

Decision support systems in Australian dryland farming: A promising past, a disappointing present and uncertain future

Peter Hayman.

South Australian Research and Development Institute, Waite Research Precinct GPO Box 397 Adelaide SA 5001 hayman.peter@saugov.sa.gov.au

Abstract

Decision support systems (DSS) have been a significant way that agricultural scientists seek to intervene and improve the way farmers manage their enterprises. Although there have always been some dissenting voices, until recently (early to mid 1990s) DSS were held as a promising means to transfer scientific information and farm management procedures to farmers. Despite relatively high levels of computer ownership, the use of DSS for routine decision making by farmers has been disappointing. The brief and unfolding history of DSS in Australian dryland farming systems provides an interesting case study of the challenges facing agricultural scientists intervening in the world of farm management decisions.

Media summary

Until recently computerised decision support systems were seen as a promising way to deliver science to farmers. What went wrong and what does it teach us about dryland farmers and the science and practice of farming?

Key words

Computerised decision support systems, DSS, managing risk, farmers

Introduction

The industrial revolution can be viewed as having three stages; machines that extend human muscles, machines that extend the human nervous systems (communication technology) and machines that extend the human brain (eg computerised DSS). Extensive dryland agriculture has been made possible by the first stage of the industrial revolution. Farmers continually show ingenuity in ways to mechanise farming operations. Farmers who are reluctant to run a simple computer program will have no trouble pulling apart and adapting complex farm machinery. The interest in the workshop rather than office is understandable, in an ABARE survey of the Australian grains industry, the major source of gains in farm productivity from 1977 to 1998 was efficiency in the use of farm machinery. (Knopke *et al* 2000 p 66). Farmers have also been quick to adopt machines that extend the nervous systems such as mobile phones, faxes and the computers as a tool for communication. In contrast, the use of computerised DSS as a machine that extend the human brain for decision making has been disappointing.

One interpretation is that dryland farming is non-cerebral activity that requires machinery and communication, but relatively unsophisticated thinking – a case of brawn not brain. Time spent with Australian dryland farmers indicates little evidence for this interpretation. On the contrary, one of the likely reasons for the low adoption of DSS is that the partial analysis offered is inferior to experienced human judgement. Farm mechanisation brings major efficiencies to the tasks of sowing and harvesting crops. It is less clear whether computerised DSS improve the efficiency or effectiveness of deciding which crop to sow and what levels of inputs to apply.

Another interpretation of the low use of DSS is that things will change once farmers have access to, and are comfortable with computers. However, the level of computer ownership on dryland farms in Australia is close to that of urban households. Computers seem to be used primarily as tools for record keeping, as a means of communication and to ensure that school aged children have access to educational

opportunities. A similar situation is reported from a study of Great Plains farmers in the US which reported “*producer adoption rate of computers has steadily grown in the last two decades and now equals the general population. However, software applications primarily used by producers are for taxes, record keeping, word processing, and spreadsheets, with low ownership and use of specialized agricultural software.*” (Ascough *et al* 2002). The high ownership, but low use of computers for farm management decisions, is one of the major reasons for a rethink from those of us who promoted DSS as a direct means of improving farm management.

Defining Decision Support Systems

As a term, DSS has been described as rich but ambiguous (Checkland and Scholes 1990). The French acronym SIAD (Systems Interactif d’Aide a la Decision) further enriches the term with reference to the interaction between the user and computer. The definition of DSS is more than semantics, because if used in its broadest sense, DSS is so encompassing that it is difficult to distinguish them from extension. At the other extreme, definitions from IT text books tend to be restrictive. However, the history of DSS in IT and business is instructive. Keen and Scott Morton (1978) maintained that DSS evolved from theoretical studies on decision-making done at Carnegie Institute of Technology in the late 1950s and 60s and technical work on interactive computer systems carried out at the Massachusetts Institute of Technology in the 1960s. Power (2003) gives an overview of the 35 year history of DSS complete with email responses from many of the earliest developers. For the purposes of this paper and consistent with the history outlined in Power (2003), a DSS is computer-based, it is interactive, it offers both information and decision-making procedures and is designed to support a specific set of decisions (adapted from Sage 1991).

Following this definition, DSS represent a means for agricultural scientists to provide farmers and their advisers with *information* (eg simulated crop yields for different levels of nitrogen fertiliser) and *procedures* for decision making (eg structured comparison of probability distribution of gross margins for each N rate). Like most buzz words of a previous decade the term DSS now sounds overused and a bit tired. Nevertheless, it is not hard to understand the reason for its attraction to agricultural scientists. It captures the aspirations of the undergraduate student; developing and delivering scientific knowledge in a way that supports farmers decision making seems a job worth doing.

Agricultural science is an applied science more akin to engineering than pure science (Passioura 1996, Hearne 1996). As an applied science it seeks to go beyond the basic question of “why is it so ?” to answer “what can we do about the situation ?” Modern farming presents many examples of the application of agricultural science. However, as pointed out by McCown (2002), the main impact has been through applying the scientific knowledge to the design of material technologies (seeds, fertilisers, herbicides and machinery) rather than the process of farm management and decision making. DSS represent an attempt of scientists to intervene and improve farmers’ management. These attempts by scientists to intervene through influencing the process of farm management rather than delivering the products of science has been harder than first thought.

The mismatch between what was offered and what was used has encouraged a close examination of the practice of both farmers and scientists. This paper gives one perspective of this interaction with an emphasis on dryland farming in NE Australia, a detailed analysis with a range of case studies and thoughtful overview can be found in McCown *et al* (2002). DSS in Australian broadacre farming have been reviewed from a Soft Systems perspective (Macadam *et al* 1990), a design perspective (Cox 1996) and degree of end user involvement (Lynch 2000).

Promising past

The disappointment of the present use of DSS and uncertainty of the future have to be viewed in the light of the past promises held by DSS. As reviewed in Hayman and Easdown (2002) although there were some dissenting voices, the 1980s and first half of 1990s were characterised by an optimism in computerised DSS. Granted the optimism came from developer enthusiasm rather than farmer demand, the promises seemed reasonable. The sense of promises is captured by the conference organised by the

Australian National Standing Committee on Agriculture entitled "The impact of computer-based information systems on pasture and crop productivity". In his opening address Wright (1988) stated *"Computer-based information systems already developed, and in the pipeline, point the way ahead for better decision making in the cropping and pastoral industry..... Farmers need all the help they can get. They need the best information available, and they need to have it delivered quickly, reliably and efficiently. Computer-based systems offer the ability to deliver the goods"*. At the same conference, Stapper (1988) spoke prophetically of a new agricultural era of information and biotechnology over the following 15 to 20 years which would rival the mechanical (1930-50) or chemical (1950-70) revolutions.

In their study on the potential of DSS in dryland farming, Hamilton *et al* (1991) saw a bright future for DSS once computers became more common and providing that developers took a team approach and considered end users. They concluded *"Computer based decision aids have not been oversold. They have just been underdeveloped,"* In the 2nd Australian National Conferences on Computers in Agriculture (Childs 1986) there were 30 presentations and the development of 12 specific DSS discussed, by the 4th National Conference (Childs 1989) there were 111 presentations, over 50 DSS and expert systems featured. Few if any of these systems are currently being used.

Disappointing present

In their role as guest editors of a special issue of Agricultural Systems McCown, Hochman and Carberry (2002) concluded *"Although there are cases of local successes, as a field of agricultural research, DSS work is in a state of crisis....As laudable as the idea of computerised scientific tools to aid farmers' decision making may be to some researchers, persistent lack of demand by farmers for DSS cannot be ignored."* McCown (2002) noted that while the poor uptake of DSS in agriculture may come as a disappointing surprise to agricultural scientists, had we as a discipline read more widely in the wider field of operations research and management science from which DSS came, we may have found many cautionary tales that would have reduced the surprise, if not the disappointment. There are many well documented case studies of mismatches between the manager and the model. Few of the failures are due not to the technical soundness of the model, most are due to the challenge of implementation. Macadam *et al* (1990) and Cox (1996) noted the disappointing history of DSS in financial administration, medicine and the military - a history largely ignored by agriculture.

In most cases DSS contributed to other tools and learning packages or helped the development team sort out the rules of thumb that could be applied in general extension. However, as pointed out by Cox (1996), if the end point is adult learning or computer aided learning, why not design a computer system for this purpose. The general line of argument that acknowledges failure but points to learning along the way should be encouraged, indeed the lack of negative reporting in the field of DSS has been a major problem. However, we must not be too quick to skip the point that most DSS did fail to hit the target of being used by farmers as part of routine decision-making. As noted 30 years ago by Passioura (1973) when he suspected that crop modellers were retrospectively setting targets that when he heard of spin-offs, he thought of white elephants.

That is not to say that a farmer today who wants access to a DSS, cannot find one. In a detailed study of modelling and DSS, Hook (1997) listed 10 groups actively producing and promoting DSS and 14 DSS available for farming. McCown *et al* (2002) noted that hundreds of DSS are affordable and available to farmers. Not only are few purchased, those that are purchased appear to have limited use. Figure 1 details some of the developments in crop simulation which have given farmers in many regions unprecedented access to sophisticated analysis and prediction of yields.

Those studying the farming system have developed many ways to move down the diagram, we have excellent access to long-term climate data and, although incomplete, there are many soil and crop parameter files available. However, those managing the farming system appear to prefer the simple approaches such as water use efficiency and the relatively low use of complex simulation models. Carberry *et al* (2002) present a sound discussion for FARMSCAPE as a model for the delivery of simulation models to farmers. This is likely to be one way forward, but ways to deliver it to a wide audience in a cost effective manner is still in an experimental phase.

It is not easy to pin down the exact basis for the optimistic view of DSS that held technology as the only barrier. Woods *et al.* (1993) made the point that while most agricultural decision support tools purport to improve farmers' decisions, the means by which this is to occur was rarely clearly established or thoroughly evaluated. Similarly McCown *et al.* (2002) found that reflection is not the strong suit of agricultural science in general or the developers of DSS in particular.

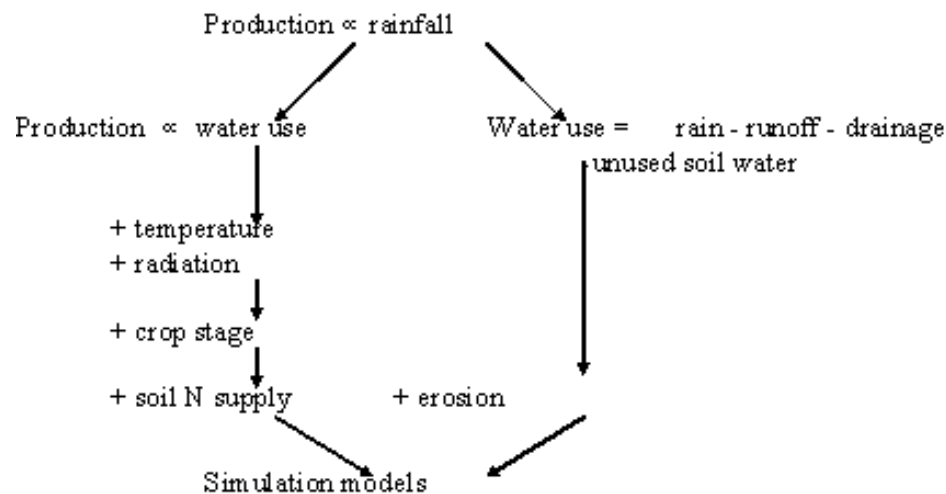


Figure 1. The pathway from a simple water use efficiency relationship to daily water balance cropping system models (after McCown 1991 *et al.*).

The promise of DSS can be captured as a series of underlying assumptions sometimes stated sometimes assumed.

- 1) computers are an appropriate tool for farmers to use in operational management
- 2) farmer decision making is limited by *information* and DSS could help
- 3) farmer decision making is limited by *procedures* and DSS could help
- 4) tactical farmer decision making is a worthwhile and efficient point for scientists to interact with farm management.

Central to my argument is that none of these assumptions were foolish, arrogant or even especially naïve. In his critique of DSS, Cox (1996) warned against DSS becoming a whipping boy, rather he acknowledged the courage of DSS developers in engaging industry and taking science to the field as a testable prediction. The challenge is how we learn from the outcomes of this engagement.

Assumption 1: computers are an appropriate tool for farmers to use in operational management.

Much of the early development of DSS in the 1980s preceded the widespread availability of personal computers. The notion was that as public advisory services were being threatened and there was a high turnover of staff and private services would become increasingly expensive that the farmer of the future would use a computer as a major source of advice and analysis for farm management.

In their overview of computerised DSS Hamilton *et al.* (1991) noted that about 5% of farmers had computers. They thought that this would change as students exposed to computers entered the farm workforce and financial pressures forced farmers to adopt. In the late 80s and early 90s the main reason given for low use of computerised tools on grain farms was the lack of cost effective hardware. A 1988 study in USA estimated the average cost of a computer for a grain farmer was US \$5889, and the estimated annual ownership and operating cost was US \$1245. Hardware is longer a limit. Over the last two decades ownership of computers on grain farms has risen from 5% to 75% or higher. Furthermore

these computers are more powerful and cheaper. Computing costs are one of the few farm costs that have decreased. This is largely due to Moore's Law, stated in 1965 by Gordon Moore co-founder of computer chip maker Intel, that the number of transistors on a silicon chip would double every 18 months. Moore's prediction has proved to be broadly accurate, between 1971 and 2001 transistor density has doubled every 1.96 years (The Economist 2003).

Assumption 2: Farmer decision making is limited by information and DSS can help.

More than half a century ago Brookes (1948) noted *"the producer of crops is concerned with the integration of all the factors which determine plant growth and development, and it is the basic knowledge of this integration which is deficient"*. Woodruff (1992) contrasted the ease of transferring technology through new varieties versus agronomic research. A new variety comes packaged in a seed and it is case of simply add water and phenology, disease resistance and quality characteristics will follow. He argued that this was one of the reasons behind the DSS WHEATMAN which sought to show how nitrogen, sowing time, phenology, frost risk and yield potential interacted.

Information for crop management comes at a considerable cost from government funds and grower levies and increasingly private R&D funded by agribusiness and farmers. Rather than a shortage of information, farmers and their advisers complain of information overload or information dazzle. The promise of DSS was as a means of organising some of the data into information or knowledge that can readily be used. For example Hamilton *et al* (1990) stated *"Never before have we been able to analyse so much data relating to a specific situation, and arrive at a solution to a complex problem"*.

Assumption 3: Farmer decision-making is limited by procedures and DSS can help.

Central to the account of the development of DSS by Keen and Scott Morton (1978) is the distinction between efficiency and effectiveness of decision-making. They described efficiency as improving the turnaround time and reducing the cost of structured decisions. They claimed that this was the early role of computers in management; to take those operational decisions that could be easily programmed and delegated. In contrast, the role of DSS was seen to work on improving the effectiveness of managerial decision-making, a task made necessary by the uncertain 1970s in the wake of the oil shock.

Although DSS have been used by agricultural scientists primarily to deliver information on crop management, a DSS is more than an electronically searchable data base. The heritage of DSS allows for the delivery of ways of structuring, managing and processing this information. The use of DSS to help decision makers overcome cognitive shortcomings such as bias is strongly rooted in DSS. Not only was it given a central place in early texts such as Keen and Scott Morton (1978), but most modern text books on DSS also refer to the subject (eg Sage 1991, Turban 1990).

Much of the psychology literature on biases relate to the way that we as humans process probabilistic information. Dryland farming involves decision making under uncertainty. One definition of risk is a quantification of this uncertainty (Knight 1921). The long-term daily rainfall record in Australia is the envy of many regions. For almost any centre in the region we can get rainfall data back to 1890. This means that we can ask simple questions such as the chance of getting a sowing rain after a certain date, or the likely yield range for a crop. We can also check what rainfall or simulated wheat yield was in any location for last 23 El Nino events. Prior to the ready access to computers, Woodruff (1975) mused *"If at planting we knew how successful a particular practice was likely to be, and what were the odds for or against success, we could make better farming decisions"*. This was a similar view as Anderson *et al* (1977) who maintained that decision making in agriculture would be improved if we asked what chances, what choices and what consequences. Information from past experiments are often presented to growers in terms of "if you use X rate of N, the wheat yield will be Y" This is the deterministic language of choice - consequence. In dryland farming, we have to speak in terms of Choice – Chance – Consequences. If you put on this N rate, depending on the season there are a range of outcomes. It seems reasonable that computers can help, not only present the information, but rapidly allow the range of possible outcomes for a range of decisions.

Assumption 4: Farmer's tactical decision making is a worthwhile and efficient point for scientists to interact with farm management.

Decision making in dryland farming can be conveniently categorised into operational decision making (spraying, sowing, harvesting decisions), tactical decisions (which crop, what area and level of inputs) and strategic (pasture to crop enterprise mix, purchasing extra land). DSS have focussed on tactical decisions that are characterised by responding to the current state of the system (soil moisture, standing feed). The emerging understanding of the El Nino southern oscillation (ENSO) has enabled decision makers to also respond to the state of the atmosphere and oceans. The strategic decision whether to buy the farm next door or change enterprises may be more important and represent a far greater source of risk. The tendency to focus on tactical decisions is in part due to the fact that this is where agronomists skill lies, but also because these decisions are less a series of messes (Ackoff 1980), these 'rates and dates' decisions enable a simple cost benefit analysis over a short time period.

Revisiting the 4 assumptions and the implications for the future of DSS

Why have farmers neglected to avail themselves of low cost (in money at least) computerised tools that offer them information and procedures on tactical decisions ? What are the implications for the future of DSS?

Questioning assumption 1 – are computers appropriate tools ?

Ownership of powerful computers by farmers in developed countries is no longer an issue. As computers become another utility service, the profitable end of the IT industry has reengineered itself as business consultants. In a special issue devoted to the IT industry, The Economist (2003) explains these changes as the mature phase of IT. It notes that Gordon Moore always warned that no exponential would lasts for ever and cites Larry Ellison chief executive of Oracle, (Worlds second largest software firm in 2003) "We became the largest industry in the world by selling things that people didn't want to buy". There have long been challenges to computers as always increasing business efficiency (Warner 1987 "Information technology as a competitive burden" Sloane Management Review). In one sense agricultural DSS are part of a wider move that has swung the emphasis on the usefulness of computers rather than just being satisfied with user-friendly software and powerful hardware.

In a study that went beyond computer ownership and examined computer use in Australian farming families, Bryant (1999) found a gender difference in the family farm whereby women had the responsibility for record keeping (largely for tax purposes) while men made most of the operational and tactical decisions using their heads or paper and pen. In her sample, rarely were past records printed out and used for future decisions. Desktop and even laptop computers do not have an easy fit in the farm workshop or paddock where many decisions are made. In the cotton industry palm held computers are being used, these may change record keeping, but few would see these as revolutionising decision making on farms.

As a learning tool DSS are being increasingly used in universities eg Grassgro (Daily *et al* 2000) and with farmers as a *discussion* support system eg Whopper Cropper (Nelson *et al* 2002) or as one part of a series of meetings with farmers based around field exercises and semi-structured discussion eg Grazplan and Grassgro (Bell and Allen 2000). Computers are powerful tools for this purpose and allow access to historical rainfall records for a local site through packages such as RAINMAN (Clewett *et al* 1993) is clever use of technology. However, computers are not the only tool or even the best tool. It is interesting to note how effective a printout of the rainfall data is as a table or time series and asking farmers to mark when they started farming and engage in a discussion about the major droughts and floods that stand as milestones in their lives before asking them to colour the El Nino and La Nina events.

Lawrence, Cawley and Hayman (2000) detail another case which challenges an over dependence on computers. The series of nitrogen budgeting workshops held in NE Australia whereby farmers and advisers were able to determine fertiliser requirements by calculating a targeted crop demand and measured soil supply were acknowledged by growers and advisers as very successful. At the time there

were a number of computer packages that could readily make this calculation, taking into account simulated crop demand for daily weather from the last 100 years and deal with the complexity of in-crop mineralisation and variable efficiency of N uptake. My personal view was why bother with a pen and paper when one could choose between a number of spreadsheets or point and click computer programs – why have a dog and bark. However, the popularity of these workshops amongst leading farmers and advisers who had easy access to DSS forced a rethink. Calculators with buttons large enough for farmers hands were found to be a powerful tool for farmers to gain answers to the question of how much N is needed, but also to learn about some of the processes and the key uncertainties.

What are the implications for the future? The question of whether computers are an appropriate tool is likely to become less important. The current trend of computers becoming ordinary is likely to continue and the use of computers as a means of extending the human nervous system and as a tool for meetings will continue (eg Net meeting Hargraves *et al* 2002). Of course computers will be used in decision-making, but in their direct role for routine decision making may be modest. As Pablo Picasso is alleged to have said “*Computers are useless, they only provide answers*”.

Questioning assumption 2, is information really the limit for decision making ?

Information is a difficult commodity to package and transfer. Hearne and Bange (2002) noted that one of the problems of the DSS for insect management in cotton (SIRATAC) was that a company developed to distribute cotton seed took on the distribution of information through management software. As discussed earlier a seed and an idea differ. For a business, hybrid seed is a much easier commodity to find a consistent market with repeat business, to stop free riders and to demonstrate the benefits to sceptics. However, the failure of DSS may be more than the complexity of handling information.

The disappointments of DSS are part of a wider problem of transferring information from research to farmer practices. This wider process of knowledge management has been described by sociologists looking on as not mal-intentioned, but sociologically naïve (Lawrence and Vanclay, 1995). DSS were developed at a time when technology transfer dominated a notion of information being generated by research, transferred by extension and used by farmers. This notion has been challenged due to the recognition of important pools of knowledge existing with farmers, extension workers and scientists (Rolling 1988).

Robinson and Freebairn (2000) in a paper reflecting on the low use of models, argued that some developers seemed more concerned with model use than users. They repeat a story of an older farmer tinkering with a machine who is interrupted by a young extension officer offering a manual on improved farming techniques. After politely listening to the polished speech the old farmer replied “*son, I don't farm half as well as I know how to now*”. The failure of DSS raises the question of whether information is the limiting factor for many of the decisions that are being addressed. Wood and Wood Harper (1993) noted that phrases such as “*better information leads to better decisions*” and “*what managers require is more information*” dominated the literature on DSS. They were critical of how these phrases were treated as self-evident and rarely supported by empirical evidence or even logical argument.

If improved decision making is plotted against information collected, the line is unlikely to be linear. In some cases it may be convex to the X axis whereby there is a critical amount of information after which decision making improves dramatically. More commonly for experienced farmers making tactical decisions, it is likely to be concave reflecting marginal and then perhaps even negative improvements in decision making with extra information. In the future farmers will increasingly want access to information. Some will use the internet and DSS tools, others will go to courses where DSS are part of the learning. An increasing number of farmers are recognising the power of humans over machines when it comes to sorting information and providing it in context and are hiring consultants as information brokers to distil the key messages for them. The target for the DSS tools becomes the consultant, but this is a different audience. One of the successes of FARMSCAPE is that it has provided the intermediary with a powerful flexible tool rather than give a more constrained DSS tool to the farmer.

Hearne (1996) used the notion of hierarchies to show how understanding at the plant and organism level could be integrated up to a crop level and then a management level. This is a powerful way to organise information. However, we must recognise that hierarchies have horizontal axes (price, machinery, whole farm considerations) as well as vertical axes. Malcolm (1994) maintained that a farm business was too complex for the deep but narrow focus provided by decision analysis and decision support systems. He asserted that it was better to be vaguely right than precisely wrong, to solve the whole problem roughly than part of the problem extremely well.

Questioning assumption 3 - can or should farmers decision making methods be improved ?

When DSS were first applied, there was little doubt that it would be an improvement for managers to formalise decision making processes, this is summarised by Carroll and Johnson's (1990) statement that because decision-makers were "*prone to error, behave inconsistently, and may not realise when their decisions are of better or worse quality, they could use some help*".

Hammond (1996) argued that the ability to show consistent mistakes in human information processing and thinking from research starting in the 1950s (eg Kahneman and Tversky) was a challenge to a previous notion of educated human managers as ideal decision makers. Hammond maintains that the pessimistic view of humans as cognitive cripples dominated thinking from 1970s to 1990s – a crucial stage for DSS development. A more optimistic view of human judgement is based partly on showing that some of the consistent mistakes might be parlour games and can be overcome when the question is reworded. More significantly, the slower than expected progression in artificial intelligence has caused a rethink on just how flawed human judgement really is. Some of aspects of jumping to conclusions with fast frugal rules of thumbs and relying on intuition is just what we pay experts for. In his text on decision support systems, Sage (1991) noted "*perhaps the most damning charge of all that affects potential user willingness to use the system is the feeling that it significantly interferes with the normal way of thinking about problems*".

As pointed out by Dreyfus and Dreyfus (1989) there are important distinctions between novices and experts. In everyday experience for any domain that we are comfortable with, the detached, deliberate and sometimes agonising weighing and selections amongst alternatives is the exception rather than the rule. A novice and advanced beginner feel little responsibility for what they do because they are applying learned rules, which will take credit or blame. Experts who chose a plan feel deeply responsible. A successful outcome is deeply satisfying and leaves a vivid memory, disasters are not forgotten. This expert/novice distinction might shed some light on the use of DSS by farmers. It is common to hear developers of DSS point to undergraduate education as a significant market for their software. Indeed a number of Australian Universities have made a concerted effort to include DSS software as part of their teaching. In the US, the university sector is a major source of DSS production. As stated earlier, although this success is akin to claiming a hole in one on an adjacent fairway, it is nevertheless a valid use of DSS. However it is naive to assume that the same tool will be used by an undergraduate and an experienced farmer. The success with 19 year old undergrad students gives us a clue to the lack of success with 50 year old farmers; DSS are more appropriate for novices.

While it is true that the products of science have been used more than management processes from science, the way that farming systems are managed is important. I am not arguing for ignorance and thoughtless decision making, however research on decision making suggests that more information and procedures are not always better (for reviews see Hammond 1996 and Gigerenzer *et al* 2000). The need for agricultural science to engage with decision makers is becoming more important as agriculture faces declining terms of trade and hence needs to use these inputs more efficiently. A further reason for improved management comes as farmers are asked to take more responsibility for their business risk and to minimise the degradation associated with excess inputs of chemicals and fertilisers. The fact that this engagement is important is one of the reasons why we need to reflect on what didn't work with DSS.

Questioning assumption 4 – should we be focussing on tactical decision making ?

Many questions that farmers ask agronomists relate to tactical decisions – when and what to sow, what level of inputs. The attraction of these decisions to DSS is obvious, the Latin origin of the word decision implies to cut off (Adair 1971). There is a time when the crop must either be sown or the land left fallow, and when the crop is sown there is a certain rate of nitrogen that must be applied. In one sense these fit the operations research definition of a decision as an irrevocable allocation of resources.

Identifying any level of decision-making as an activity that can be separated from the wider context of acting and learning in the world is problematic. The way that management science has isolated, categorised and dissected decisions has been criticised by psychologists and the newer interpretivist (“softer”) schools of management science. For example Ackoff (1981) maintained that rather than solve a series of unrelated problems, managers manage messes.

Woods *et al.* (1997) questioned the notion that managing dryland cropping was largely about decisions as distinct choices with well-defined cost and benefit streams. They maintained that decision points were often quite restricted and in any case the outcomes of a ‘wrong’ allocative decision can be remedied. The example given is that if a fertiliser rate is too high for the season, this can be remedied by applying less the following season. The memory in the system means that it is relatively forgiving of mistakes. It may be more important to learn to manage these messy situations of embedded sequential risk than make the best decision the first time.

A personal experience, gained largely from using the DSS Wheatman and the cropping systems model APSIM, was the relative insensitivity around the optimum of many sowing dates and input rates. (Hayman and Turpin 1996, Hayman 2001, Pannell 2004). When it comes to many tactical decisions the response surface is steep and then flat, hence decision makers are often confronted with situations that are either obvious (large response to N fertiliser/ very suboptimal sowing time) or marginal (gain in N fertiliser is equal to the cost/ small differences if a sown a week earlier or later). Given this relative flatness of response, there may be less to be gained from being precisely right with detailed simulation models than being approximately right with coarse rules of thumb, especially when you factor in the risk of being precisely wrong with detailed modelling. On an issue like N management, the amount of low yielding low protein wheat on one hand and bulges of nitrate in some profiles suggest some farmers are getting it roughly wrong. However, it does not need a very sophisticated decision tool to improve these decisions, a simple N balance will show the error.

Tactical decisions are difficult because they are uncertain. Although risk can be examined at the level of a tactical decision, production risk only really matters inasmuch as it impacts on business risk. There is a mismatch between the understanding of risk by farmers dealing with farm level business risk with clever but relatively simple intuition and the detailed specification of risk by scientists modelling relatively constrained agricultural production systems at a paddock level with complex formal analysis. Boehlje (2002) argued that as agriculture develops to be biological manufacturing with differentiated products and as farmers focus on the supply chain with quality guarantees, that the nature of risks facing agriculture have changed. The loss of a business partner or key market due to product contamination is an equal or greater risk than drought. He stressed that risk management was as much about defining new decision problems as finding more accurate specifications of the current problem.

Simplicity on the far side of complexity

It is unlikely that currently in Australia there will be substantial funding for a new DSS activity. Farmers are likely to have their decisions supported by consultants – some of whom will be using simulation models. The lack of institutional DSS effort may encourage the notion of DSS offered by Turban (1993) and picked up by Cox (1996) whereby the DSS is build by the people who will use it, it reflects the decision making style of the user, the time to construct it is short – perhaps a few days and it is seen as an adjunct to other procedures.

In a quick search of the latest Australian Farming Systems conference, there was only one paper on Decision Support with the question in the title “More about learning than software packages?” (Armstrong *et al* 2003). An overview of most of the other papers in the conference indicated a shift away from

technology and tactical decisions and onto livelihood and social systems. In this environment DSS seem like a relic from a bygone era. However, as argued in more detail in Hayman and Cox (2003) the attempt to understand and intervene in farmer's management of risk, to talk the language of chances and consequences was like a Rosetta stone that brought scientists and farmers together to think about tactical decisions in a variable climate. This interaction was illuminating and in the case of the DSS WHEATMAN (Hayman and Easdown 2002) the real benefit was the interaction between the developer farmers and advisers, which brought to mind the quote from Judge Wendle Holmes "*I don't give a fig for simplicity this side of complexity, but I would give my life for simplicity on the far side of complexity*". Some critics of DSS seem to be arguing for a role of the agronomist as non-interventionist and being a content free facilitator not bothering with any numerical analysis— simplicity on the near side of complexity. At its best, agronomy has always offered simplicity on the far side of complexity. DSS may have been one way to get there, at the time it was reasonable, but to repeat the DSS model without reflection is at best an unnecessarily long journey, at worst a cul-de-sac.

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References

- Ackoff, R. L. (1981) Creating the corporate future. New York: John Wiley and Sons.
- Adair, J. E. (1971) Training for decisions. London: Macdonald and Co.
- Anderson, J. R., J. L. Dillon, and J. B. Hardaker. (1977) Agricultural Decision Analysis. Ames: Iowa State University Press.
- Armstrong, D (2003) Decision support - More about learning than software packages? Australian Farming Systems Conference, Toowoomba, Queensland 7-11 September 2003. <http://afsa.asn.au/cgi-bin/papers>
- Ascough, J.C. D.L. Hoag, G.S. McMaster and W.M. Frasier (2002) Computer use and satisfaction by Great Plains Producers: Ordered Logit Model Analysis. Agronomy Journal 94:1263-1269.
- Boehlje, M. (2002) Risk in U.S. agriculture: new challenges and new approaches. Staff paper # 02-07. Department of Agricultural Economics, Purdue University. West Lafayette, Indiana.
- Brooks, F. T. (1948) Roy.Soc. Empire Scientific Conf. Rep. 1: 313.
- Bryant, L. (1999) Computers on the farm. Farmer's usage patterns and impact on farm management. Rural Industries Research and Development Corporation Research Paper No 99/13. RIRDC project USA-4A. www.rirdc.gov.au/pub/cat/contents.html.
- Carroll, J. S., and E. J. Johnson. (1990) Decision Research. A Field Guide. Newbury Park: Sage.
- Childs, J.R. (1989) Proceedings of the Fourth National Computers in Agriculture Conference. Maroochydoore, Qld. 8-12 May.
- Childs, J.R. (1986) Computers in Agriculture: second national conference, 1986. Queensland Department of Primary Industries Conference and workshop series, QC86006

Clewett, J. F., P. G. Smith, I. J. Partridge, D. A. George, and A Peacock. (1999) Australian Rainman Version 3. An integrated software package of rainfall information for better management. Q198071.Department of Primary Industries Queensland.

Cox, P G (1996) 'Some issues in the design of agricultural decision support systems' *Agricultural Systems* 52: 355-81

Daily, H.G., G.N. Hinch, J.M. Scott, J.V. Nolan (2000) The use of a decision support system to facilitate the teaching of biological principles in the context of agricultural systems. Available http://www.tedi.uq.edu.au/conferences/teach_conference00/papers/daily-hinch-et al.html.

Dreyfus, H. and S. Dreyfus. (1990). Why computers may never think like people in Forester T (ed) *Computers in the human context* Basil Blackwell, Oxford.

Grains Research Development Corporation (2001) On-farm computers: Adults take over but complain about Internet. Groundcover Issue 35, Winter. Available from www.grdc.com.au/growers/gc/gc35/research2.htm#net

Gigerenzer, G, and P. M. Todd. (1999) *Simple Heuristics that make us smart*. Oxford University Press.

Hamilton, W. D., D. R. Woodruff, and A. M. Jamieson. (1991) Role of computer-based decision aids in farm decision making and in agricultural extension. In *Climatic Risk in Crop Production: Models and Management for the Semiarid Tropics and Subtropics*, Brisbane R. C.

Malcolm LR (1994). Managing Farm Risk: There may be less to it than is made of it. In *'Risk Management in Australian Agriculture'* University of New England Armidale pp. 75-90.

Muchow, and J. A. Bellamy, CAB International. 411-24.

Hammond, K R (1996) *Human Judgement and Social Policy. Irreducible uncertainty, inevitable error, unavoidable injustice* New York, Oxford University Press

Hargreaves, D.M.G. Z. Hochman, N. Dalglish, P. Poulton (2001) FARMSCAPE online – developing a method for interactive Internet support for farmers situated learning and planning. In. *Proceedings of the Tenth Australian Agronomy Conference*, Hobart, Australia (www.regional.org.au/asa/2001/5/a/hargreaves.htm)

Hayman, P.T and Easdown, W.J. (2002) An ecology of a DSS: reflections on managing wheat crops in the northeastern Australian grains industry with WHEATMAN. *Agricultural Systems* 74:57-78.

Hayman, P.T. (2001) Precision farming in this land of droughts and flooding rains. A simulation study of nitrogen fertiliser on the Liverpool Plains, NSW. *Geospatial Information and Agriculture. Incorporating Precision Agriculture in Australasia 5th annual symposium*. Sydney, July 2001 71-84

Hayman, P.T. and Cox, P.G. (2003) Perceptions of drought risk: The farmer, the scientist and the policy economist 153-173 In Botterill L and M Fisher (ed) *Drought in Australia: People Policy and Place*. CSIRO, Melbourne.

Hearne, A. B. (1996) An Agronomist's Odyssey. In 7th Australian Agronomy Conference, ed M. Asghar, 2-16.

Hook, R. A. (1997) *Predicting farm production and catchment processes. A directory of Australian modelling groups and models*. Melbourne: CSIRO Publishing.

Keen, P. G. W., and M. S. Scott Morton. (1978) Decision support systems: an organizational perspective. Addison-Wesley .

Knight, F H (1921) Risk, Uncertainty and profit New York, Century Press

Knopke, P., V. O'Donnell, and A. Shepherd, (2000) Productivity growth in the Australian grains industry. ABARE research report 2000.1, Canberra.

Lawrence, D. N., S. T. Cawley, and P. T. Hayman. (2000) Developing answers and learning in extension for dryland nitrogen management. Australian Journal of Experimental Agriculture 40: 527-40.

Lynch, T., S. Gregor, and D. Midmore. (2000) Intelligent support systems in agriculture: how can we do better? Australian Journal of Experimental Agriculture 40: 609-21.

Macadam, R., I. Britton, D. Russell, W. Potts, B. Baillie, and A. Shaw. (1990) The use of soft systems methodology to improve the adoption by Australian cotton growers of the Siratac computer-based crop management system. Agricultural Systems 349: 1-14.

McCown, R. L., GL Hammer, and D. R. Woodruff. (1991) The contribution of crop models. In Workshop on crop production decision making, APSRU, Toowoomba.

McCown, R.L. (2002) Locating agricultural decision support systems in the troubled past and socio-technical complexity of 'models for management'. Agricultural Systems 74::11-26.

McCown, R.L. Z Hochman and P.S..Carberry (2002) Preface: Probing the enigma of the decision support systems for farming: Learning from experience and from theory. Agricultural Systems 74:1-10.

Malcolm LR (1994) Managing Farm Risk: There may be less to it than is made of it. In '[Risk Management in Australian Agriculture](#)' University of New England Armidale pp. 1-15.

Nelson, R A, D P Holzworth, G L Hammer and P T Hayman (2002) 'Infusing the use of seasonal climate forecasting into crop management practice in North East Australia using discussion support software' Agricultural Systems 74: 393-414

Carberry, P.S Z Hochman, R.L McCown, N.P. Dalgleish, M.A. Foale, P.L.Poulton, J.N.G. Hargreaves, D.M.G. Hargreaves, S.Cawthray, N Hillcoat and M.J. Robertson. (2002) The FARMSCAPE approach to decision support: farmers', advisers', researchers', monitoring, simulation, communication, and performance evaluation. Agricultural Systems 74::141-178.

Passioura, J.B. (1973) Sense and nonsense in crop simulation. J. Aust. Inst. Agric..Sci 39: 181-83

Passioura, J.B. (1996) Simulation models: science, snake oil, education, or engineering? Agronomy-Journal 88, no. 5: 690-694

Robinson, J.B. and D.M. Freebairn (2000) The decision maker has an important, but often neglected role in model use. Modsim 2000, Canberra.

Sage, A. P. (1991) Decision support systems engineering. New York: Willey.

Siegele, L (2003) Information technology – a survey. The Economist May 10th 2003, 1-18.

Stapper, M. (1988) Computer-based information systems: An overview of developments overseas. in Proceedings of the impact of computer-based information systems on pasture and crop productivity. Standing Committee on Agriculture Workshop Melbourne, 15-17 August 1988. 79-95.

Vanclay, F and G. Lawrence (1995) The environmental imperative: Eco-social concerns for Australian agriculture. Rockhampton: Central Queensland University Press.

Warner, T.N. (1987) Information technology as a competitive burden. Sloan Management Review, 29: 27-80.

Wood, J. R. G., and A. T. Wood-Harper. (1993) Information technology in support of individual decision-making. Journal of Information Systems, no. 3: 85-101.

Woodruff, D. R. (1992) 'WHEATMAN' a decision support system for wheat management in sub-tropical Australia. Australian Journal of Agricultural Research 43: 1483-99.

Woodruff, D.R. (1975) Decision making for wheat growers in Queensland. Agriculture branch technical bulletin no. 16. Queensland Department of Primary Industries.

Woods, E. J., P. G. Cox, and S. Norish. (1997) Doing things differently: the R,D&E revolution? in Intensive Sugarcane Production: Meeting the Challenges beyond 2000. in B. A. Keating, and J. R. Wilson (ed) Wallingford, U.K.: CAB International.

Woods, E., G. Moll, J. Coutts, R. Clark, and C. Ivin. (1993) Information exchange. A report commissioned by Australia's rural research and development corporations.

Wright, J. (1988) Forward in Proceedings of the impact of computer-based information systems on pasture and crop productivity. Standing Committee on Agriculture Workshop Melbourne, 15-17 August 1988. 3