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Managerial ability — a review of its basis and potential improvement using psychological concepts

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Abstract

Achieving an appropriate resource allocation structure usually revolves around the farm manager. His or her ability is crucial to success. Yet, most farmers learn by experience and/or through various courses that concentrate on technical, production economic and related aspects. Putting more effort into understanding the components of managerial ability and how a managers' ability to perform well in each component might be improved is well overdue. As psychology is the study of people and their actions it is the obvious discipline to turn to for assistance. This paper contains a review of the psychology of decision making from a farm management perspective, outlines what psychology offers for changing a person's attributes, and considers the structure of a research programme aimed at developing methods for improving individual's managerial ability. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Managerial ability has always been regarded as an important parameter in agricultural production. However, while there have been studies on descriptive aspects of management processes and abilities (e.g. Johnson et al., 1961), few studies have focussed on developing methods and procedures for improving the level of individual manager's abilities. Managerial skill is almost a forgotten resource. This review is designed to appraise the background to managerial ability, particularly with respect to relevant psychological aspects, and to consider what is necessary to develop programmes for improving ability and associated research programmes.

Despite all the development in decision theories and models, and computer technology and use (Nuthall and Benbow, 1998), Malcolm (1990) concluded that the farmers of today still largely rely on intuition, experience, and simple budgeting. This has not changed. In this respect it is interesting to consider the paradigms (Kuhn, 1996) traditionally taken on by agricultural economists and farm management researchers, and ask whether they might have looked further afield. Perhaps a study of philosophy (Popper, 1959; Dewey, 1964) would be helpful.

Fortunately, some researchers are looking for new approaches such as the management factor and its psychology. Ohlmer et al. (1998) developed concepts of the steps Swedish farmers used when making decisions — this work was a useful and timely start. Rougoor et al. (1998) looked at measuring management capacity and noted 'explicit definitions (of management capacity) together with an elaboration

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Table 1

Discipline	Focus on	Anomalies studied	Proxy for importance
Psychology	Explaining processes Individual behaviour Learning phenomena	Deviations from normal behaviour	Can it lead to preference reversals?
Economics	Predicting outcomes Aggregate behaviour Equilibrium solutions Theory	Market inefficiencies	Can anybody make money with it?

of the concept are hard to find'. They introduced the notion of psychological aspects being important and reviewed efficiency studies. They noted the next step would be to include 'aspects of the decision making process'. While not in regard to managerial ability, Willock et al. (1999a), and others, considered the psychological variables of Scottish farmers in relation to their objectives and provided a valuable step towards quantifying the relationships (Austin et al., 1998a,b). Clearly the seeds have been sown.

Every farmer's aim can generally be defined as:

Achieve goals/objectives
 $= f(\text{goal/objective recognition, resources available, farm environment, regulations, managerial ability})$

Traditionally farm management research has concentrated on the resource allocation, environmental and regulation aspects of profit maximisation and multi-objective achievement (Piech and Rehman, 1993). Its time emphasis was placed on managerial ability and goal/objective classification: the two are intertwined.

To investigate the more fundamental aspects of decision thought processes the obvious place to turn is the discipline of psychology which Atkinson et al. (1990, p. 8) defined as: "the scientific study of (human) behaviour and mental processes".

Both psychology and economics are concerned with choice theories. Weber (1994a,b) compares the two disciplines in Table 1.

Perhaps some of the psychology foci should become components of economic study. In particular, individual behaviour and learning are clearly related to managerial ability. Thus, as Salmon (1980, p. 20)

concludes "the psychological correlates of farm management still remain a clouded issue and a new approach was needed from a different theoretical base". This situation has not changed.

This review contains a summary of man's psyche as it is helpful in understanding decision processes. This is followed by a review of the limited work that is available on farmers' managerial ability. Section 4 contains a brief review on relevant decision making research from expert system and psychology studies and section five mentions goals, objectives, attitudes, and competencies as it is important to consider what must be improved. As managerial ability is the main focus, Section 6 contains a discussion on whether the ability of mature managers can in fact be altered. Fortunately, the evidence regarding adults is positive. Finally, consideration is given to research methods and a possible research programme. A brief conclusion is then presented. It should be stressed that the emphasis is on improving decision making skills, not on simply predicting decisions taken.

2. Psychological variables in decision ability

To understand decision capability requires rather more than a study of the decision processes used (e.g. as reported by Ohlmer et al. (1998)). It must be clear how humans observe information, how information is stored and retrieved, how it is processed and so on. The study of learning and thinking processes (cognitive psychology, e.g. Eysenck and Keane, 1990) is relevant and related to managerial ability.

A manager's genotype, combined with the environment gives rise to managerial ability (phenotype).

The manager is exposed to 'cues', observes some, processes them and subsequently acts, sometimes appropriately, sometimes not so appropriately. A review of the literature suggests many psychologists tend to believe how a person behaves is dependent on just three attribute groups — their personality, intelligence, and, possibly, motivation.

Personality is made up of several components (traits) with many studies concluding that there are probably five basic traits. A recent review (Matthews and Deary, 1998) lists these as neuroticism, extroversion, openness, agreeableness and conscientiousness. They conclude that the genetic contribution is about 36% with the remainder determined by the unique environment experienced. Thus, the environment is a powerful factor in personality and consequently managerial ability. Cantor and Zirkel (1990, p. 136) note "... personality... serves as a source of autobiographical continuity for the individual, at the very same time it facilitates a break with the past and provides a thrust to the future via imaginative self-reflection and goal setting".

Intelligence is another important trait in managerial ability and consists of at least two components — 'fluid ability' (broad basic reasoning ability) and 'crystallised ability' (fluid ability as it is expressed in a particular culture). Horn and Cattell (1966), as reported in Kline (1993), include additional aspects so their components are fluid (inference, induction, memory span, flexibility of closure, intellectual speed), crystallised (verbal, mechanical, numerical and social skills), visualisation (orientation, form), retrieval capacity, and cognitive speed factors.

Aiken (1991) notes that fluid intelligence is largely genetic, whereas crystallised intelligence is environment related. Other than for Willock (1997) the literature does not appear to contain studies of farm management/intelligence measure correlations, but clearly factors such as visualisation and retrieval capacity would seem to be crucial. Some psychologists also believe motivation is a basic trait though Kline (1993) notes the distinction between personality and motivation is somewhat arbitrary. Koestner and McClelland (1990) conclude that feelings of self determination are important to intrinsic motivation, and studies have shown positive feedback enhances intrinsic motivation. Kline (1993), however, does conclude that much more research is needed to clarify

the motivation situation. Entrepreneurship (Ollsson, 1988) might also be worth exploring, as might 'emotional intelligence' (Goleman, 1998) which focuses on personal qualities such as initiative and empathy, adaptability and persuasiveness, though much of Coleman's focus is on group situations.

A further crucial factor is whether man is, or wants to be, rational. Abelson and Levi (1985) provide a useful and extensive discussion on the rationality question, but do not venture into providing a strong evidence-based conclusion. They hint at a tendency towards believing in the existence of rationality. They also note (p. 234) "the common sense view of the major cause of irrationality, when it occurs, is that people fall into the grip of emotional or motivational forces they cannot, or will not, control" ... "complimentarily — general motives such as the enhancement of self esteem, the management of the impression one makes on others, and the avoidance of anxiety, might produce well organised and systematic violations of normative standards". If man is content to be irrational then developing systems to improve the managerial ability loses much of its reason. Few would accept this tenant.

Memory is also important in managerial ability. It appears the brain has a memory and processor in much the same way as a computer. Memory is thought to consist of short and long-term components (Eysenck and Keane, 1990). Initial observations are held in short term memory, are processed in the same area, and are then transferred to long term memory if thought to be of significance. Short-term memory capacity, and thus processing capacity, is thought to be limited. In contrast, long-term memory is virtually limitless. Miller (1956) believes it is only possible to hold five to nine pieces of information in short-term memory so given the serial arrival of material problems can arise when too much information is offered. It is also generally accepted that 'rehearsal' is necessary to commit information to long-term memory, and the more the better.

Eysenck and Keane (1990) discuss in some detail the whole process of observing, learning, recording and responding. A commonly accepted concept is the 'lens' model. The 'lens' (brain) takes in information and modifies it in some way (like the lens in glasses) to give a result (Burnside and Faithfull, 1993). Abelson and Levi (1985) review this work and comment on the perception and adjustment of cues. Similarly, some workers believe a person's

psyche is embedded in what Kelly (the inventor) called 'constructs' (Salmon, 1980). Kelly believed 'man' is constantly striving to make sense of the world through actively setting up hypotheses and putting them to experimental tests. Those that are successful become 'constructs' — rules by which to operate. These constructs are in a continuous state of change resulting from new experiences. Bannister (1997) has brought together a series of essays that portray the use of this theory in a contemporary context. Managers might use a series of constructs that have evolved from a person's personality, intelligence and motivation, all tempered by the environmental influences. When cues are observed the appropriate construct (rule of thumb) comes into play and action occurs.

Some researchers might argue farmers' objectives, such as their attitude to risk (Anderson et al., 1977) are part of an individuals' make up. This is true in that they impact on the choices, but they do not affect managerial ability. Thus, personality, intelligence, motivation, memory and processing systems all seem to be important in assessing and changing managerial ability so any research must consider all these components.

3. Psychological aspects of farmers' managerial processes and ability

There have been many studies directed at rational production economics (Rae, 1977) and farm/farmer efficiency, but few on the farmer *per se*. One of the early studies was of US midwestern farmers (Johnson et al., 1961). The main objective was to examine the role of information in decision making, to examine the components of management (hypothesised as observing, analysing, deciding, action and acceptance), and to learn what analytical procedures and expectation models were used. They concluded that their hypothesis was correct, and while no work on the farmers' psychology or personal parameters was conducted, it was decided that farmers intuitively knew when a problem existed and there was a positive correlation between education and understanding problems.

Shanteau (1984) noted that most basic disciplines had an agricultural form (agricultural economics, agricultural botany, . . .), but this had never occurred in psychology though one or two pioneers worked

in this area (like Shanteau himself). Examples include Muggen (1969) who concluded, after a review of 73 studies, that farmers were not different to the population at large in factors such as abstract reasoning, memory, numerical ability right through to motivation and risk aversion attitudes. Willock (1997) came to a similar conclusion for Scottish farmers with respect to personality and intelligence. In addition, Salmon (1980) reviewed some of the early work and noted that Van Den Ban (1970) considered 25 Dutch studies and concluded that they did not know which personal qualities were associated with high income. In contrast, Salmon also reports that Krause and Williams (1971) found a positive relationship between change in net worth and personality factors. Furthermore, Bigras-Poulin et al. (1985) believed socio-psychological variables were important in achieving successful production levels. Clearly more work is required to build on these studies. Two other works looking at aspects of farmers' personality are Jose and Crumly (1993), and Nuthall and Bishop-Hurley (1996).

Work on the adoption process, technology transfer and extension (e.g. Morris et al., 1995), on the other hand, has been extensive and has made a major contribution. Many textbooks have been written in this area (e.g. Rogers, 1983; Roling, 1988). This work focuses on the manager and change rather than the whole process of management. Reid et al. (1996), for example, believed farmers were rational in their adoption decisions in that apparent irrationality could be explained using triability, complexity, comparability and observability aspects of innovations. Similarly, there has been an appreciable amount of work on goals, objectives and attitudes (e.g. Gasson, 1973; Fairweather and Keating, 1990). A common conclusion is that profit is only a small component of what underlies the decisions made. This is an important recognition, but is only background to the question of managerial ability. What is also important is farmers' attitudes to, and use of, information (e.g. Lively and Nuthall, 1983; Ryde and Nuthall, 1984) as part of success is knowledge and successful forecasting. However, little more than recording the practices used has been achieved.

Also of relevance to altering ability is the farmer's view of how important he/she is in the control of a farm. Kaine et al. (1994) showed the variation that exists in a sample of Australian farmers. Similarly,

McNairn and Mitchell (1992) found that 85% of a sample of farmers in Ontario had an 'internal locus of control' when it came to soil conservation practice. Clearly, the environment and the farmers' backgrounds will impact on how much control they believe they have. Despite the control belief of the Ontario farmers they had not adopted the soil conservation processes to the extent expected.

It is only very recently that managers' psychological variables have been measured in meaningful ways. One significant study is currently appearing in the literature — this is the Edinburgh Study of Farmer Decision Making (McGregor et al., 1996; Willock, 1997; Edwards-Jones et al., 1998; Austin et al., 1998a,b; Willock et al., 1999a,b). A sample of over 200 Scottish farmers completed many psychological tests as well as questionnaires on goals, objectives, attitudes and farming practices. The tests included intelligence, personality, innovation and health/stress questionnaires. A major emphasis in the study was farmers' attitudes to the environment as an underpinning objective was to provide policy makers with sufficient understanding to enable good environmental rules and regulations. The study was not directed at understanding managerial ability.

Willock (1997, p. 5) noted psychological factors do play an important role in farm decision making. The researchers also related personality factors to goals and attitudes and gave what they regard as the direction and strength of causation. They also noted (p. 6) "... The study permits the identification of those who change more quickly ... they are extrovert, outgoing and likely to communicate the change to a number of other farmers". McGregor et al. (1996) reports that there was a correlation between farmers' IQ and gross farm income per hectare. Edwards-Jones et al. (1998) reported that personological variables explained between 20 and 30% of the observed variation in environmentally oriented behaviour. They also report on a number of structural equations developed to predict environmental and production behaviour. These results are important as they focus attention on the psychology of decision making in a modern context.

Besides recognising the specific competencies important in management (see a later section) it is important to consider a person's inherent capacity to manage. Rougoor et al. (1998) notes that capacity can be divided into (i) drives and motivation, (ii) abilities,

and (iii) biography. They comment on the alternative ways of observing a farmers' managerial ability, and list studies looking at efficiency. They note there is a clear correlation between education and efficiency, but mixed conclusions on the importance of age and experience. One study reported a positive correlation between the 'level of ambition' and milk yield, another reported a correlation between personality and debt levels. Overall clear theories and conclusion did not emerge, but they did conclude that the decision making process is 'under exposed'. Ohlmer et al. (1998) concentrate on exploring this process and how it might be improved. They worked on a number of case studies and concluded the process was not a linear system through planning, execution and control, but a more complex system of dynamic 'visits' to various phases and sub-processes. Many would agree with this concept.

They also concluded that their case study farmers exhibited five characteristics in their decision making (p. 288) "(i) continual updating, (ii) a qualitative approach, (iii) a 'quick and sample' approach, (iv) small tests and incremental implementation, and (v), checking clues during implementation". In attempting to improve managerial ability these attitudes must be taken into account. Ohlmer et al. (1998), also comment that personal networks and clubs are very important in the management process, but when it comes to improving ability their single suggestion is 'education'.

Overall it is clear some acceptance of the importance of managerial ability has occurred and a start made on relating the managers' psychology to decision outcomes, but obtaining an understanding of how to improve managerial efficiency has only been superficially considered.

4. Contributions from decision theorists

4.1. Process steps and skills

Nickerson and Feehrer (1975) conclude decision making involves information gathering, data evaluation, problem structuring, hypothesis generation, hypothesis evaluation, preference specifications, action selection, and decision evaluation. Throughout the decision making literature many variations on this process list can be found. This section presents ideas

on the various steps and, most importantly, biases that tend to modify the rationality of the process. These are important in assessing and improving managerial ability.

Bolger (1995) adds additional components in noting problem recognition and interpretation are important as are cognitive skills, declarative and procedural domain knowledge, as well as knowledge of one's limitations and abilities. For the output phase social communication, production and application skills are all crucial. Extending these ideas further Nickerson (1994) added problem solving involves induction and deduction, and the development of a path through problem space. At each point there is a need to respond to the mental representation of the problem though there is a limit to working memory so the representation may need to be simplified. To overcome this problem schemata are developed thus shifting some of the problem to long term memory. In real world situations, which tend to be dynamic, the complexity means it is seldom possible to face a new problem and produce a totally rational and complete decision process. Experience and repetition are important (Slovic et al., 1977; Brehmer, 1990), as is the correct observation of the relevant cues in the first place (Stevenson et al., 1990).

The decision process is started through some form of problem recognition (Weber, 1994a). Abelson and Levi (1985) suggest decision makers monitor whether there is a discrepancy between the existing and desired states. Accumulating stimuli must reach a 'threshold level' before problem recognition occurs. Information gathering and the isolation of alternatives then starts. Of course, 'problems' might occur when it is recognised new opportunities have been observed in some way even though a problem in the traditional sense has not been isolated.

The dynamic nature of most decision situations is a complicating factor. Thus, not only must correct choices be made but they must also be made in the correct sequence and at the right time. Little research has been conducted on dynamic problems (Stevenson et al., 1990), but one worker, Brehmer (1990), developed simulation models to study the problem and stressed the value of experience. Indeed, there is evidence that 'heuristics' are a common decision procedure, i.e. decision systems and guidelines developed from past experience. Stevenson et al. (1990), note this, as does Plous (1993). People often transfer

an acceptable heuristic from one problem type to another if it is similar and they have no better procedures available. Of course, if this process is not successful, changes will be necessary. Where the best process or course of action is not initially acceptable, the concept of cognitive dissonance comes into play (Festinger, 1957). This theory of attitude change suggests procedures that may not initially be acceptable are eventually taken as normal as no alternatives exist. Thus, the initial dissonance reduces through rationalisation.

Many people make decisions in complex situations without an apparent formal process, and certainly cannot explain how they achieve the outcome. Cook and Stewart (1975) compared subjective/intuitive processes with statistical measures and found few outcome differences. Broadbent et al. (1986) found that decision makers can learn to improve their performance without actually knowing why. The experience has provided lessons which are automatically absorbed by processing and memory systems. This whole area of subjectivity and intuition has been little studied. Hammond (1990) provides a fascinating, though brief, review of the situation regarding intuition and notes there are few models explaining the process. Clearly, however, intuition is an important skill, and needs to be explored as a factor in managerial ability.

The study of experts, who may well develop excellent intuition, is important in considering managerial ability. Cooke (1992), in reviewing expertise, quotes several authors and lists the characteristics of experts as (1) excelling mainly in their own domains; (2) perceiving large meaningful patterns; (3) quickly solving problems with little error; (4) having superior short-term and long-term memory; (5) seeing and representing a problem in their domain at a deeper (more principled) level than novices; (6) spending a great deal of time analysing a problem quantitatively; and (7) having strong self-monitoring skills.

Shanteau and Phelps (1977) complemented this list with noting that learning to be an expert involves (1) defining what the problem is and what its dimensions are; (2) accurately perceiving stimuli; (3) knowing how much weight to put on each stimuli and (4) developing the appropriate combination rule and output domain for making the final judgement.

The decision making psychologists reinforce common observations that the process involves many steps that relate to each other in complex ways. To achieve

decision rationality each must be understood and successfully concluded if a person is to become an expert, in this case, farm manager. Practice, with feedback, and experience are clearly important in this process of developing successful heuristics and constructs.

4.2. Biases in decision making

Despite the best intentions to follow the correct processes, many decision makers look back and decide they could have made a better decision. This might be due to chance, or more likely, error. In many cases people may not be aware of lost opportunities and mistakes. This raises the whole area of decision biases — they are part of the human decision process. Weber (1994b) talks about some of the reasons for error — objectives unknown, unsure, alternatives not clear, too much uncertainty, ambiguous information to process, time pressure and stress, and so on. Clearly, a decision maker should be aware of potential biases and make every effort to overcome them. This is where training could be crucial to improving managerial ability.

Decision makers are influenced by emotions and stress despite the best intentions. Bohm and Pfister (1996) showed that emotions can have a significant effect on the rationality of decisions. From a trait/state point of view Matthews and Deary (1998) discuss anxiety and decisions and note the impact of neuroticism on decisions. Eysenck and Keane (1990) similarly note that depressed people operate differently when in this state. Furthermore, McGregor et al. (1995) found that British farmers did experience considerable stress. Thus, personality, emotions and current anxiety levels must influence decision rationality and processes, and must be appropriately allowed for. Atkinson et al. (1990) talk about stress coping mechanisms.

Overall, there has been a significant amount of research into decision biases. It is appropriate to briefly mention biases that may have significance in managerial ability. Anchoring (Chapman and Johnson, 1994) refers to conclusions being altered by the starting point. For example, real estate appraisers came to different conclusions when given different suggested valuations. Estimates of probabilities are notoriously prone to error (Stevenson et al., 1990; Payne et al., 1992; Bolger, 1995). Furthermore, general estimates are not adjusted according to the sample size. Other cognitive errors (De Rubeis and Beck,

1988) include conclusions without evidence, selective abstraction — picking out evidence that suits, over-generalisation — creating an hypothesis on a minimum of evidence and applying it widely, observation errors, dichotomous thinking — putting observations into two extreme categories rather than recognising the continuous reality, chunking — breaking difficult tasks into inappropriate chunks.

Remembering the good and not the bad outcomes is common, as is the 'availability effect' (Abelson and Levi, 1985). 'Availability effect' is the ease of retrieval which means that such evidence is overweighted. Memory is fallible and often alters what happened in the light of hindsight. Similarly, what is remembered often depends on the context (Plous, 1993). Often the first information in a list is remembered (primacy effect), which is in contrast to a 'recency effect' where the most recent impression dominates. Then there is the 'halo' effect, i.e. something good is assumed to have several good attributes (e.g. high quality is assumed when getting a high yield). The way a problem or information is 'framed' can also influence the outcome. Thus, the way technical information is presented in a journal may well influence the conclusion. Research also shows that the 'availability heuristic' affects conclusions, i.e. the ease with which instances come to mind.

Social influences and confidence are also important (Plous, 1993). Who presents the information, and who assists in decision making can well lead to bias. Similarly, there is good evidence that overconfidence is a danger in making correct decisions (Bolger, 1995). Then there is the 'self fulfilling prophecy' which means clearly that there are many traps. Another common mistake is to continue investing in a bad project in the hope of recovering some of the money, and there is also the tendency to assume a good outcome is likely after a run of bad events. Slovic et al. (1977) describe some of the experiments associated with these biases. Besides selective memory recall, experiments indicate (Weber, 1997) people tend to smooth recollected reality thus reducing the real variability.

Some people are less than diligent in seeking good decisions. Slovic et al. (1988) review work where an 'acceptable' outcome is chosen rather than continuing the search. Perhaps this is rational in some cases as the cost of extra seeking is considered too great. Similarly, they found (p. 721) that as a problem becomes

more complex simplifying processes are sought, for example, concentrating on what is regarded as the most important goal in a multi-goal situation. No doubt a decision makers' self esteem (Heatherton, 1991) impacts on their diligence in the search for excellence, as will other personality factors.

Thaler and Shefrin (1981) looked at self control and rates of impatience, maintaining that a person was both a 'doer' and a 'planner', with the planner wanting to be rational, whereas the doer wants to act now. One of these aspects tends to dominate at various levels giving rise to individual impatience. Similarly, a farmers' 'locus of control' (Kaine et al., 1994) can lead to irrational decisions.

No doubt more biases will be discovered as the work in this area is quite extensive. This research is emerging into popular texts for managers (e.g. Russo and Schoemaker, 1989).

Work continues on the development and quantification of decision models and processes, particularly systems that explain how decision makers operate (e.g. Lusk and Hammond (1991) who looked at weather forecasting using the lens model). However, for an individual decision maker, what is important is recognising failures and biases and then attempting to counteract these actions. Rules and procedures are stored and become automatic in many cases including all the 'irrational' aspects (biases). The challenge is to devise methods of observing the biases and then removing them. Is this possible?

5. Goals, objective, attitudes and competencies

To gauge managerial ability requires some form of yardstick. To improve ability requires an understanding of the components, or competencies, of the managerial task. There is a mass of literature on goals, objectives and attitudes, but rather less on the competencies. For competencies this section mentions a minor segment of this work though future research must consider these aspects in considerable depth. A difficulty is that there is little agreement in the literature on a general theory of goal measurement. However, in the end it is the farmer/farm family that chooses so perhaps in developing means of improving managerial ability it should equally be the farmer/family that decides whether using such means might be beneficial.

When choices are made, according to Mischel (1990), a range of positive and negative emotional states are experienced resulting from the stimuli emanating from the alternatives. Mischel maintains the basic values, goals and interests are relatively stable, though other work (see below) suggests their expression may not. Performance is monitored by a person relative to the goals thus self criticism and reward occurs leading to potential change in behaviour. Numerous workers have tried to quantify this process in various ways leading to many proposed models. Plous (1993) reviews many of these such as prospect theory, regret theory, multi-attribute utility theory (MAUT — Slovic et al., 1977), and non-compensatory strategies. Weber (1994a) introduces the concept that people compare possibilities relative to a 'base' and acceptance occurs if this is exceeded. Then there is the impact of risk and uncertainty as a factor in objectives (Anderson et al., 1977; Dillon and Perry, 1977). This is undoubtedly important as variability is an important feature of the real world with the shape of the utility function influencing choice (Abelson and Levi, 1985). It also appears past good, or bad, luck influence the approach taken (Weber, 1994b).

In most of this work quantification of the objective function has been important (Dillon and Perry, 1977). This quantification, however, has also made it clear that there are often many contrasting choices that produce a near optimal objective value (Thorngate, 1980). This is an important point as with the failure to achieve a general agreement on objectives this does not prevent positive and useful work from continuing. Another potentially complicating factor is the intransitivity of goals and objectives. Payne et al. (1992) maintain that goals are dynamic and the current mood can affect choice. Bentler and Speckart (1981) maintain that behaviour impacts on attitudes. Thus, if behaviour ends up being inconsistent with an attitude, then the attitude is often changed through rationalisation. Effectively, a dynamic behaviour attitude complex exists. Slovic et al. (1988, p. 705) also note "people do not always make the same choice when faced with the same alternatives under seemingly identical conditions". They postulate that there is a random element in choice as well as changing tastes. This random element may follow a definable probability distribution.

It is clear that developing an ability to quantify objective attainment that is universally acceptable is

probably impossible. Thus, assessing improvement in managerial ability will need to rely on a range of measures with the decision operator making his/her own decisions. If the recipient feels that a particular approach has led to gains then clearly they will deem the process a success. Equally as important is the need for the decision maker to learn to consider and clearly enunciate his or her objectives in the light of the research presented above.

Turning to other competencies, a study of expert decision makers is clearly a starting point in listing the important areas, as is a search of the literature for already compiled lists. Such lists have been developed through logic and asking practitioners to consider the skills they use (see Lees (1991) for a review of methods).

Shanteau (1992) concluded that experts tend to select specific key information and use simplifying heuristics which only practice and experience can produce. As noted earlier, Cooke (1992) found experts perceive large meaningful patterns in their domain. In making a list of competencies such lists of the characteristics of expert needs to be taken into account. Not mentioned in this referred to work is record keeping. Studies have found a correlation between success and adequate records (see, for example, Benbow and Nuthall, 1998).

Shanteau (1990) believes experts have (1) highly developed perceptual abilities, i.e. can see/observe things novices do not notice; (2) good sense of what is relevant/irrelevant; (3) ability to simplify complex problems (see also Payne et al., 1992); (4) ability to handle adversity, i.e. can work under stressful conditions; (5) are good at identifying and adapting to exceptions to standard procedures; (6) strong self confidence; (7) are creative in adapting old decision strategies or finding new ones and (8) up to date current knowledge. Most would agree with this list. More general lists have been created by several workers. For commerce in general Page et al. (1994) interviewed many groups and concluded on a 45 component list. Goleman (1998) considers personal competencies and another list was provided by Linstead (1990). For Australian educational purposes Lees (1991) interviewed groups from different farming backgrounds and produced further comprehensive lists. Salmon (1980) also produced Australian oriented lists. The importance of risk and uncertainty (Knight, 1921)

in primary production should be singled out. Consequently, assessing and allowing for non-certainty (Anderson et al., 1977) is an important competency that requires special attention.

An amalgam of these lists also includes such factors as an ability to identify problems and opportunities, an ability to observe and find relevant information, an ability to visualise the consequence of possible actions, an ability to anticipate outcomes and act in good time, and having appropriate technical skills. In devising managerial training programmes all these basic competencies must be elucidated and catered for. These are the starting points for a research programme.

6. Changing and improving managerial ability

Each manager exhibits a skill level for each competency, which is a product of his or her genotype and environmental experiences. To achieve improvement training programmes are necessary. These programmes may involve relatively formal course work and/or reading programs through to working with a mentor on a more intensive one to one way, or some combination of these extremes. This process involves improving the competencies in contrast to simply acquiring new technical knowledge *per se* — this is a different process. A major concern is whether modern methods are capable of changing many of the embedded competencies. This section considers this crucial factor.

It is useful to consider the learning process and studies on its effectiveness. According to Anderson (1983), learning involves (1) an interpretative stage, i.e. factual/declarative knowledge related to the domain is learned; (2) knowledge compilation, i.e. development of general purpose production rules consisting of (a) composition (putting together in chunks and understanding the structure and theories), and (b) proceduralisation (embedding domain specific factual knowledge into production rules), and (3) fine tuning (strengthening of successful production rules and weakening of unsuccessful ones).

Nuthall (1997) similarly believes learning is a highly interactive process with, eventually, new concepts being embedded into long term memory. Furthermore, this process takes place in everyday life as well as in formal teaching/learning situations. Page et al.

(1994) stress this point as does Linstead (1990) who contends the best approach is 'experiential learning'. This does not mean leaving the process to experience, but rather developing teaching methods that are discovery based experiential, use simulated problem solving and involve group working. Nickerson and Fehrer (1975) also stressed the importance of experience and the need to repeat a process with proper instruction following an erroneous activity. The mental model of the process can thus be corrected. As Eysenck and Keane (1990) also point out, many decision systems eventually become internalised and thus automatic. This is acceptable if the lessons learnt are logical and correct, but if not, changing these internalised rules can be difficult.

As Paine (1993) stresses, each manager has his/her unique personality and intelligence and therefore acquires new and improved skills in slightly different ways. Thus, any programme must be sufficiently flexible to enable individuals to use methods that best suit them. It would also seem feedback (Busemeyer and Myung, 1992) is a very important part of the learning process.

There is considerable evidence to support the effectiveness of formal training in adults with respect to a wide range of skills. Gaeth and Shanteau (1984) report on making lasting improvements to soil judges after comparing alternative training systems. Nickerson (1994) reports the quality of statistical and probability thinking processes is improved by training as was deductive reasoning. Bolger (1995), in reviewing 50 comparisons between experts and novices, concludes that training has a significant effect on accuracy, but simple experience has little or no effect (perhaps due to the lack of appropriate feedback). Garb (1989) comments formally on this point that he found a correlation between training and clinical judgement, but not between experience and judgement due to the poor feedback.

In a study of farmer education and efficiency in less developed countries, Phillips (1994) concludes that 4 years of education increases efficiency by approximately 6%. In another study Lockheed et al. (1980) found 4 years of study increased productivity by 7.4% in a range of less developed countries. The results are remarkably similar. In a study of US dairy farmers Stefanou and Saxena (1988) showed that education and experience were substitutes in improving

efficiency (production levels). Perhaps the higher levels of base education allow learning from experience more effectively than in less developed countries.

Other studies are Shanteau (1978) reporting on the impact of training on livestock judges, Slovic et al. (1977) noting the impact of various procedures on probability estimation improvement, Slovic et al. (1988) pointing out the benefits of training on reducing decision bias, and, finally, Burnside and Faithfull (1993) demonstrating the improvement of Western Australian graziers' judgement of flora through the use of photographs. The conclusion must be that appropriate formal training programmes can improve adult farmers' competency skills. The quantification of the potential benefits, both monetary and other, has yet to be determined in developed country situations.

Formal courses are only part of the picture. Some farmers might require more intensive training. Psychologists and psychiatrists have developed theories and procedures for modifying personalities and skills. There is no reason why appropriate components cannot be utilised for improving management competencies. The therapies used are designed to alter the stimuli-reaction processes to ones more appropriate. The same situation exists in decision making. Some people wish to modify their decision processes for a better achievement of their goals.

An overview of the mass of literature in psychology indicates there are many theories on how to modify thinking and action. Dobson (1988) and Atkinson et al. (1990) both provide summaries of the more important theories. Dobson gives 18 different concepts ranging from classical psychoanalysis developed by Freud with its emphasis on the sub-conscious, through to conditioning systems with an emphasis on external events, behavioural changes and association. Atkinson et al. (1990) note that many of the therapies do have common features. These include desensitisation which reduce the threatening qualities of each situation; reinforcement of adaptive responses increase the positive attitudes and actions and reinforce them; understanding or insight i.e. providing an explanation of the problems experienced; interpersonal relationships with warmth, trust and understanding; reassurance and support.

There are a range of variations on cognitive behaviour therapies. Dobson and Block (1988) review many of these. They state (p. 17) "logical errors

in thinking acquired during the development period become the substance of schemata that predispose individuals to experience (emotional) problems". Therapy involves replacing the irrational appraisals. The components of treatment involve teaching the recipient to (i) monitor automatic thoughts, (ii) recognise the relations between cognition, affect and behaviour, (iii) test the validity of the automatic thoughts, (iv) substitute more realistic cognition for these distorted thoughts and (v) learn to identify and alter the underlying assumptions or beliefs that predispose individuals to engage in faulty thinking patterns. It would seem logical to apply this proven process to decision making competencies.

There is considerable statistically grounded evidence that cognitive behaviour therapy creates lasting and beneficial change. This evidence relates to conditions such as depression and agoraphobia, so research is necessary to test the model on management competencies. Dobson and Block (1988) note the benefits for depression, D'Zurilla (1988) similarly quotes work on unipolar depression trials, Rehm and Rokke (1988, p. 194) found that with constant reinforcement of appropriate attributions permanent shifts occur, and they also give reference to treatment versus control studies that have shown significant success. Similarly, Dryden and Ellis (1988, p. 259) provide reference to the positive results of using rational emotive therapy.

It would seem that both appropriate formal training and specifically designed cognitive behaviour therapy could well be a significant force in improving the managerial ability of farm managers.

7. Research and development

The theme of the discussion is that a farmers' managerial ability can be improved. Research is necessary to develop procedures to achieve this, to compare and contrast these to isolate the most appropriate for different situations, and to ascertain the extent and type of the improvement possible.

Initially it will be necessary to verify the list of important competencies through interacting with farmers and associated groups (for example, farm consultants). It will then be necessary to develop psychometric tests (Kline, 1993; Loewenthal, 1996) to measure skill in

each competency. Associated with this work must be the development of training programmes and management therapy procedures and protocols for each competency. The tests can then be used throughout the change periods to gauge success levels. In addition, throughout and beyond the treatment periods it will be necessary to monitor and gauge levels of the goals and objectives nominated by the farmers as these values must be the final arbiter in quantifying the success or otherwise of the programmes. Such data will enable comparison between the approaches.

This whole programme requires many observation measuring and questioning procedures. The obvious discipline to turn to for assistance is psychology. Many tests already exist for personality, intelligence, stress, innovation and coping (Austin et al., 1998a,b), and these can be used for observing the basic psychological characteristics of farmers, though, as they have been developed and tested for the general population, some modification to better suit primary production situations may be appropriate.

Psychologists and sociologists, as well as statisticians, have developed a body of literature on the development of defensible tests. These procedures will need to be instituted for the development of competency tests. Aiken (1991), Kline (1993) and Loewenthal (1996) all discuss the principles involved and, in particular, Kline gives examples. For ascertaining competencies workers such as Krzystofiak et al. (1979) and Lees (1991) need to be consulted.

According to Kline (1993), tests must be reliable, consistent and valid. It is also necessary to have test values for normal populations so individual test recipients can be assessed relative to these norms. Reliability refers to stability over time and internal consistency, i.e. you get the same results with test and re-test situations given reasonable time lapses. Split half reliability is also important. This means splitting the series of questions making up the test into two groups (odds and evens) with the results from each being perfectly correlated. Frequently it is necessary to have several forms of a test (a different set of questions designed to test the same factor (competency)) so that when repeating a test on the same subjects they are not exposed to the same set of questions. These must have a 'parallel form' reliability with correlations greater than the generally accepted cut off of 0.7.

Kline (1993) defines a valid test as one that measures what it purports to measure. Thus, an overall test for managerial ability for farmers that profess to be profit maximisers might be related to historic farm profit data suitably amended for time trends. Validity can be broken into concurrent validity (the correlation between several tests), predictive validity (correlation of test with subsequent verifying measures, e.g. future profit), content validity (cover all components of a competency), and differential validity (valid answers in different areas).

Having developed a test it must be standardised (Kline, 1993, p. 42), i.e. population samples are used to develop expected scores. Normal sampling and stratification procedures are necessary. Use of regression analysis over large samples enables creating correction factors for age, education, sex and perhaps other potentially modifying parameters that should be eliminated (e.g. farming type experience).

All proposed test questions need to be analysed for correlation and the underlying factors. Kline (1993) believes factor analysis (Lewis-Beck, 1994) should be used to ensure that each test group only tests for one basic factor, otherwise the results can be confounded. Thus, test development requires initially setting up a series of questions designed to test a competency, then using the set on several samples, testing its reliability and validity, and then developing norms after proper factor and statistical analysis.

The major component in the research programme will be the development of a range of competency enhancement training programmes. These can range from group programmes to courses for individual tuition with or without tutor support. Use of computer based programmes must also be considered including simulation games. Salmon (1980) believes games are a powerful way to alter beliefs. Initially dichotomous approaches should be used to indicate the most rewarding approach for each competency. The psychometric tests development can then be used to gauge the success of the programmes.

It will be necessary to quantify the relationships between training programmes and outcomes for no other reason than to assess the potential gains relative to costs. However, it will also be important to obtain a basic understanding of the personality and intelligence relationships to the various competencies and their change. Linear and non-linear multi-variable

procedures will be necessary. Austin et al. (1998a,b) provide a good review of analytical methods suitable for psychological, social and economic variables.

8. Conclusions

Efficient farm production and appropriate goal attainment depends on the correct resource allocation. Research into the technology of production has dominated the study of efficiency. Economists' contributions have been relatively insignificant in that farmers have seldom used the decision models developed (Malcolm, 1990; Ohlmer et al., 1998), relying largely on common sense to make their decisions. Farmers' success levels vary enormously as shown by many studies including the economists' efficiency studies using both data envelope analysis and stochastic frontier production function approaches. For example, Battese et al. (1996) found Pakistani wheat farmers exhibited a mean efficiency of 57–79% depending on the district, which is surprisingly low. Arnade (1998), who used a data envelope analysis, compared efficiency in 70 countries and found, in relative terms, countries like New Zealand had 100% efficiency, but this ranged down to 35% for Zambia.

Most efficiency studies look at technical and profit efficiency and rely on comparing one farm with another. The variation is assumed to occur through misallocation and thus due to managerial efficiency failure. This crucial aspect has had little study over the decades of primary production research. The tenant of this discussion is that there could be significant returns by increasing the research effort. The production economics assumption of diminishing marginal returns and its conclusion that optimality demands equi-marginal returns would suggest greater research funds should be directed to research on improving managerial ability. This does not mean that there is a need for some mega-theory incorporating all aspects of production, but rather work on the components of ability.

It has been argued that for this research to proceed it is necessary to introduce what psychologists have learnt about cognitive processes, judgement and decision making into a new programme. This should ascertain the important competencies and develop valid and reliable tests for these competencies, create

competency training programmes, and then test their effectiveness. Due to the complexities of the human mind, and the many components to manage, it will take many years of research to enable assessing the likely payoff for well tested training regimes that are designed for both group and individual use. While a study of management in general (e.g. industrial psychology; Kelley, 1992) can provide some lessons, the uniqueness of primary production with all its complexities, demands specific procedures and programmes.

Farm management is essentially a pragmatic, as well as normative, discipline relying on utilising methods evolved in other areas. Some would argue that many components of psychology are positivistic, as its objective is to explain actions and re-actions. Thus, in using psychologists' models as a guide to managerial ability research care must be exercised.

Thinking of the future, Stevenson et al. (1990) noted (p. 364) "judgement and decision making research has made few inroads into our psychological understanding of cognition and choice. We think this will change". The opportunities for applying this to primary production are clearly significant and potentially profound.

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References

Abelson, R.P., Levi, A., 1985. Decision making and decision theory. In: Lindzey, G., Aronson, E. (Eds.), *The Handbook of Social Psychology*, 3rd Edition, Vol. 1. Random House, New York (Chapter 5).

Aiken, L.R., 1991. *Psychological Testing and Assessment*, 7th Edition. Allyn & Bacon, Boston.

Anderson, J.R., Dillon, J.L., Hardaher, J.B., 1977. *Agricultural Decision Analysis*. Iowa State University Press, Ames, IA.

Anderson, J.R., 1983. *The Architecture of Cognition*. Cambridge, MA., Harvard University press.

Arnade, C., 1998. Using a programming approach to measure international agricultural efficiency and productivity. *J. Agric. Econ.* 49 (1), 67–84.

Atkinson, R.L., Atkinson, R.C., Smith, E.E., Bem, D.J., 1990. *Introduction to Psychology*, 10th Edition. Harcourt, Brace and Jovanovich Publishers, San Diego.

Austin, E.J., Willock, J., Deary, I.J., Gibson, G.J., Dent, J.B., Edwards-Jones, G., Morgan, O., Grieve, R., Sutherland, A., 1998a. Empirical models of farmer behaviour using psychological social and economic variables. Part I: Linear models. *Agric. Syst.* 58 (2), 203–224.

Austin, E.J., Willock, J., Deary, I.J., Gibson, G.J., Dent, J.B., Edwards-Jones, G., Morgan, O., Grieve, R., Sutherland, A., 1998b. Empirical models of farmer behaviour using psychological social and economic variables. Part II: Non-linear and expert modelling. *Agric. Syst.* 58 (2), 225–241.

Bannister, D. (Ed.), 1997. *New Perspectives in Personal Construct Theory*. Academic Press, London.

Battese, G.E., Malik, S.J., Gill, M.A., 1996. An investigation of technical inefficiencies of production of wheat farmers in four districts of Pakistan. *J. Agric. Econ.* 47 (1), 37–49.

Benbow, C., Nuthall, P., 1998. Food for thought. Management of sheep feed — the search for efficiency. *Primary Ind. Manage.* 1 (2), 30–34.

Bentler, P.M., Speckart, G., 1981. Attitudes cause behaviors: a structural equation analysis. *J. Personality Social Psychol.* 40 (2), 226–238.

Bigras-Poulin, M., Meek, A.H., Blackburn, D.J., Martin, S.W., 1985. Attitudes, management practices, and herd performance — a study of Ontario dairy farm managers. I. Descriptive aspects, and II. Associations. *Preventative Vet. Med.* 3, 250–277.

Bohm, G., Pfister, H., 1996. Instrumental or emotional evaluations: what determines preferences? *Acta Psychol.* 93, 135–148.

Bolger, F., 1995. Cognitive expertise research and knowledge engineering. *Knowledge Eng. Rev.* 10 (1), 3–19.

Brehmer, B., 1990. Strategies in real-time, dynamic decision making. In: Hogarth, R.M. (Ed.), *Insights in Decision Making. A Tribute to Hillel J. Einhorn*. University of Chicago Press, Chicago, pp. 262–279.

Broadbent, D.E., Fitzgerald, P., Broadbent, M.H.P., 1986. Implicit and explicit knowledge in the control of complex systems. *Br. J. Psychol.* 77, 33–50.

Burnside, D.C., Faithfull, E., 1993. Judging range trend: interpretation of rangeland monitoring data drawn from sites in the Western Australian shrublands. *Rangeland J.* 15 (2), 247–269.

Busemeyer, J.R., Myung, I.J., 1992. An adaptive approach to human decision making: learning theory, decision theory, and human performance. *J. Experimental Psychol.: Gen.* 121 (2), 177–194.

Cantor, N., Zirkel, S., 1990. Personality cognition & purposive behaviour. In: Pervin, L.A. (Ed.), *Handbook of Personality: Theory and Research*. Guilford Press, New York (Chapter 6).

Chapman, G.B., Johnson, E.J., 1994. The limits of anchoring. *J. Behav. Decision Making* 7, 223–242.

Cook, R.L., Stewart, T.R., 1975. A comparison of seven methods for obtaining subjective descriptions of judgmental policy. *Org. Behav. Human Performance* 13, 31–45.

Cooke, N.J., 1992. Modelling human expertise in expert systems. In: Hoffman, R.R. (Ed.), *The Psychology of Expertise* —

Cognitive Research and Empirical A.I. Springer, New York (Chapter 3).

Dewey, J., 1964. Logic: The Theory of Enquiry. Holt, New York.

De Rubeis, R.J., Beck, A.T., 1988. Cognitive therapy. In: *Handbook of Cognitive Behavioural Therapies*. Guilford Press, London (Chapter 7).

Dillon, J.L., Perry, C., 1977. Multiattribute utility theory, multiple objective and uncertainty in *ex ante* project evaluation. *Rev. Marketing Agric. Econ.* 45 (1/2), 3–27.

Dobson, K.S., 1988. The present and future of cognitive behavioural therapies. In: Dobson, K.S. (Ed.), *Handbook of Cognitive Behavioural Therapies*. Guilford Press, London (Chapter 10).

Dobson, K.S., Block, L., 1988. Historical and philosophical bases of cognitive behavioural theories. In: Dobson, K.S. (Ed.), *Handbook of Cognitive Behavioural Therapies*. Guilford Press, London (Chapter 1).

Dryden, W., Ellis, A., 1988. Rational-emotive therapy. In: Dobson, K.S. (Ed.), *Handbook of Cognitive Behavioural Therapies*. Guilford Press, London (Chapter 6).

D'Zurilla, T.J., 1988. Problem solving therapies. In: Dobson, K.S. (Ed.), *Handbook of Cognitive Behavioural Therapies*. Guilford Press, London (Chapter 3).

Edwards-Jones, G., Deary, I., Willock, J., 1998. *Modelling Farmer Decision Making. What Can Psychology do for Agricultural Policy Assessment Models*. Etudes et Reserches sur les Systemes Agraires et la Development, 153–173.

Eysenck, M.E., Keane, M.T., 1990. *Cognitive Psychology — A Students' Handbook*. Erlbaum Associates, London.

Fairweather, J., Keating, N., 1990. Management Styles of Canterbury Farmers: A Study of Goals and Success from the Farmers' Point of View. Agribusiness and Economics Research Unit, Research Report No. 205, Lincoln University, Canterbury.

Festinger, L., 1957. A Theory of Cognitive Dissonance. Harper & Row, New York.

Gaeth, G.J., Shanteau, J., 1984. Reducing the influence of irrelevant information on experienced decision makers. *Org. Behav. Human Performance* 33, 263–282.

Garb, H.N., 1989. Clinical judgement, clinical training, and professional experience. *Psychol. Bull.* 105 (3), 387–396.

Gasson, R., 1973. Goals and value of farmers. *J. Agric. Econ.* 24 (3), 521–542.

Goleman, D., 1998. *Working with Emotional Intelligence*. Bloomsbury, London.

Hammond, K.R., 1990. Intuitive and analytical cognition: information models. In: *Concise Encyclopaedia of Information Processing in Systems and Organizations*, 1st Edition. Pergamon Press, Oxford, pp. 306–312.

Heatherton, T.F., 1991. Development and validation of a scale for measuring state self-esteem. *J. Personality Social Psychol.* 60 (6), 895–910.

Horn, J., Cattell, R.B., 1966. Refinement and test of the theory of fluid and crystallised intelligence. *J. Educ. Psychol.* 57, 253–270.

Johnson, G.L., Halter, A.N., Jensen, H.R., Thomas, D.W. (Eds.), 1961. *A Study of Managerial Processes of Mid-Western Farmers*. Iowa State University Press, Ames, IA, 221 pp.

Jose, H.D., Crumly, J.A., 1993. Psychological type of farm/ranch operators: relationship to financial measures. *Rev. Agric. Econ.* 15 (1), 121–132.

Kaine, G., Lees, J., Sandall, J., 1994. *Planning and Performance: An Exploration of Farm Business Strategy and Perceptions of Control*. The Rural Development Center, University of New England, Armidale.

Kelley, K., 1992. *Issues, Theory, and Research in Industrial/Organizational Psychology*. North-Holland, Amsterdam.

Kline, P., 1993. *The Handbook of Psychological Testing*. Routledge, London.

Knight, F.H., 1921. *Risk, Uncertainty and Profit*. Harper & Row, New York.

Koestner, R., McClelland, D.C., 1990. Perspectives on competence motivation. In: Pervin, L.A. (Ed.), *Handbook of Personality: Theory and Research*. Guilford Press, London (Chapter 20).

Krause, K.R., Williams, P.L., 1971. Personality characteristics related to managerial success. *Technical Bulletin* 30, South Dakota State University, Agr. Expt. Station, Brookings.

Krzystofiak, F., Newman, J.M., Anderson, G., 1979. A quantified approach to measurement of job content: procedures and payoffs. *Personnel Psychol.* 32, 341–357.

Kuhn, T.S., 1996. *The Structure of Scientific Revolutions*, 3rd Edition. Chicago University Press, Chicago.

Lees, J.W., 1991. *Competencies for Farming: A Compendium of Profiles*. The Rural Development Center, University of New England, Armidale.

Lewis-Beck, M.S., 1994. *Factor Analysis and Related Techniques*. Saga Publications, London.

Linstead, S., 1990. Developing management meta-competence — can distance learning help? *J. Eur. Industrial Training* 14b, 17–27.

Lively, R.T., Nuthall, P.L., 1983. A Survey of Farmers' Attitudes to Information. Agricultural Economics Research Unit, Discussion Paper No. 76, Lincoln College, Canterbury.

Lockheed, J.E., Jamison, D.J., Lau, L.J., 1980. Farmer education and farm efficiency: a survey. *Econ. Dev. Cult. Change* 29 (1), 37–76.

Loewenthal, K.M., 1996. *An Introduction to Psychological Tests and Scales*. University College London, London.

Lusk, C.M., Hammond, K.R., 1991. Judgement in a dynamic task: microburst forecasting. *J. Behav. Decision Making* 4, 55–73.

Malcolm, L.R., 1990. Fifty years of farm management in Australia: survey and review. *Rev. Marketing Agric. Econ.* 58 (1), 24–55.

Matthews, G., Deary, I.J., 1998. *Personality Traits*. Cambridge University Press, Cambridge.

McGregor, J., Willock, J., Deary, I., 1995. Farmer stress. *Farm Manage.* 9 (2), 57–65.

McGregor, J., Willock, J., Dent, B., Deary, I., Sutherland, A., Gibson, G., Morgan, O., Grieve, B., 1996. Links between psychological factors and farmers' decision making. *Farm Manage.* 9 (5), 228–239.

McNairn, H.E., Mitchell, B., 1992. Locus of control and farm orientation: effects of conservation adoption. *J. Agric. Environ. Ethics* 5 (1), 87–101.

Miller, G.A., 1956. The magical number seven, plus or minus two: some limits on our capability. *Psychol. Rev.* 63 (2), 81–97.

Mischel, W., 1990. Personality dispositions revisited and revised: a view after three decades. In: Pervin, L.A. (Ed.), *Handbook of Personality — Theory and Research*. Guilford Press, London (Chapter 5).

Morris, C., Loveridge, A., Fairweather, J.R., 1995. *Understanding Why Farmers Change Their Farming Practices. The Role of Orienting Principles in Technology Transfer*. Agribusiness and Economics Research Unit, Research Report No. 232, Lincoln University, Canterbury.

Muggen, G., 1969. Human factors and farm management. A review of the literature. *World Agric. Econ. Rural Sociol. Abstracts* II (2), 1–11.

Nickerson, R.S., 1994. The teaching of thinking and problem solving. In: Sternberg, R.J. (Ed.), *Thinking and Problem Solving*. Academic Press, San Diego (Chapter 13).

Nickerson, R.S., Feehrer, C.E., 1975. A Review of Theoretical and Empirical Studies of Decision Making and Their Implication for the Training of Decision Makers. Technical Report 73-c-0128-1, Naval Training Equipment Center, Orlando.

Nuthall, G.A., 1997. Learning how to learn. The social construction of knowledge acquisition in the classroom. In: Proceedings of the Paper Presented at the 7th Biennial Conference of the European Association for Research in Learning and Instruction.

Nuthall, P.L., Benbow, C., 1998. Computer System Uptake and Use on New Zealand Farms — 1998 and 1993 Comparisons. Mimeo, Management System Research Unit, Lincoln University, Canterbury, p. 54.

Nuthall, P.L., Bishop-Hurley, G.J., 1996. Expert systems for animal feeding management. Part II. Farmers' attitudes. *Comput. Electron. Agric.* 14, 23–41.

Ohlmer, B., Olson, K., Brehmer, B., 1998. Understanding farmers' decision making processes and improving managerial assistance. *Agric. Econ.* 18, 273–290.

Olsson, R., 1988. Management for success in modern agriculture. *Eur. Rev. Agric. Econ.* 15, 239–259.

Page, C., Wilson, J., Kolb, D., 1994. Management Competencies in New Zealand: On the Inside Looking In. Ministry of Commerce, Wellington.

Paine, M.S., 1993. Extension agents can perform more effectively through an appreciation of individual learning styles. *Proc. New Zealand Soc. Anim. Prod.* 53, 115–119.

Payne, J.W., Bettman, J.R., Johnson, E.J., 1992. Behavioural decision research: a constructive processing perspective. *Annu. Rev. Psychol.* 43, 87–131.

Phillips, J.M., 1994. Farmer education and farmer efficiency: a meta-analysis. *Econ. Dev. Cult. Change.* 43 (1), 149–166.

Piech, B., Rehman, T., 1993. Application of multiple criteria decision making methods to farm planning: a case study. *Agric. Syst.* 41, 305–319.

Plous, S., 1993. *The Psychology of Judgement and Decision Making*. McGraw-Hill, New York.

Popper, K.R., 1959. *The Logic of Scientific Discovery*. Basic Books, New York.

Rae, A., 1977. *Crop Management Economics*. Crosby Lockwood Staples, London.

Rehm, L.P., Rokke, P., 1988. Self management therapies. In: Dobson, K.S. (Ed.), *Handbook of Cognitive Behavioural Therapies*. Guilford Press, London (Chapter 4).

Reid, J.I., Coulson, J.L., Cameron, E.A., 1996. A framework for understanding the adoption and use of technologies by dairy farmers. In: *Proceedings of the 3rd Annual Conference of the New Zealand Agricultural Economics Society*, Blenheim, pp. 209–217.

Rogers, E.M., 1983. Attributes of innovations and their rate of adoption. In: *Diffusion of Innovations*, 3rd Edition. Collier MacMillan, London.

Roling, N., 1988. *Extension Science*. Cambridge University Press, Cambridge.

Rougoor, C.W., Trip, G., Huirne, R.B.M., Rendema, J.A., 1998. How to define and study farmers' management capacity: theory and use in agricultural economics. *Agric. Econ.* 18, 261–272.

Russo, J.E., Schoemaker, P.J.H., 1989. *Decision Traps: Ten Barriers to Brilliant Decision Making and How to Overcome them*. Simon & Schuster, New York.

Ryde, J., Nuthall, P.L., 1984. Farmers Record Keeping and Planning Practices: A Postal Survey. Agricultural Economics Research Unit, Discussion Paper No. 81, Lincoln College, Canterbury.

Salmon, P.W., 1980. A psychological investigation of farm management education. In: *A Personal Construct Theory Approach to Agricultural Extension*. School of Agriculture & Forestry, University of Melbourne, Melbourne, p. 138.

Shanteau, J., 1978. *Psychological Abilities of Livestock Judges*. Bulletin 620, Agricultural Experiment Station, Kansas State University, Manhattan.

Shanteau, J., 1984. Agricultural psychology. *Encyclopaedia Psychol.* 1, 42–43.

Shanteau, J., 1990. Psychological characteristics of agricultural experts: application to expert systems. In: Weiss (Ed.), *Climate and Agriculture: System Approaches to Decision Making*. University of Nebraska, Lincoln.

Shanteau, J., 1992. How much information does an expert use? Is it relevant? *Acta Psychol.* 81, 75–86.

Shanteau, J., Phelps, R.H., 1977. Judgement and swine: approaches and issues in applied judgement analysis. In: *Human Judgement and Decision Processes in Applied Settings*. Academic Press, New York, pp. 255–271.

Slovic, P., Fischhoff, B., Lichtenstein, S., 1977. Behavioural decision theory. *Annu. Rev. Psychol.* 28, 1–39.

Slovic, P., Lichtenstein, S., Fischhoff, B., 1988. Decision making. In: Atkinson, R.C. (Ed.), *Stevens' Handbook of Experimental Psychology*. Wiley, New York (Chapter 10).

Stefanou, S.E., Saxena, S., 1988. Education, experience, and allocative efficiency: a dual approach. *Am. J. Agric. Econ.* 70 (2), 338–345.

Stevenson, M.K., Bussemeyer, J.R., Naylor, J.C., 1990. Judgement and decision making theory. In: Dunnette, M.D., Hough, L.M. (Eds.), *Handbook of Industrial and Organizational Psychology*. Vol. 1. Consulting Psychologists Press Inc., Palo Alto (Chapter 6).

Thaler, R.H., Shefrin, H.M., 1981. An economic theory of self control. *J. Pol. Econ.* 89 (2), 392–406.

Thorngate, W., 1980. Efficient decision heuristics. *Behav. Sci.* 25, 219–225.

Van Den Ban, A.W., 1970. The Human Factor in Farm Management. Some Research Findings from the Netherlands. *The Human Factor in Agricultural Management*. Warszawa.

Weber, E.U., 1994a. Behavioral decision theory: insights and applications. In: Christensen, J., Rasmussen, S. (Eds.), *Proceedings of the 38th EAAE Seminar on Farmers' Decision Making — A Descriptive Approach*, Copenhagen, pp. 13–29.

Weber, E.U., 1994b. Production and pricing decisions in cash crop farming. Effects of decision traits and climate change expectations. In: Jacobsen, B.H., Pederson, D.E., Christensen, J., Rasmussen, S. (Eds.), *Proceedings of the 38th EAAE Seminar on Farmers' Decision Making — A Descriptive Approach*, Copenhagen, pp. 203–218.

Weber, E.U., 1997. Perceptions and expectation of climate change. Precondition for economic and technological adaptation. In: Bazerman, M., Tenbrunsel, A., Wade-Benzon, K. (Eds.), *Psychological Perspectives to Environmental and Ethical Issues in Management*. Jossey-Bass, San Francisco.

Willcock, J., 1997. A Layman's Guide to the Role of Psychological Influences on Farming Behaviour. Edinburgh Study of Farmer Decision Making. School of Agriculture, University of Edinburgh, Edinburgh.

Willcock, J., Deary, I.J., Edward-Jones, G., Gibson, G.J., McGregor, M.J., Sutherland, A., Dent, J.B., Morgan, O., Grieve, R., 1999a. The role of attitudes and objectives in farmer decision making. *Business and environmentally oriented farming in Scotland*. *J. Agric. Econ.* 50, 286–303.

Willcock, J., Deary, I.J., McGregor, M.J., Sutherland, A., Edwards-Jones, G., Morgan, O., Dent, J.B., Grieve, R., Gibson, G., Austin, E., 1999b. Farmers' attitudes, objectives, behaviours. *J. Vocational Behav.* 54, 5–36.