got so much going on right now I can guarantee there’s some data that wouldn’t get entered.

Farmers were also asked if they would consider getting a consultant to help them use the program. There was less support for using consultants, with only half of those interviewed saying they would consider using a consultant. Three of the farmers who said that they would not use the program themselves indicated that they would consider asking a consultant to use it.

**Those most likely to use Irrigator Pro**

Finally, farmers were asked who they thought would be less likely as well as most likely to use Irrigator Pro. Based on the predictions of the diffusion model, it would be expected that those who are more innovative and risk takers, are better connected, have larger farm sizes, who are more educated, and are younger would be more likely to use Irrigator Pro.

The most commonly mentioned predictor of adoption was attitude towards change which is related to risk aversion (see Table 3). Farmers thought that those who were not open to change were unlikely to adopt Irrigator Pro:

- Someone that’s not willing to change to try new things. If it ain’t broke, don’t fix it.
- Negative farmers. Farmers who won’t change from what they’ve been doing.
- Less apt to embrace change.
- Probably older or ones that are set in their ways. Ones that don’t change at least till they see how someone else does with something, to see how it works.

While those whom they considered to be innovative and aggressive they thought would be the first to adopt. These quotes indicate that these farmers tend to be well connected:

- They are aggressive. They usually like to be the first to know about new products and new information. They’re usually some of the better farmers.
- I guess you would say innovative, maybe, in a way, progressive.
- They would be innovative. They would be the kind that are always trying something new, always keeping in contact with the universities or the equipment manufacturers. They’d be people who were constantly changing equipment.
- I think they would be ones that are very aggressive, they are ones that keep up with the politics of agriculture, they’re probably involved with different organizations.
- Maybe an aggressive farmer who looked for new options any way he could to improve his bottom line. He would be a more aggressive farmer who would not be used to keeping the status quo.

The next most commonly mentioned determinant of who would or would not use Irrigator Pro was age. More than a third of farmers interviewed thought that younger farmers would be more likely to use the product and older farmers would be less likely to use the product. This finding is supported from the farmers’ own responses, as the average age of farmers who indicated that they would definitely use Irrigator Pro was 45 years, while the average age of those who indicated that they might consider using Irrigator Pro or would not use it was 52 years.

In contrast with the predictions of the diffusion model, education was only mentioned by a couple of farmers as being likely to be a predictor of adoption. Furthermore, the level of education did not differentiate between farmers in this survey in terms of whether they would consider using Irrigator Pro. Of greater importance was computer literacy and having a positive attitude to technology, which was cited by about a third of those interviewed as being a characteristic of those likely to use Irrigator Pro. The farmers’ own responses about whether they would use Irrigator Pro also support the view that computer skills differentiate farmers in terms of likely adoption. About three-fifths of farmers who said that they would not or might consider using Irrigator Pro could use a computer, while almost all of
the farmers who said they would definitely use Irrigator Pro could use a computer.

_Somebody that’s really into computer programs and that uses computers for everything._

_Computer literate, who would feel comfortable with computers._

_Computer friendly farmers_

_A lot more computer oriented and a lot more precise in technical life_

Again, contrary to the predictions of the diffusion model making a better financial position was only mentioned by a single farmer as being a predictor of adoption. Several farmers suggested that those who were poor managers or undergoing financial stress would be unlikely to use Irrigator Pro. In terms of farm size, none of those interviewed suggested that owners of larger farms would be more likely to adopt Irrigator Pro. Indeed one farmer suggested the opposite:

_They would be not extremely large in number of acres, they would be successful, and they would be the ones that started using computers earlier. . . ._

His reasoning was that Irrigator Pro would be difficult to use for larger farms where properties are not contiguous, as the regular collection of data would exacerbate the travel required between properties:

_They would probably be a larger farmer, busy, probably still successful . . . if your farm is big and you’re scattered or if you’re farming the land that you own and you’re always in one place, it’s a little easier to come up with gathering all this data than it is if maybe like we farm from one side of the county to the other. So it may rain ½ an inch out here, we still got to drive 30 or 40 miles to find out if it rained everywhere to put in all this data in the system. If you’ve got 10 or 12 pivots and you’ve got to gather this data on a daily basis then you’re just about dedicating one-half day for a man to go get all this information on a daily basis that you got to put in this thing._

An examination of the farm sizes of those who indicated that they would consider using Irrigator Pro amongst the 30 farmers interviewed suggests that this was an astute observation. All of the farmers with mid-sized properties (1000–2500 acres) said they would consider using Irrigator Pro next year, or use a consultant to help with the program. This can be contrasted with those who owned larger farms where only about half said they would either use or trial using the program next year. It appears that farmers with mid-sized properties are

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<th>Those more likely to use</th>
<th>Number of times mentioned</th>
<th>Those less likely to use</th>
<th>Number of times mentioned</th>
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<tbody>
<tr>
<td>Younger farmers</td>
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<td>Older farmers</td>
<td>11</td>
</tr>
<tr>
<td>Positive attitude towards change/innovative/progressive</td>
<td>11</td>
<td>Those not willing to accept change</td>
<td>12</td>
</tr>
<tr>
<td>Positive attitude towards technology</td>
<td>9</td>
<td>Those who don’t keep up with new products</td>
<td>5</td>
</tr>
<tr>
<td>Computer literate framers</td>
<td>5</td>
<td>Dryland farmers</td>
<td>2</td>
</tr>
<tr>
<td>Mid-sized farms</td>
<td>1</td>
<td>Large sized farms</td>
<td>1</td>
</tr>
<tr>
<td>Higher educated</td>
<td>3</td>
<td>Low education level</td>
<td>1</td>
</tr>
<tr>
<td>Good managers</td>
<td>3</td>
<td>Poor managers</td>
<td>3</td>
</tr>
<tr>
<td>Want to save money</td>
<td>1</td>
<td>Poor financial position</td>
<td>4</td>
</tr>
<tr>
<td>Better financial position</td>
<td>1</td>
<td>Renting cropland</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3: Summary of sample responses regarding the characteristics of farmers more likely and less likely to use Irrigator Pro.
more motivated to maximise the profitability of their farms, even if it requires additional time. Note the following comments by those who own mid-sized farms, who recognise the need to fine-tune, their operations and increase profitability:

“With the economics right now of agriculture, I think, you have to have somebody to do it. We don’t have any margin of error. This would help fine-tune your whole system. . . . After you got started this would keep you right on track. You have something besides your gut feeling and the feeling of dirt. . . . This really could be a tool that you could know what you were doing.

To just fine tune the operation, to make more money on the bottom line and to conserve resources.

Improve my bottom line, whether it is saving money or increasing yield.”

**Discussion and implications for the marketing of decision support systems**

The results from this survey indicate that there is opportunity for farmers to improve irrigation scheduling through the use of DSS such as Irrigator Pro. Only a few of those interviewed currently use DSS for scheduling decisions, about a fifth rely on advice from extension officers and consultants and the remainder rely primarily on experience and judgment to make scheduling decisions. Moreover, the farmers interviewed could see the potential benefits of using Irrigator Pro, such as reduced water usage and fungicides, and increased yields as well as assisting with record keeping and monitoring of crops. Nonetheless there are several challenges in developing a marketing strategy for Irrigator Pro. Awareness could be improved with only half of the farmers interviewed having heard of the program, a number of farmers were uncertain about the benefits of using it, and there were concerns about the time required to enter data and the possibility of making mistakes in data entry. The question given the market potential for this program as well as the obstacles to adoption is what marketing strategy will be most effective in encouraging uptake of this program?

In developing a marketing strategy, several factors are typically considered, including how to design the product, how to set price, how to promote the product, and how to distribute or place it (McCarthy, 1960). When a target marketing strategy has been chosen, the 4 Ps should be tailored according to the preferences and behaviors of targeted groups or segments. For this paper the primary goal has been to investigate the appropriateness of basing marketing strategy for Irrigator Pro on the diffusion model. According to the diffusion model, those most likely to be early adopt this technology, and hence those who should be targeted, are those who are innovators, more willing to take risks, have access to more up to date information, have higher than average wealth, are younger and better educated.

However, while it might be appropriate to characterise farmers with these socio-demographics and attitudes as being more likely to be innovators or early adopters, it doesn’t mean that they will be innovators and early adopters for all products. Some products – such as Irrigator Pro – because they are time consuming may be less suitable for use by wealthier farmers with larger acreages who have less necessity to increase profit and are relatively time poor. As one farmer commented when asked about the type of farmer he thought would be most likely to use Irrigator Pro: ‘They would not be . . . large in number of acres’. Indeed the results confirmed this: the farmers most likely to adopt the technology were those with an average sized farm. They had the time to do so (because they were managing a smaller farm) and the motivation to do so (as the profitability of a smaller farm is generally less). Education also did not appear to be a good predictor of adoption of Irrigator Pro. Many farmers who had a university education were unwilling to trial the product while some farmers with only a high school education were willing to adopt the software. What mattered more than education was having the necessary computer skills, which has been found in previous studies (Khanna et al., 2001).

Nonetheless, several predictions of the diffusion model appeared to be sound. The probability of adoption appeared to be related to age, with older farmers generally less willing to trial Irrigator Pro. Unwillingness to try new things and take risks, because of fear of the consequences of financial loss, also appeared to be a predictive variable.
These findings have significant marketing implications. It appears that those most likely to use this particular technology do not have all of the characteristics of those who would generally be considered to be innovators or early adopters. Thus target marketing\(^2\) should not always be focused on those farmers with a higher sociodemographic status because they are more likely to initially adopt a product. If this were done in this instance, it is possible that there would be relatively low initial uptake (because the product is less suited to high-end farmers) and adoption would be slower overall. An alternative strategy would be to attempt to first identify the target market for the product and then initially promote the product to those most likely to adopt the product within this target market. In the case of Irrigator Pro this is farmers with average sized farms, who are younger and computer literate. This is consistent with the recommendations made by Röling (1985, 1988).

The use of target marketing also partly deals with one of the criticisms of the diffusion model – that is, it tends to reinforce privilege. The implications from this study are that not all products should initially be targeted solely at high-end farmers. Consequently it is less likely that this approach will have as pronounced negative effect on equity. Furthermore, it is possible that some agricultural innovations could be developed and targeted primarily at low income farmers, which would improve equity.

The use of target marketing for Irrigator Pro implies a different method of product promotion and distribution than would be followed than if the diffusion model were to be relied upon. Those who are not high end farmers generally make less use of extension and are less connected to other agricultural organizations. This implies that solely relying on these communication channels may not be appropriate for this sort of technology, as many of those who are likely to adopt these technologies may not use these channels. Diffusion via word of mouth or observation many not be as effective for these sorts of products because only a proportion of those who generally have better access to information channels (ie high end farmers who are typically considered to be innovators) will utilise this product. That is not to say that these distribution channels are not important; given the perceived high level of uncertainty about the benefits of using Irrigator Pro efforts to demonstrate the benefits of using Irrigator Pro through on-farm trials should be continued. However, on-farm contact and demonstrations – such as was used in this study – or other forms of direct promotion may be needed to achieve more widespread and rapid adoption.

Furthermore, in the design of promotional activities, efforts should be made to respond to some of the perceived disadvantages of the program, such as the time required to input data and the possibility of making mistakes with data entry. Promotional messages should be designed that seek to inform farmers about the actual time involved and how other farmers have sought to manage the tasks involved in collecting data, as well as explaining how robust program recommendations are to incorrectly entered data.

In summary, the appropriateness of using the diffusion model for marketing decisions appears to be a function of product characteristics. For some products, such as hybrid corn or conservation tillage, the model may be a good predictor of consumer behaviour. However products and services differ, and the groups or segments within the community that are most likely to adopt the product may be different. For some products, such as Irrigator Pro, those most likely to use the product may not have all of the characteristics of those usually considered to be innovators and early adopters. This implies a need to understand to whom the product will most appeal when developing a marketing strategy.

Endnotes

1 Decision support systems are computerized information system that analyses data to assist in business decision-making activities.

2 That is, first identifying market segments and then choosing product features and price and designing promotions to encourage product adoption amongst one or more of these segments (Kotler and Armstrong 2008).
References


