The Australian Journal of Agricultural and Resource Economics

Journal of the Australian Agricultural and Resource Economics Society

The Australian Journal of Agricultural and Resource Economics, 53, pp. 413–436

Modelling the origins of managerial ability in agricultural production*

Peter Nuthall†

The efficiency of production from a farm's land, labour and capital is critically dependent on the ability of the farm manager. Yet, while there are studies correlating a wide range of manager-related variables with returns, and, therefore, probably ability, little understanding of the basic determinants of managerial ability exists. Questions such as 'what is the importance of a farmer's family experiences and training in determining the farmer's managerial ability?' need answering. The solution to this, and other, questions will enable determining ways of improving farmers' inherent ability developed both in early, and later, life. In that most decisions on a farm are made intuitively, in contrast to the use of a formal analysis, improving farmers' inherent ability will have a significant payoff. The research reported here uses data from a large stratified random survey of 740 developed farmers (29 per cent had tertiary education, 30 per cent had 4 or more years secondary education) to create a structural equation model of the determinants of managerial ability. The results suggest that a farmer's exposure to experiences is a significant factor in ability, as is the farmer's management style and the family influence on early life experience.

Key words: explaining ability, importance of contributors to ability, improving managerial ability, managerial ability, origins of ability.

1. Introduction

The key factor in the management of land, labour and capital is the managerial ability applied. Early texts (Case and Johnson 1953) and research (Johnson *et al*. 1961) refer to the importance of the manager and discuss managerial processes. However, until recently the emphasis on studying the manager and 'his' attributes has declined, perhaps due to the difficulties involved. Humans are not easy to quantify. This study has re-visited this area to better understand the factors associated with managerial ability. If these factors are known, quantified and causative, it is possible to consider methods of improving ability. Furthermore, a measurable ability variable is an essential factor in successfully explaining agricultural output and supply relationships. While ability can be divided into sub-components such as strategic, operational, production, marketing, financial, labour relationships and so on, this research covers overall ability due to the difficulties in dividing out the components. Also, the data show ability in each aspect tends to be correlated.

* The referees' challenging comments are gratefully acknowledged. Thanks are also due to all the farmers who gave their time, and to Claudia Jimenez Castro for data entering.

† Peter Nuthall (e-mail: nuthallp@lincoln.ac.nz) is at Lincoln University, Farm management and agribusiness, Lincoln, Canterbury 7647, New Zealand.

doi: 10.1111/j.1467-8489.2009.00459.x

A wide range of ability exists thus providing data to determine the factors related to ability. Efficiency studies (Alvarez and Arias 2003; Wu *et al*. 2003) demonstrate this wide range, though these studies often assume both technical and financial efficiency *per se* are the farmer's objectives. Farmers have other goals (e.g. ease of work) so the farmer's view of efficiency may vary from the researchers'. Despite this, research has shown the value of high managerial ability (e.g. Hayes and Schaefer 1999).

Beyond agriculture considerable effort has gone into developing tests for assessing ability (e.g. Smith and Blackham 1988). In agriculture the situation is quite different. Rougour *et al*. (1998, p. 270) reviewed the situation and noted that 'It can be concluded that the decision making process is under exposed'. They also conclude 'management capacity (can be) defined as having the appropriate personal characteristics and skills (including drives and motivations, abilities and capabilities and biography), to deal with the right problems and opportunities in the right moment in the right way' Rougour *et al*. 1998, p. 270);. The challenge is to develop measures of all these factors, and also develop techniques to improve ability. If the origins of ability were better understood this would provide direction in developing the tests. Given tests it would be possible to aid the process of selecting good managers, and their training, through developing diagnostic tools highlighting areas of deficiency. Studies on correlations between performance and a wide range of farm and human variables have been conducted (see, for example, Solano *et al*. 2006), but have failed to produce an understanding of the factors determining high ability. Furthermore, despite automated decision support systems having been developed, most farmers do not use other than financial packages, relying on their inherent skills, particularly for the ongoing day to day decisions. Internalising good procedures through training is, consequently, an important aspect in improving managerial ability.

This article progresses by reviewing a selection of research on what underpins managerial ability, using this information to develop a hypothesised model of the origins of ability, and then reports on the use of farmer data to test the structural equation model developed, and ends with a discussion on the implications of the results. A farmer's experiences, and the lessons learnt from them, are particularly important in developing good ability. The farmer's personality and family influence are also important. This means to improve ability a farmer must concentrate on learning from experiences using approaches outlined below. A farmer should also assess his personality or management style it is called in a management context, as well as past parental influences and develop approaches to counteract any lasting sub-optimal effects.

2. Factors correlated with ability

2.1 Introduction

If factors correlated with, or giving rise to, managerial ability are observable then it would be possible to predict ability. In earlier years many studies, pri-

marily non-agricultural, have looked for correlations and have explored the concepts of intellectual and social capital (Sumner and Lieby 1987 (human capital in dairying); Nahapiet and Ghosal 1998). Intellectual capital, or what is commonly called managerial ability, is thought to be also related to social capital which involves the networks a manager may have, as well as the relevant components of the current culture. For ability, factors studied have included age, education, experience, training, personality in various forms, objectives, job satisfaction, communication ability, planning, execution and control practices, and many other factors. Furthermore, while some argue that good managers are born in contrast to being trained, high ability is likely to involve both the farmer's genetic background as well as environmental influences including experience and training. Some of the correlations strongly suggest this. Some researchers also mention the importance of intuition (Kerr 1995; Kuo 1998) which some regard as an indefinable characteristic that only some managers have. Studies show, however, that intuition is definable. Kuo (1998, p. 90) explores how intuition is developed and lists its characteristics (a person with successful intuition might be called an 'expert'). He notes 'what appears to others (as) intuition is actually a display of well trained cognitive ability to handle ill-structured problems'. Similarly, Kerr (1995, p. 2) talks about tacit knowledge (intuition) as 'the acquisition of know-how through experience'.

In developing a model of ability all the factors that might underlie managerial ability, including aspects of intuition (experience) through to genetic considerations, must be considered. The next sections review these basic variables.

2.2 Factors correlated with ability – management style (personality)

As it is believed by many psychologists (e.g. Matthews and Deary 1998) an individual's behaviour, in this case their managerial actions, can be categorised by two broad factors, personality and intelligence. These factors need to be major components of any model. Fortunately both, including their sub components, can be quantified.

Many researchers have explored the links between personality and managerial factors. For example Young and Walters (2002) related the Myer-Briggs (Myers and McCaulley 1985) indicator of a persons' personality 'type' (16 types are defined based on characteristics like judging, expressive, thinking and observant) to various dairy farming efficiency measures and found significant relationships with efficient physical output (e.g. milk yield). Jose and Crumly (1993) also used the Myers-Briggs test to show that farmers are distinctly different from the general population and, consequently, need to be treated differently in, for example, extension activities. While the Myers-Briggs test has had extensive use in all areas of society, many contemporary researchers (e.g. Matthews and Deary 1998) believe personality is better described by five basic factors – openness, conscientiousness,

extroversion, agreeableness and emotional stability. Each factor has unique sub-components or facets. Identical twin studies suggest the environmental influence on personality, relative to the genetic component, may be as much as 65 per cent, though other work suggests a 50/50 division (Caspi *et al.* 2005). Most of the work on personality and managerial ability has been in sectors other than agriculture. An example includes Barrick and Mount (1991) who reviewed a range of studies in different industries. They concluded that specific job types determine which personality factors are important and noted, for example, extraversion is correlated with success in occupations involving social interaction. On the other hand, conscientiousness is correlated with success in all occupations. Tett *et al.* (1991, p. 702), in a major review, concluded there are grounds for optimism concerning the use of personality measures in employee selection. One of the originators of the five factor model (Costa 1996) looked at the facets of each trait (e.g. assertiveness, ideas, values, compliance, self-discipline) when reviewing a range of research and similarly found correlations with managerial success, though he also discussed job type suitability for different personalities (he talked about finding the optimal match between person and position). Not all the studies are consistent. Salgado (1997), in reviewing further studies, agreed conscientiousness and emotional stability were predictors of ability, but noted that the other factors are valid in only some cases. However, he also noted openness and agreeableness were valid predictors of training proficiency. Robertson *et al.* (2000), however, concluded conscientiousness was not always influential in determining managerial performance.

Another frequently used test measures a person's 'locus of control' (Carpenter and Golden 1997). This refers to the person's belief in the extent of control they have over outcomes and the factors influencing profit (e.g. weather, product prices). While this control belief probably influences a manager's actions, Caspi *et al.* (2005) believe emotional stability is a predictor of a person's 'locus of control', and is, therefore, a manifestation of at least one of the five basic personality factors.

Returning to agriculture, Howard *et al.* (1997) found correlations between a test called the 'life style inventory' (LSI) and financial measures. 'Dependency' (e.g. concern with pleasing people, not questioning others, or taking independent action, lack of self respect) was negatively correlated with income and assets. However, if it is true that personality is a basic human determinate, there is likely to be a strong correlation between the LSI and the five basic personality factors.

Overall, there is sufficient evidence to conclude personality is likely to be a major factor in managerial ability, and must be included in any model. Furthermore, in a recent study of various decision variables and farm management performance, Solano *et al.* (2006, p. 425) concluded 'The study's findings …. provide support for the rapidly developing literature that has found the human component to be a significant determinant of farm management and performance'. Logic would strongly support this statement.

2.3 Factors correlated with ability – education, training and intelligence

The evidence linking education and training to successful management is not as extensive as the personality case. However, it is logical to expect education in its various forms to impact on managerial ability. There are many studies that include education as an explanatory variable of agricultural production. For example, Warren *et al.* (1974) found managerial ability (as measured by scores on tasks such as planning, organisation, directing and similar) was significantly related to years of formal schooling. They concluded performance was 20 per cent knowledge, 12 per cent value orientation, 6 per cent job satisfaction and 11 per cent schooling – the remaining 51 per cent was unexplained. Similarly, the many efficiency studies show education as a strong contributor to efficiency (e.g. Dhungana *et al.* 2004) and, thus, probably managerial efficiency. Education is also correlated with the uptake of farm computers which may well relate to managerial efficiency (Alvarez and Nuthall 2001).

Intelligence (cognitive ability) should be related to managerial ability. Young *et al.* (2000), for example, while noting many factors were important, concluded cognitive ability predicted the thinking and knowledge criteria aspects of managerial performance. They also reviewed many other studies relating cognitive ability to managerial ability. Sternberg and Grigorenko (2001) also strongly conclude on the relevance of cognitive ability, particularly certain components (intelligence can be divided into various aspects and some may be more important than others. See Sternberg *et al.* 2000).

Overall, the evidence, and obvious logic, suggests intelligence, education and, probably, vocational training are all precursors of managerial ability. However, there is a paucity of studies on farmers' cognitive ability. One exception was the work of Austin *et al.* (1998) who used a standard intelligence test in researching farmer's environmental attitudes and objectives to conclude there were significant correlations. They did not, however, look at managerial ability.

2.4 Factors correlated with ability – age and experience

While, there is a lack of farm related research on experience, one would expect it to be important in managerial ability. Similarly for age in that useful experience is probably related to the length of experience. Furthermore, there could well be a link between intelligence, personality and experience as experience will only enhance ability if the lessons available are correctly absorbed. Chance must also play a part in that the farmer needs to be in the right place at the right time to be exposed to the full range of potentially rich experiences. In this regard, length of time in a relevant job is probably a significant factor. While, there is ample data relating age to efficiency (e.g. Dhungana *et al.* 2004), there are limited studies measuring relevant experience and its

relationship to managerial ability. Sumner and Lieby (1987), however, did find significant relationships between the years on the current dairy farm and herd size and growth. They also used education, age and the use of various management devices (e.g. herd testing) as independent variables. Similarly, Wilson *et al.* (1998) found a relationship between technical efficiency in potato production and the years of potato growing experience. In this case, however, the relationship was negative as newer growers used contemporary technology. Education was not included. Overall, significantly more work should be directed at exploring experience as a factor for it seems likely that experience would be a major contributor to good ability provided its lessons are well learnt.

2.5 Factors correlated with ability – general

No doubt many other factors actually correlate with managerial ability. The real question is whether any such factors are basic determinants of ability. For example, Warren *et al.* (1974) found a significant relationship between job satisfaction (based on answers to eleven statements covering rewards, management roles…) and managerial ability as scored by a set of judges. However, there could be a correlation between job satisfaction, objectives, personality and intelligence with the latter two the underlying causative factors. Similarly, the recently emerging concept of 'emotional intelligence' (EI) may also fall into the same category. Zeidner *et al.* (2004) note EI has four components – awareness of emotions in self, awareness of emotions in others, management of emotions in self, and management of emotions in others. Higgs (2001) also found a high correlation between sections of the Myers-Briggs (Myers and McCaulley 1985) indicators and sections of the EI test. However, Zeidner *et al.* (2004, p. 384) note that parts of EI are correlated with personality and conclude '…there is currently only a modicum of research supporting the meaningful role of EI in determining occupational success'.

Another component of a manager that could be important is their objectives, particularly as many farmers are owner-operator based. In more complex ownership structures the combined objectives of the owners and manager is less likely to be a significant factor in managerial success. For farm situations, if the manager believes, for example, sufficient leisure time is a priority, this may well impact on the effort devoted to making decisions and, consequently, impact on, say, efficient least cost production.

In overall summary, researchers have examined a wide range of factors believed to impact on managerial ability, and many do correlate with ability. There is yet to emerge, however, a consensus on which of the basic human factors do determine a person's managerial ability and their relative importance. The review indicates personality, intelligence, education and training, and experience are likely to be strong contenders. The next section outlines a model to move towards a better understanding of the importance of these factors.

3. A model of managerial ability

3.1 Introduction

Muggen (1969, p. 3), in a review of 'Human factors in farm management', proposed the following (Figure 1) general model.

Muggen is suggesting a person's 'biography' (e.g. education, training, experience, socioeconomic status), capabilities (e.g. intelligence, abstract reasoning, vocabulary, agricultural knowledge), drives and motivations (e.g. motivation, industriousness, scientific orientation) are basic to managerial behaviour, and impact on outcomes. Muggen listed 61 variables for which he found research relating the variable to outcomes. He concluded 'Further research in this area seems urgently needed, because these human factors probably have a considerable influence on the incomes of farmers. Such research could be of great help for professional guidance…' (p. 9). The following sections contain a proposal to follow Muggen's advice. As many of the factors mentioned by Muggen are sub-components of personality and intelligence (as suggested by the evidence) these factors, and their constituents are likely to be important in explaining ability. It is also assumed a farmer's objectives impact on ability as part of Muggen's 'drives and motivation'.

3.2 A model of managerial ability – structural model

The following model (Figure 2) represents the factors discussed. The term 'management style' has been introduced in place of personality as it is the expression of personality in a farmer's management that is of interest.

A farmer's management style is dependent on 'his' genotype and early experience (e.g. family background, social capital, culture, peer experiences), as is intelligence. Similarly the objectives and motivation acquired through life are probably highly influenced by the family background and experience. These all impact on both the exposure and success of educational experience which in turn impacts on ability as do management style and intelligence in a more direct way. For example, the studies clearly suggest style factors like

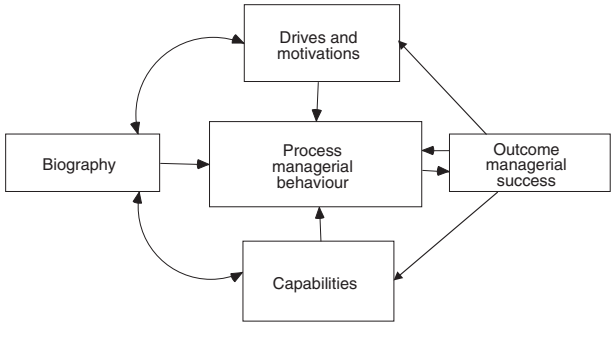

Figure 1 Human factors in farm management.
(*Source*: Muggen 1969)

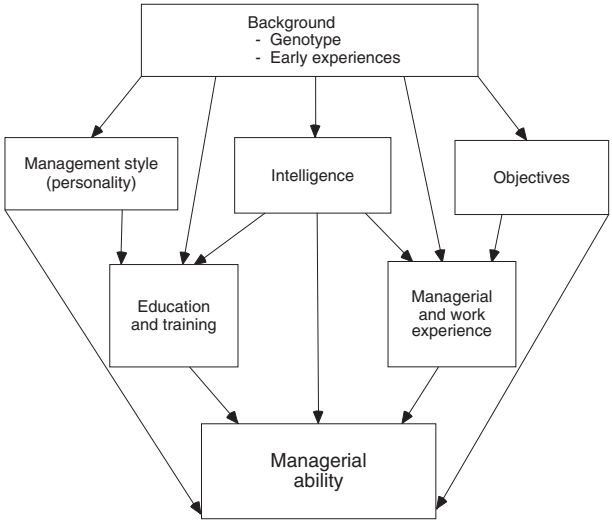

Figure 2 A structural model of managerial ability.

conscientiousness have a direct impact. The studies also show the relevance of experience even if through the age proxy. A real difficulty in testing such models is obtaining measurements for the possible components of experience.

3.3 A model of managerial ability – towards quantification

A mail survey of a stratified random selection of farmers was used to obtain the data. While the summary model does not contain a large number of variables, there are many linkages and sub variables (see the structural equation model presented later) making a large number of observations desirable. The survey contained a set of 25 statements to assess 'management style' (personality), 19 statements on objectives, and another 19 on 'locus of control' aspects, as well as questions on age, education, self-rated intelligence (1–5 score), and self-rated managerial ability (1–10 score) in five areas (animals, soils and plants, labour, financial and marketing, and strategic planning). In addition, there were 45 statements and questions related to experience covering the decision maker's background (e.g. years on farms), forebears, parental influences, school years, technical and financial experiences as well as problem situations. The management style, locus, most experience, and objective statements were rated on a 1–5 'degree of truth' scale. Finally, 20 questions to assess a farmer's sources of learning in technical and financial matters were included. The survey was posted to 2300 farmers in 2006 (from a population of 39 000) and produced an effective response rate of 41 per cent. Hair *et al.* (1995) suggest five observations per variable giving a requirement of at least 680 observations – this was exceeded. Stratification was for farm type, farm area (ha's) and region. Details of the questions on management style and objectives are given in Nuthall (2006a) as the same set was used in this earlier

work on competencies. Details of the 45 experience and 20 learning source questions can be obtained from the author. While it would be useful to conduct full intelligence tests and interviews to obtain further detailed data, this was not practical for the large sample. Instead, information on education, grades, gender and self-rated intelligence was obtained.

As the various sets of questions (e.g. the set of management style questions) had groups of similar questions designed to cover most aspects of a concept it was important to combine the data into core variables using factor analysis (which produces summarising 'factors' that are linear combinations of the original variables. This approach also reduces potential multi-collinearity.) While the factors are given names reflecting the loadings on the original variables, another researcher might choose slightly different names. There is no perfectly correct label for each.

The 25 management style questions were factorised to give six factors with Eigenvalues greater than 1.0 which explained 46 per cent of the variance. They were given the summarising names (based on factor constituents) 'concern for correctness' (anxiety), 'conscientious planning' (conscientousness), 'thoughtful creativity' (openness), 'community spirit' *(extraversion – community)*, 'consultative logician' (extraversion – family and friends) and 'benign management' (agreeableness). The factors (Eigenvalues greater than 1.0) encapsulating the farmers' objectives (which explained 54 per cent of the variance), were labelled 'profiteer', 'way of life', 'family supporter', 'balanced', 'risk remover' and 'reluctant farmer' (leave farming was one objective). The objectives were labelled Obj 1 to Obj 6. They encapsulate the facets of most people's objectives. The survey described in Nuthall (2006a) produced virtually identical sets of style and objective factors.

The 19 'locus of control' (Kaine *et al*. 2004) questions produced a measure of the farmers' view of his level of control over outcomes. When converted to a percentage scale the mean was 67 per cent (standard deviation 8.5) similar to the earlier survey (Nuthall 2006a) using the same question set gave a mean of 71 per cent (standard deviation 8.1) providing good consistency.

There were 45 items covering a farmer's experience related to forebears, parental influences, years spent in various situations, and learning aspects of experience. The responses were factorised (Eigenvalues greater than 1.0) to provide 17 factor variables. Based on the constituent variables and their loadings, the factors were labelled:

Experience based on time (explained 62 per cent of the variance in 5 variables)
- Years of managing experience (Exptime 1)
- Pre-management experience (Exptime 2)

Forebears (explained 73 per cent of the variance in 10 variables)
- Ability better than parents (Forb 1)
- Objectives different from parents (Forb 2)
- Labour management across generations (Forb 3)
- Generation differences in intelligence and ability (Forb 4)

Parental influences (explained 63 per cent of the variance in 13 variables)
- Early management involvement (Parent 1)
- Early agricultural experience (Parent 2)
- Training in basic management skills (Parent 3)
- Country schooling, primary and secondary (Parent 4)

Experienced based learning aspects (explained 60 per cent of the variance in 17 variables)
- Learning from mistakes (Explearn 1)
- Learning from the recent past (Explearn 2)
- Learning from early experiences (Explearn 3)
- Development of tacit knowledge (intuition) (Explearn 4)
- Experienced good luck, few problems (Explearn 5)
- Help and support from colleagues (Explearn 6)
- Speed of learning management skills, including labour factors (Explearn 7)

All these variables were built into a structural equation model which was an expansion on the general model presented in Figure 2. Figure 3a,b contains a schematic of this hypothesised model. The diagram is presented in two parts for clarity of presentation. The variables labelled 'Style', 'True intelligence' and 'Management experience' are common to both providing the linkage between the two diagrams with Figure 3a containing all the variables enabling these linking variables to be determined. Figure 3b on the other hand, presents the 'True ability' variable together with all the variables directly influencing it (some of which also influence the linking variables).

The variables in rectangular boxes are the observed variables, while the elliptical variables are unobserved (latent variables), the values of which are obtained from the defined relationships. The variables in circles are error terms (labelled ErA, ErB to ErJ). The arrows give the hypothesised direction of influence. Each one represents a linear equation. For example, the Gender (Ge) $\rightarrow$ Grades (Gr) relationship is $Gr = a + bGe + e$ (the results gave $a = 54.13$ and $b = 7.31$ (0.103 in standardised form)). Taken together the 'arrows' provide a set of simultaneous equations so, given an identified set, it is possible to find the parameters for all the equations including those for the latent variables.

The objective is to determine the 'True ability' of any farmer (the targeted latent variable), and, most importantly, the variables influencing a farmer's ability level. It is hypothesised that True ability depends on the latent variables 'Style', 'Management experience', and the farmer's 'True intelligence'. None of these variables are directly observed, rather they are inferred from their impact on observed variables. For example, one would expect 'True intelligence' to impact a farmer's education level (Education), the 'Grades' achieved in the farmer's final year of formal education, which is in turn affected by the farmer's 'Gender'. 'True intelligence' also contributes to the farmer's 'Rated intelligence' (self-rated 1 to 5 score). Similarly, 'Management style' gives rise to the six observed style factors (Style 1 – 6) as previously

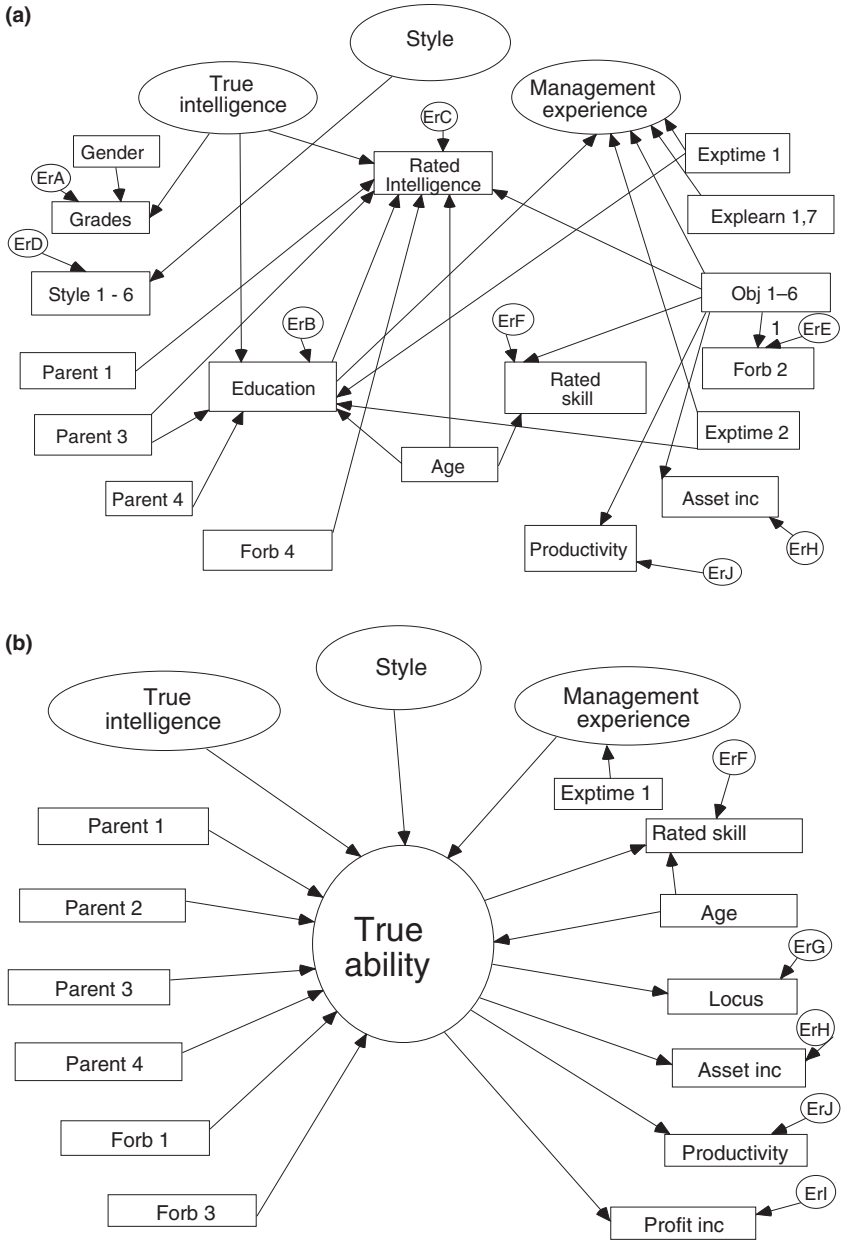

Figure 3 A model of managerial skill (a,b). The rectangles are the observed variables, the circles unobserved (Latent). ErA refers to the error variable for Grades, and similarly for the other variables.

defined. It is hypothesised that each farmer has an inherent management style which is portrayed in the grading they give to the 25 style questions. These factorise into the 6 style factors, and thus the direction of the arrow leading from 'Style' to the Style factors 1–6.

Moving back in the sequence, a farmer's highest level of formal 'Education' is not only dependent on his intelligence, but also on his age (older farmers are less likely to have higher education given the changing opportunities), parental influences (Parent 3 and 4) and also management time (Exptime 1).

'Management experience', hypothesised to be an important determinant of ability, is the culmination of a farmer's experience history and his comprehension of this experience. This total package is hypothesised to be dependent on 'Education' (the higher the level of education the more likely a farmer will learn from valuable experience), on the length of experience variables (Exptime 1 and 2), and on the experience based learning variables (Explearn 1 to 7). Also, effecting 'Management experience' are the farmer's objectives (Obj 1–6) as a farmer's attitude to the farm and production impacts on the benefit obtained from experience.

'Rated intelligence' (the farmer's self-rating on a 1 to 5 scale) is hypothesised to be dependent on the farmer's 'True intelligence', 'Education' (the higher the level the more likely the rating is accurate), Parent 1 and 3 (similarly, better self recognition), generation differences (Forb 4), and objectives (Obj 1–6). It is also expected a farmer's objectives will influence the accuracy of his self-rating. For this reason, 'Age' was also included as an explanatory variable.

Finally, the various observed and latent variables are used to infer the unobserved 'True ability'. Thought to be highly relevant, as noted above, are the farmer's 'Style', True intelligence', and 'Management experience'. Also included as contributory factors are the farmer's 'Age' (wisdom), Forb 1 and 3 (generation differences), and, finally, Parent 1 to 4 (clearly a farmer's parents influence ability both genetically and environmentally).

Other observed variables which are dependant on the farmer's 'True ability' were included as they help to determine a farmer's ability through inference. Three such observed variables included in the survey were the average profit increase over the last 5 years ('Profit inc'), the net asset value increase over the last 5 years ('Asset inc', though location and chance would also impact on this variable), self-rated managerial ability ('Rated ability'), and the farmer's locus of control ('Locus'). Ability should also impact on the physical production efficiency achieved ('Productivity'). This latter variable was based on a 1 to 10 rating of variables such as meat, milk and wool production per hectare (depending on the farm type, scored relative to each other so each farm type had the same average). The objective factors (Obj 1–6) are assumed to influence self-rated ability, productivity, and the asset increase. A farmer's objective set will influence the effort to achieve high productivity, high profit and increasing asset value. Thus objectives must be included when judging ability for low profit increase, for instance, does not necessarily mean low ability.

It might also be suggested that a person's view of their relative management ability could relate to the size of their farming business, and that if they managed a farm of greater size their self assessment might be lower. In this regard, it is telling that the correlation between self assessed ability and farm size was a non-significant 0.045. Similarly the correlation between the labour

units employed (another measure of farm size) and self assessed ability was a non-significant 0.031.

Given the proposed model and values for all the observed variables it was then possible to calculate the parameters of the model and 'goodness of fit' statistics using the structural equation modelling package AMOS (Arbuckle and Wothke 1999). The particular version of the model presented was the culmination of many trials selected on the basis of its compliance with argued logic of ability formation and its goodness of fit.

3.4 A model of managerial ability – quantification

The majority of the variables complied with the normality requirement. The exceptions were the gender variable (the majority were males) and the increase in asset value variable which had a positive skew. Solving the model as originally proposed produced some path coefficients that were statistically insignificant. These relationships (e.g. the direct impact of Forb 1 and 3 on 'True ability') were removed and the model resolved until all paths had a significance probability of 0.25 or less. While any cut off figure is arbitrary, it was judged a variable with at least a 75 per cent chance of being acceptable was worth including. As will be noted from the table of model parameters (Table 1) the majority are acceptably significant.

The 'goodness of fit' parameters of the final model all indicated it was statistically acceptable and certainly supported the management ability relationships. While there is no single statistic used in assessing structural equation models, the most commonly used is Chi-squared divided by the degrees of freedom (CMIN/df). In this case, the value was 3.552 with a significance probability of 0.000. Any value below 5.0 is regarded as reasonable (Carmines and McIver 1981) with two or less regarded as excellent. Another frequently used figure is the 'comparative fit index' (Bentler 1990) which compares the model parameters with those where it is assumed the observed variables are uncorrelated and have means of zero. Values of the index range from 0 to 1 with 1 being a perfect fit. In this case the index was 0.939 further indicating the acceptability of the hypothesised model. Another commonly used statistic is the 'root mean square of approximation' (RMSEA) (Browne and Cudeck 1993) which fits the model to the population moments in contrast to the sample moments. The value of this RMSEA is required to be less than 0.1. In this case, it was 0.059 with a probability of 0.000.

Table 1 contains the relevant regression parameters, including the significance probabilities, obtained from solving the model. As the objective is to obtain the relationship for the latent variables, the constants are not presented, and the R^2 values are commented on below. As the units used vary across the model, the standardised regression coefficients are presented to enable assessing the importance of the variables relative to each other. The signs on the coefficients are not always indicative of the direction of influence due to the scoring methods used. For example, the highest level of self-rated

Table 1 Model parameters

Variable pair and relationship direction	Standardised regression coefficient	Significance robability	Direction for ability improvement
Intelligence → True ability	0.109	—*	Greater
Style → True ability	0.232	—*	Greater
Experience → True ability	0.971	—*	Greater
Parent 1 → True ability	−0.032	0.006	Higher
Parent 2 → True ability	−0.049	0.000	Higher
Parent 3 → True ability	−0.038	0.001	Higher
Parent 4 → True ability	−0.022	0.048	Higher
Exptime 1 → Experience	0.018	0.168	Less
Explearn 1 → Experience	0.045	0.000	Higher
Explearn 5 → Experience	−0.024	0.048	Higher
Explearn 6 → Experience	−0.015	0.235	Less
Explearn 7 → Experience	−0.021	0.091	Less
Obj 1 (balanced) → Experience	−0.202	0.059	Greater
Obj 2 (profiteer) → Experience	0.144	0.153	Lesser
Obj 3 (way of life) → Experience	−0.541	0.010	Greater
Obj 4 (family sup.) → Experience	0.013	0.229	Lesser
Obj 5 (risk remover) → Experience	0.656	0.011	Lesser
Obj 6 (reluctant …) → Experience	0.470	0.016	Lesser
Education → Experience	−0.098	0.000	Higher
Style → style 1 (correctness)	0.126	0.034	Less
Style → style 2 (conscientousness)	−0.217	0.007	Greater
Style → style 3 (creativity)	−0.194	0.009	Greater
Style → style 4 (community)	−0.125	0.036	Greater
Style → style 5 (family)	−0.084	0.114	Greater
Style → style 6 (benignness)	0.128	0.033	Less
Age → Education	−0.037	0.000	Lower
Parent 4 → Education	0.047	0.133	Less (country school)
Obj 3 (way of life) → Education	−0.187	0.000	Greater
True intelligence → Grades	0.351	0.000	Higher
True intelligence → Education	0.683	0.000	Higher
Gender → Grades	0.103	0.009	Female
Education → Rated intelligence	0.781	0.128	Lower
Age → Rated intelligence	0.270	0.096	Higher
True intelligence → Rated intelligence	−1.179	0.070	Lower
Parent 1 → Rated intelligence	0.121	0.002	Higher
Parent 3 → Rated intelligence	0.113	0.004	Higher
For 4 → Rated intelligence	−0.166	0.000	Lower
Obj 3 → Rated intelligence	0.250	0.020	Greater
Obj 1 → Rated ability	0.571	0.093	Less
Obj 2 → Rated ability	−0.557	0.082	Greater
Obj 3 → Rated ability	1.593	0.017	Less
Obj 5 → Rated ability	−2.075	0.011	Greater
Obj 6 → Rated ability	−1.460	0.019	Greater
True ability → Rated ability	3.275	—*	Higher
True ability → Locus	0.434	0.008	Higher
Explearn → Locus	0.157	0.000	Less
Obj 3 → For 2	0.115	0.006	Less
Obj 4 → For 2	−0.00088	0.035	Greater
Obj 5 → For 2	−0.063	0.128	Greater
Obj 6 → For 2	0.099	0.018	Less

Table 1 (continued)

Variable pair and relationship direction	Standardised regression coefficient	Significance robability	Direction for ability improvement
Parent 2 → Profit increase	−0.093	0.050	Greater
Obj 1 → Profit increase	0.140	0.081	Less
Obj 2 → Profit increase	−0.124	0.099	Greater
Obj 3 → Profit increase	0.289	0.049	Less
Obj 4 → Profit increase	0.128	0.003	Less
Obj 5 → Profit increase	−0.393	0.027	Greater
Obj 6 → Profit increase	−0.232	0.089	Greater
Explearn → Profit increase	0.074	0.120	Less
True skill → Profit increase	0.609	0.008	Greater
True skill → Asset increase	0.140	0.036	Greater
Obj 2 → Asset increase	−0.107	0.015	Greater
Obj 4 → Asset increase	0.081	0.052	Less
True skill → Productivity	0.250	0.017	Greater
Obj 2 → Productivity	−0.098	0.048	Greater
Obj 6 → Productivity	−0.131	0.018	Greater

*As these variables are latent, it is not possible to calculate a significance probability.

intelligence (highly intelligent) was scored with a one, the lowest with a five. Thus, the negative coefficient on the true intelligence → rated intelligence path means a higher level of true intelligence improves 'Rated intelligence'. To aid interpretation the final column of Table 1 indicates whether a greater, or lesser, value of the variable is related to an improved ability. The impact on managerial ability of a variable may pass through more than one path to provide its impact. The impact of a farmer's objectives, for example, is related to the 'Experience' variable, which, in turn, gives rise to ability.

The most notable feature of the results are the relative impacts of the latent variables 'Style', 'Experience', and 'True intelligence' on managerial ability. Of the more genetically determined features of a manager, management style is twice as important as intelligence. But of even more importance is the impact of experience – it is four times as important as 'Style'. Useful and relevant experience factors should be sought by managers in developing their ability. Also significant, but less important, are all the Parent factors further confirming the long-held belief that early experiences are important in a person's development.

Considering the variables influencing 'Experience', a farmer's objective set impacts on how life's experiences are viewed and utilised. The coefficients suggest a farmer with a strong desire to reduce risk will have a weaker experience factor. On the other hand, a farmer with a strong desire to enjoy farming as a 'way of life' utilises his experiences with benefit, and, no doubt, develops appropriate intuition. For 'Management style', anxiety ('concern for correctness') is an undesirable trait, and so is 'benignness'. On the positive side, conscientiousness is most desirable assuming, of course, high managerial ability is the objective.

Most of the other paths relate to predicting the various observed variables which in their turn contribute to finding the latent variable values. The parameters for 'True intelligence', for example, are derived from its impact on the farmer's educational level, his self-assessed intelligence ('Rated intelligence'), and his grades (which in turn is affected by gender). Education is also dependent on parental influences, age and the 'Exptime' variables. Each of the dependent observed variables has an R^2. For example, Education has an R^2 of 0.598, self-rated ability ('Rated ability') 0.765, and 'Grades' 0.134, 'Rated intelligence' 0.730, and 'Locus' 0.213. Also of importance was the 0.88 correlation coefficient between the farmers' predicted 'True skill' and their 'Profit increase' variable.

To highlight the characteristics associated with high managerial ability the equations were used to calculate a managerial ability score for each farmer which, in turn, was used to divide the sample into two groups for comparative purposes. To make the nature of the ability, style, intelligence and experience latent variables clear, they were converted into percentages. The raw figures by themselves do not have an obvious meaning except to rank the farmers (there is no absolute standard for benchmarking). Figure 4 gives the distributions relative to a normal distribution. As expected each latent variable closely follows normality though 'True intelligence' does have two aberrations which do not have an obvious explanation.

The comparison groups were formed using a 70 per cent ability score division. All farmers with a score greater than 70 per cent were regarded as having 'high' ability. This criterion puts 25 per cent of the farmers in the top group with some variations depending on the variable and whether some values were missing for a farmer. For each variable the difference in mean value between the top group and the remainder was expressed as a percentage difference to give a comparable figure as the scales were quite different between many variables. The results are presented in Table 2 and include the *t*-test significance probabilities as well as a comment on whether higher/greater value of the variable was desirable relative to the high ability group.

In general, the data present clear differences, though there are some notable exceptions. The 'Extent of management experience', 'Country schooling', 'Learning from mistakes', 'Experiencing few problems' all have large percentage differences, but the differences are particularly insignificant. Most other variables are statistically different at reasonable levels. For the major differences, as expected, intelligence and experience factors are at least 100 per cent greater in the high ability group. Furthermore, most of the style factors are quite different with 374 per cent on the 'Concern for correctness' factor being particularly important. The lower the anxiety factor the better. For the farmer's objectives, all factors are very different. While the percentage differences are not great, the 'Profiteer' component does not translate into higher ability. This objective is somewhat irrelevant to ability.

Many of the remaining variables are also quite different with 'Developing tacit (intuition) knowledge from mistakes and new situations' being

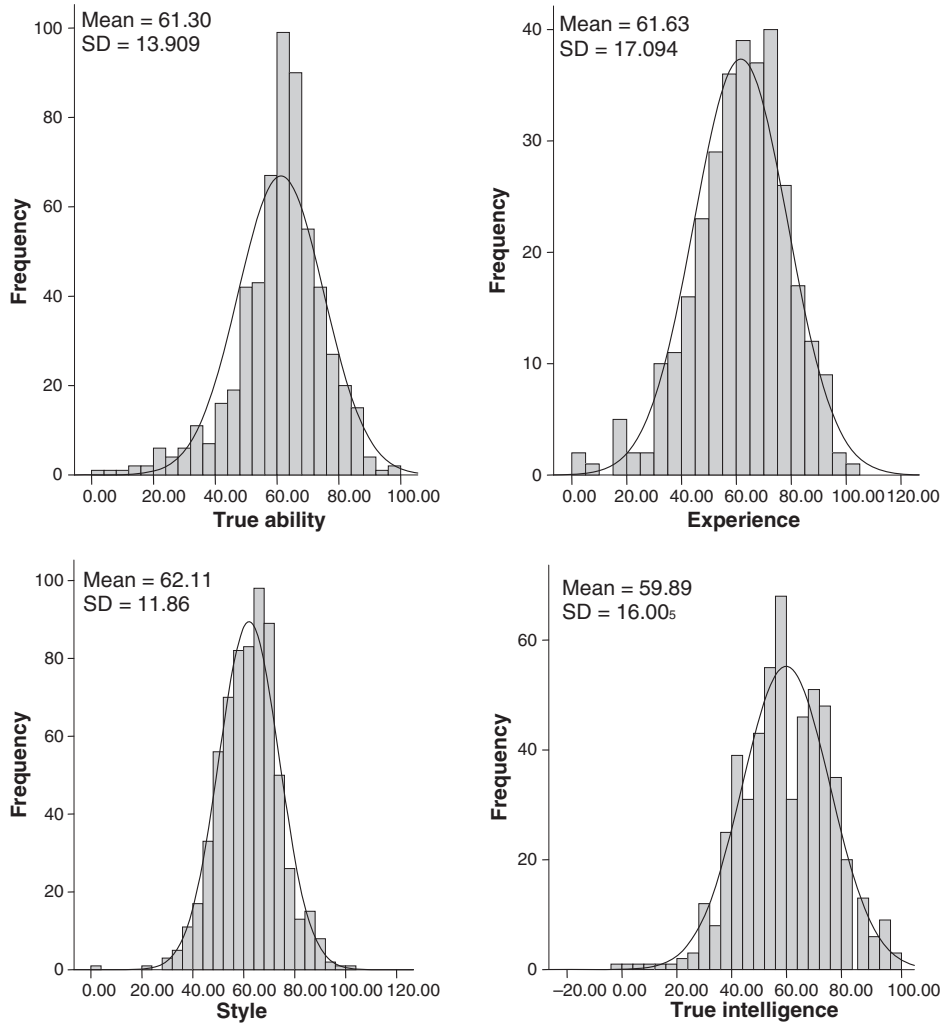

Figure 4 Distributions of the latent variables after conversion to percentages.

particularly notable. Similarly 'Assistance from colleagues', and therefore relationships with family and other farmers is important, as are the parental influences. This observation reinforces the earlier comment on how early life lays a basis for success. Finally, note the 'Generations in farming' difference, though it is not particularly significant (20 per cent).

4. Implications

The clear conclusion is the major importance of 'Experience', and its components, in the development of managerial ability, though managerial style is also important to ability, 'True intelligence' is not as important as might be expected.

Table 2 Attributes associated with high managerial ability. Comparison between farmers with 70 per cent or greater ability rating relative to the remainder

Variable group	Variable	Percentage difference	Significance probability	Desirability
General	Age	4	0.101	Older
	Education level	11	0.002	Greater
	Rated intelligence	8	0.003	Greater
Latent	Intelligence	104	0.000	Greater
	Experience	154	0.000	Greater
	Style	30	0.000	Ref style fact
Style factor	Locus of control	9	0.000	Greater
	Concern for correctness	374	0.000	Lower
	Thoughtful creator	68	0.000	Higher
	Conscientious planner	134	0.008	Higher
	Community spirit	129	0.000	Higher
	Consultative logician	129	0.000	Higher
	Benign manager	135	0.000	Lower
Objective factor	Balanced	384	0.003	Desirable
	Profiteer	214	0.178	Not desirable
	Way of life	503	0.000	Desirable
	Family supporter	407	0.036	Desirable
	Risk removal	490	0.000	Not desirable
	Reluctant farmer (leave)	574	0.022	Not desirable
Experience –time	Extent of experience	601	0.615 (poor)	Own farm not desirable
	Generations in farming	684	0.207	Extensive desirable
Experience – parental	Early management experience	425	0.000	Desirable
	Early practical experience & knowledge	426	0.045	Desirable
	Imagination, observation & people skills help	426	0.004	Desirable
	Country schooling	256	0.638 (poor)	Desirable
Experience – learning	Learning from mistakes	179	0.918 (bad)	Desirable
	Learning from recent past	344	0.109	Desirable
	Learning from early experiences	413	0.000	Desirable
	Developing tacit knowledge	1023	0.201	Desirable
	Experiencing few problems	87	0.744 (bad)	Desirable
	Experiencing assistance from colleagues	507	0.029	Desirable
	Speed at learning management	309	0.118	High speed beneficial

A major reason for studying managerial ability is to improve both future and current managers. For future managers, parents need to take note of the important influence of the 'Parent' variables. In particular exposing children to the decision making process through including them in the discussions had a positive impact. Similarly, general involvement in production activities was beneficial. Encouraging children to 'use my imagination to find solutions and how things worked', 'improve my observation skills of the surroundings and markets', and 'get along' with friends and relatives' had significant beneficial

effects (these were the basic variables in the Parent 3 factor). Parents should also encourage children to obtain a good education (of course), but they should also encourage gaining experience on other farms in contrast to the home farm where this exists (as suggested by Exptime 1 variable which largely reflected the time spent on one farm). When working for other managers a potential manager will gain benefit from choosing an employer who will involve them in the decision making (Explearn 6 factor). All these conclusions need to be promulgated to farmers with younger families.

Once becoming a manager, the family influence variables and impact are fixed. A manager must then consider his objectives and managerial style as well as concentrating on learning from mistakes (Explearn 1 factor) and encouraging help from colleagues and family (Explearn 6 factor). Most other variables are fixed (e.g. Explearn 7 involving the number of years it took to become a good manager).

The results indicate the importance of the farmer's management style and objectives, and consequently which components might be altered with benefit. For example, in many cases putting less effort into reducing risk as an objective will be beneficial where the farmer's inherent personality will allow it. This raises the question of whether a farmer's managerial style and objective factors can in fact be changed.

Fortunately the evidence suggests this is possible. The argument has been referred to as 'plaster or plasticity?'. Is personality fixed, or changeable? For example, Roberts (1997, p. 205) concludes '…pattern of associations between personality change and work experience provided support for the plasticity model of personality change'. Similarly Caspi *et al.* (2005, p. 467) in a major review note '…the meta-analytic findings show that rank order stability peaks some time after age 50, but at a level well below unity. Thus, personality traits continue to change throughout adulthood, but only modestly after age 50'.

Robins *et al.* (2001) also concluded personality can change, but they could not tell whether this was due to normal maturation, or the particular experiences. However, there is considerable evidence that change can be managed (e.g. Rehm and Rokke 1988), and evidence on the conditions necessary. For example, Atkinson *et al.* (1996) talk about the need for reinforcement of adaptive responses, increasing positive attitudes and action, and their reinforcement, providing explanations of the problems experienced, reassurance and support. In a direct management situation Cherniss and Goleman (2001, p. 214) conclude, with respect to emotional intelligence (EI), 'taken together, all these interventions demonstrate it is possible for adults to develop EI competencies'. The work referred to generally provides a positive view of the ability to change personality.

Accordingly, extension and other support system personnel need to institute testing and training programmes to modify and enhance the beneficial components of a farmer's managerial style (personality), and the farmer's experiences, being the two factors not inherently fixed in existing managers. Another positive way to achieve this is through farmer mentor groups.

Through these support systems, and possibly also through professional mentors and consultants, the objective is to enhance both the farmer's intellectual and social capital.

Using a mail survey may have provided bias. As many questions required eliciting the farmer's opinion there is a chance that re-asking might give a different answer. An interview sample can, however, have the same bias. Two questions relied on the farmers providing a subjective self assessment (relative intelligence and ability). To allow for possible bias these variables were related to the farmer's objectives, profit and asset increase, and productivity variables when influencing true ability. For example, some farmers with certain objectives could have an inflated self view of ability. Allowing for their objectives counteracts such bias. It should also be noted that research on self rankings (Das *et al*. 1998; Fitzgerald *et al*. 2003; Gramzow *et al*. 2003) indicate reasonable accuracy (an ability to self assess is probably critical in learning appropriately from experience). In assessing the results, it is relevant that data from an earlier survey (Nuthall 2006a) was used to develop a similar model that resulted in much the same relative rankings of the important factors in ability. As this survey did not provide data on experience *per se*, various proxies were used (e.g. age). The model (Nuthall 2006c) gave standardised regression coefficients of 0.25 for intelligence, 0.73 for style, and 0.99 for 'Family origins' (akin to experience in the current study). Thus, the rankings for experience, style and intelligence were identical.

There is one potentially important variable set that was not included that, in hindsight, should have been. This set should measure a farmer's formal training experienced post secondary or tertiary education. Many would argue that such courses can be beneficial and surveys show farmers find them useful (e.g. Kilpatrick 1998; Cameron and Chamala 2002). This training could be based on computer packages as well as on face-to-face programmes. The data from the survey, however, showed the farmers ranked 'courses and lectures' seventh and sixth (out of 9 learning sources) with average scores 3.11 and 3.43 respectively (out of a 1(a lot) to 5 (little) for amount learnt). The farmers believed they learnt most from 'watching other farmers' and 'parents and relatives' respectively (scores of 1.87 and 2.51), with the second most important being 'reading – books, magazines, papers' in both the technical and financial areas. These sources are part of a farmer's social capital.

Another enhancement to the model would be to include the facets of intelligence (Sternberg *et al*. 2000) as some are likely to be more important than others. It would be necessary to design tests to isolate components like spatial and calculational aptitude as related to management (Nuthall 2006b). As overall managerial ability is an amalgam of various aspects (e.g. strategic planning, operational decision making), it may be helpful for future research to explore precursors of each aspect separately as the factors and their significance might vary with the component. However, it should be noted that the surveyed farmers rated their ability in a range of areas (from feed and animal management through to strate-

gic planning), but the rankings had high correlations with average ability (0.691 to 0.785, all highly significant).

Tests for predicting ability need to be developed to provide data for models, and to provide a test to assess potential managers. For urban business, many tests have been developed and assessed (see, for example Parker and Fischhoff 2005), and measures of bias developed (for example, Sieck and Arkes 2005 (overconfidence); Luan *et al*. 2004 (information weighting)). These tests should be a starting point. Some attempts at developing tests have been made within agriculture. For example Trip *et al*. (2002) related efficiency to the practices used and found aspects of data recording and outcome evaluation were significantly related, but not goals and planning practices. These tests, however, were based on the systems used in contrast to measuring the farmer's inherent characteristics. In contrast, Nuthall (2006b) developed a managerial aptitude test, but it was only partially successful in predicting ability.

Training packages and processes (e.g. mentoring groups) that might be suitable for one person may need to be adjusted for others, and the skills required in one environment (e.g. a glasshouse situation) will be very different in others (e.g. range lands). McKena (2004) stresses this point. McKena also comments that standard text book learning is unlikely to be successful. Kolb (1984) developed a widely used learning style test which helps in assessing, for example, whether a person might learn abstractly (e.g. from books) in contrast to requiring 'concrete' experience. Bigelow (1998) similarly concludes each situation needs a unique approach, and stresses skill training requires hands-on action, not classroom abstracting. It is likely farmers will require this approach.

While using carefully constructed and appropriate management processes (e.g. constant updating of cash flow budgets) will help to improve farm outcomes (as shown by, for example, Gillen and Carroll 1985; Trip *et al*. 2002), the aim of mentoring and training to improve a farmer's management style and the lessons from experience should be in improving intuitive skills. These have lasting benefits that are constantly and automatically available to the manager during decision making.

In summary, to improve a farmer's inherent management ability this research has shown that farmer support systems must help farmers extract lessons from their experiences through their careful analysis, and secondly, develop systems that help farmers change the nature of their management style towards attitudes shown to be related to high ability. Further, parents of potential farmers should work to provide their children with opportunities and experiences that have been shown to develop superior managerial ability.

The task over the next decade should be to move increased resources into further research with the objective of developing formalised ability tests, training systems and processes that will enable managers to constantly improve their decision heuristics. Success will have lasting impacts on resource use efficiency.

References

Alvarez, A. and Arias, C. (2003). Diseconomies of size with fixed managerial ability, *American Journal of Agricultural Economics* 85(1), 134–142.

Alvarez, J. and Nuthall, P.L. (2001). *Factors Affecting Canterbury, NZ farmer's Adaption and Use of Computerized Information Systems*. Farm and Hort. Management Group Research Report No. 7/2001, Lincoln University, New Zealand.

Arbuckle, J.L. and Wothke, W. (1999). *AMOS Version 4, Users Guide*, Small Waters Corporation, Chicago.

Atkinson, R.L., Atkinson, R.C., Smith, E.E. and Bern, D.J. (1996). *Introduction to Psychology*, 12th edn, Harcourt Brace, Fort Worth.

Austin, E.J., Willock, J., Deary, I.J., Gibson, G.J., Dent, J.B., Edwards-Jones, G., Morgan, O., Grieve, R. and Sutherland, A. (1998). Empirical models of farmer behaviour using psychological, social, and economic variables. Part 1: Linear modelling, *Agricultural Systems* 58, 203–224.

Barrick, M.R. and Mount, M.K. (1991). The big five personality dimensions and job performance: a meta analysis, *Personnel Psychology* 44(1), 1–25.

Bentler, P.M. (1990). Comparative fit indexes in structural models, *Psychological Bulletin* 107, 238–246.

Bigelow, J.D. (1998). *Teaching managerial skills: moving beyond current practice*. Available from URL: http://cobe.boisestate.edu/msr/jbskills/sitskil2.htm. [accessed 30 September 2005].

Browne, M.W. and Cudeck, R. (1993). Alternative ways of assessing model fit. in Bollen, K.A. and Long, J.S. *Testing Structural Equation Models*. Sage, Newbury Park, CA, pp.136–162.

Cameron, D. and Chamala, S. (2002). Measuring impacts of an holistic business management training program, *Proceedings of the 13th IFMA Congress of Farm Management, Papendal*. the Netherlands.

Carmines, E.G. and McIver, J.P. (1981). Analysing models with unobserved variables. in Bohrnstedt, G.M. and Borgatta, E.F. (eds). *Social measurement. Current Issues*. Sage, Beverly Hills, pp. 61–73.

Carpenter, M.A. and Golden, B.R. (1997). Perceived managerial discretion: a study of cause and effect, *Strategic Management Journal* 18(3), 187–206.

Case, H.C.M. and Johnson, P.E. (1953). *Principles of Farm Management*. J.B. Lippincott, Chicago, pp. 466.

Caspi, A., Roberts, B.W. and Shiner, R.L. (2005). Personality development: stability and change, *Annual Reviews of Psychology* 56, 453–484.

Cherniss, C. and Goleman, D. (2001). Training for emotional intelligence: A model. in Cherniss, C.A. and Goleman, D. (eds.) *The Emotionally Intelligent Workplace*. Jossey – Bass, San Francisco, pp. 209–233.

Costa, P.T. (1996). Work and personality: Use of the NEO-PI-R in industrial/organizational psychology, *Applied Psychology* 45(3), 225–241.

Das, M., Mpofu, D., Dunn, E. and Lanphear, J.H. (1998). Self and tutor evaluations in problem-based learning tutorials: Is there a relationship? *Medical Education* 32, 411–418.

Dhungana, B.R., Nuthall, P.L. and Nartea, G.V. (2004). Measuring the economic efficiency of Nepalese rice farms using data envelope analysis, *The Australian Journal of Agricultural and Resource Economics* 48(1), 347–369.

Fitzgerald, J.T., White, C.B. and Gruppen, L.D. (2003). A longitudinal study of self-assessment accuracy, *Medical Education* 37, 645–649.

Gillen, D.J. and Carroll, S. (1985). Relationship of managerial ability to unit effectiveness in more organic versus more mechanistic departments, *The Journal of Management Studies* 22(6), 668–677.

Gramzow, R.H., Elliot, A.J., Asher, E. and McGregor, H.A. (2003). Self evaluation bias and academic performance: Some ways and some reasons why, *Journal of Research in Personality* 37, 41–61.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Blake, W.C. (1995) *Multivariate Data Analysis*. 4th edn. Prentice Hall, NJ.

Hayes, R.M. and Schaefer, S. (1999). How much are differences in managerial ability worth? *Journal of Accounting and Economics* 27(2), 125–148.

Higgs, M. (2001). Is there a relationship between the Myers-Briggs type indicator and emotional intelligence? *Journal of Managerial Psychology* 16(7), 509–533.

Howard, W.H., Brinkman, G.L. and Lambert, R. (1997). Thinking styles and financial characteristics of selected Canadian farm managers, *Canadian Journal of Agricultural Economics* 45, 39–49.

Johnson, G.L., Halter, A.N., Jensen, H.R. and Thomas, D.W. (eds.) (1961). *A Study of Managerial Processes of Midwestern Farmers*. Iowa State University Press, Ames, pp. 221.

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

Kaine, G., Sandall, J. and Bewsell, D. (2004). Personality and strategy in agriculture, *Proceedings of the 20th Annual Conference AJAEE*, Dublin, pp. 790–801.

Kerr, M.R. (1995). Tacit knowledge as a predictor of managerial success: a field study, *Canadian Journal of Behavioural Science* 27, 1–13.

Kilpatrick, S. (1998). Education and training impacts on profitability in agriculture, *Australian and New Zealand Journal of Vocational Educational Research* 5(2), 11–36.

Kolb, D.A. (1984). *Organizational Psychology, fourth edn*, 4th edn, Prentice-Hall, Upper Saddle River, NJ.

Kuo, F.Y. (1998). Managerial intuition and the development of executive support systems, *Decision Support Systems* 24(2), 89–103.

Luan, S., Sorkin, R.D. and Itzkowitz, J. (2004). Weighting information from outside sources: a biased process, *Behavioral Decision Making* 17, 95–116.

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

McKena, S. (2004). Predispositions and context in the development of managerial skills, *The Journal of Management Development* 23(7/8): 664–674.

Muggen, G. (1969). Human factors and farm management. A review of the literature, *World Agricultural Economics and Rural Sociology Abstracts* 11(2), 1–11.

Myers, I.B. and McCaulley, M.H. (1985). *Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator*. Consulting Psychologists Press, Palo Alto, CA.

Nahapiet, J. and Ghosal, S. (1998). Social capital, intellectual capital, and the organizational advantage, *The Academy Management Review* 23(2), 242–267.

Nuthall, P.L. (2006a). Determining the important management skill competencies. The case of family farm business in New Zealand, *Agricultural Systems* 88, 429–450.

Nuthall, P.L. (2006b). *Development of tests for assessing managerial ability on New Zealand farms*. FHMG Research Report 01/2006. Lincoln University, Canterbury, New Zealand.

Nuthall, P.L. (2006c). Psychometric testing for assessing farmers' managerial ability (and modelling the origins of ability). Conference paper, New Zealand Agricultural and Resource Economics Society. Available from URL: http://ageconsearch.umn.edu. [accessed 21 May 2009]

Parker, A.M. and Fischhoff, B. (2005). Decision making competence: External validation through an individual – differences approach, *Journal of Behavioural Decision Making* 18(1), 1–27.

Rehm, L.P. and Rokke, P. (1988). Self management therapies. Chapter 4 in Dobson, K.S. (ed.), *Handbook of Cognitive Behavioural Therapies*. Guildford Press, London, pp. 136–166.

Roberts, B.W. (1997). Plaster or plasticity: are adult experiences associated with work experience in women, *Journal of Personality* 65(2), 205–232.

Robertson, T., Baron, H., Gibbons, P., MacIver, R. and Nyfield, G. (2000). Conscientiousness and managerial performance, *Journal of Occupational and Organizational Psychology* 73(2), 171–185.

Robins, R.W., Fraley, R.C., Roberts, B.W. and Trzesniewski, K.H. (2001). A longitudinal study of personality change in young adulthood, *Journal of Personality* 69(4), 617–640.

Rougour, C.W., Trip, G., Huirne, R.B.M. and Renkema, J.A. (1998). How to define and study farmer's management capacity: theory and use in agricultural economics, *Agricultural Economics* 18, 261–272.

Salgado, J.F. (1997). The five factor model of personality and job performance in the European Community, *Journal of Applied Psychology* 82(1), 30–43.

Sieck, W.R. and Arkes, H.R. (2005). The recalcitrance of overconfidence and its contribution to decision aid neglect, *Journal of Behavioral Decision Making* 18(1), 29–53.

Smith, D. and Blackham, B. (1988). The measurement of managerial abilities in an assessment centre, *Personnel Review* 17(4), 15–22.

Solano, C., Leon, H., Perez, E., Tole, L., Fawcett, R.H. and Herrero, M. (2006). Using farmer decision making profiles and managerial capacity as predictors of farm management and performance in Costa Rican dairy farms, *Agricultural Systems* 88, 395–428.

Sternberg, R.J. and Grigorenko, E. (2001). *Practical intelligence and the principal*. Spotlight on Student Success No. 603, an occasional series, Laboratory of Student Success, Philadelphia.

Sternberg, R.J., Forsythe, G.B., Hedlund, J., Horvath, J.A., Wagner, R.K., Williams, W.M., Snook, S.A. and Grigorenko, E.L. (2000). *Practical Intelligence in Everyday Life*. Cambridge University Press, Cambridge.

Sumner, D.A. and Lieby, J.D. (1987). An econometric analysis of the effect of human capital on size and growth among dairy farms, *American Journal of Agricultural Economics* 69, 465–470.

Tett, R.P., Jackson, D.N. and Rothstein, M. (1991). Personality measures as predictors of job performance; a meta-analytic review, *Personnel Psychology* 44, 703–742.

Trip, G., Thijssen, G.J., Renkema, J.A. and Hairne, R.B.M. (2002). Measuring managerial efficiency: the case of commercial greenhouse growers, *Agricultural Economics* 27(2), 172–181.

Warren, R.D., White, J.K. and Fuller, W.A. (1974). An errors-in variables analysis of managerial role performance, *Journal of the American Statistical Association* 69, 886–893.

Wilson, P., Hadley, D., Ramsden, R. and Kaltsas, I. (1998). Measuring and explaining technical efficiency in UK potato production, *Journal of Agricultural Economics* 49(3), 294–305.

Wu, S., Devadoss, S. and Lu, Y. (2003). Estimation and decomposition of technical efficiency for sugar beet farms, *Applied Economics* 35(4), 471–485.

Young, A.J. and Walters, J.L. (2002). Relationship between DHI production values and Myers-Briggs type indicator as a measure of management ability, *Journal of Dairy Science* 85, 2046–2052.

Young, B.S., Arthur, N. and Finch, J. (2000). Predictors of managerial performance: more than cognitive ability, *Journal of Business and Psychology* 15(1), 53–72.

Zeidner, M., Matthews, G. and Roberts, R.D. (2004). Emotional intelligence in the workplace, *Applied Psychology* 53(3), 371–390.