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Why small farms persist? The influence of farmers' characteristics on farm growth and development. The case of smaller dairy farmers in NZ*

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Human capital is an important resource in primary production impacting on farmers' decisions and actions. Given their current and expected economic environment, farmers must use their human capital in mapping out a trajectory for their farm. This study considers particular aspects of farmers' human capital and its influence on farm growth, or lack of it. Farmers' characteristics as expressed through their personality, intelligence and objectives are the main human capital aspects considered in a sample of smaller NZ dairy farms. They are somewhat typical of western farmers working on smaller farms. They can be broadly classed into Expanders, Maintainers and Retractors. It is hypothesised each group will have distinct and different personal characteristics and these influence the farmers' choice of trajectory. This is in addition to purely economic factors. It is also hypothesised the characteristics influence the farmers' choice of development strategy and how challenges to the strategy are viewed. The data collected from the small dairy farms support the hypotheses suggesting the design of policy and extension programs must allow for these human capital drivers. Using past data, it is also shown aspects of human capital are different in large farms emphasising the same conclusion.

Key words: development attitudes, farmer typologies, growth challenges, human capital, objectives and typologies, personality and farm growth.

1. Introduction

Over the decades, the ever-present cost/price squeeze has meant farmers have had to constantly strive to increase production to maintain reasonable profit levels (Shields 2010). This has meant, amongst other things, the average farm size in developed economies has increased (Burton and Walford 2005). However, some farmers do continue to operate off their existing farm even where profit levels make continued operation challenging. This study reports on research exploring the nature of these farmers relative to the others to conclude why these phenomena should exist. The conclusions have

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implications for farm policy and extension. Effectively, the work examines specific constituents of human capital (defined as a manager's stock of knowledge, habits, and social, personality and creative attributes) (Heckman 2000) and their relationship with farm growth outcomes which may emanate from a range of sources (Brummer *et al*. 2002).

While farmers always face choices over their best strategy (Suess-Reyes and Fuetsch 2016), those becoming subeconomic (Glau 1971) need to pay particular attention to the challenge. If anything, with the opening of markets worldwide, and the consequent lowering of farm supports (Key and Roberts 2006), together with the increasing price volatility of open markets and commodity cycles, the number of managers facing these issues has increased in recent years. Accordingly, the topic under study is becoming increasingly important to governments and analysts as reactions to policy measures are dependent not only on monetary factors, but also on farmers' human capital features including their values and objectives.

Despite the pressures, research has shown in both less developed and developed economies (Hoppe *et al*. 2010; Westbrooke 2013), some managers of small farms do maintain their farm's existing size and remain relatively content (Aubert and Perrier-Cornet 2009). Others either work successfully at expansion (Meert *et al*. 2005) or, alternatively, entirely retract from farming through retirement or sale (Aubert and Perrier-Cornet 2009). Effectively, there are three broadly different groups (Maintainers, Expanders and Retractors), although the boundaries between the groups are placed might be problematic in some cases. For example, a farmer who holds cow numbers, but improves income through pluriactivity (Knickel *et al*. 2011), might be defined as either an expander or maintainer. Similarly, for increasing/decreasing production per cow.

In contrast to economic factors (Eastwood *et al*. 2010) such as prices, costs, capital requirements, and the like, being the major influence on the actions and existence of these three groups, it is specifically hypothesised the farmers' objectives, personality and intelligence (the personal characteristics) have a significant part to play in the farmers' decisions to (i) become Maintainers or Expanders, and (ii) choose a particular development path and attitude to the associated challenges.

A sample of the managers of small NZ dairy farms was used to assess these hypotheses. While potential Retractors may be in the sample, data for past Retractors were not available.

Consequent to the outcomes of past decisions, it is also hypothesised (iii) that relative to larger farms, farmers of small farms have different personal characteristics.

Sometimes farmers that stay small become involved in additional, both economic and noneconomic, activities (Johnsen 2004; Meert *et al*. 2005; Aubert and Perrier-Cornet 2009) facilitating both their financial survival and satisfaction levels. Such activity (pluriactivity) is likely to be related to their level of entrepreneurship (Pato and Teixeira 2016), a factor also thought to be

closely aligned to their objectives, personality (Obschonka *et al*. 2013), background and training (Skuras *et al*. 2005). Managerial ability is also important (Nuthall 2009b).

In the past, the reality that farmers, within the bounds of weather and markets, are largely the controllers of their own destiny through the impact of their personal characteristics has not been recognised to the extent deserved. Most work in developing strategies for adjustment, survival and growth has revolved round the economics of production and resource combination issues (Tweeten 1983; Keating and McCown 2001; Nuthall 2011), yet the application of economic reality largely depends on the personal characteristics of the managers for they drive both economic and other decisions.

In considering farmers' personal characteristics, it is important to recognise psychologists believe (DeYoung 2011) a manager's modus operandi is largely determined by her/his personality (Matthews and Deary 1998) and intelligence (Sternberg 2004). Both factors are influenced by genetic and environmental factors. Training and knowledge also have an impact, but they are part of a farmer's environment.

Many factors including family and farm location factors, influence small dairy farmers and their actions. The research reported here specifically considers the influence of the farmers' personal characteristics. If, as expected, they influence actions, policymakers and extension personnel have defined areas to include in their analyses and work with both smaller and other farmers.

This study proceeds through a discussion on the factors defining the characteristics of farmers, an outline of the data collected to analyse the hypotheses, the method used in its collection and an analysis of the data divided into sections covering aspects of the famers' past and future situation. The study also shows a comparison of small and larger dairy farmers as, if the hypotheses are not rejected. differences in the personal and other characteristics would be expected between these two groups. Finally, some concluding comments are presented. Classification of farm size has been based on cow numbers, and, when considering expansion, herd size change was used as the criterion.

2. The farmers' personal attributes as they relate to management and decision-making

2.1 Background

Besides acknowledging that farmers' personal characteristics must be included in any analysis, it is also important to accept that humans are complex organisms difficult to predict with consistency. Farmers, and everyone else, obtain their decision influencing characteristics from their genes and the influence of the environment experienced (Eysenck 1990), particularly in their earlier years. Accordingly, parentage is particularly

influential, as are schooling and ongoing experiences and training. Inconsistencies are most likely due to emotional factors and their variation stemming from these background factors (Andrade and Ariely 2009).

A farmers' background helps them develop a set of objectives which directs their decisions. In assessing farmer's decisions, it is the specific set of objectives that must be used in contrast to assuming a simple profit maximisation goal which few farm families actually exhibit (Gasson *et al.* 1988).

Summarising, the main farmer characteristics influencing decisions are their personality, intelligence and objectives together with biographical factors such as their age and education which influence the expression of the first three factors (influence of the era). It is generally hypothesised therefore that these factors are an important influence on farmers' decisions over development.

Personality, as it expresses itself in managerial actions, is better termed 'management style' being the expression of personality in a farmers' managerial approach (Nuthall 2006). For example, decision support is potentially available from farmer's networks (Baumgart-Getz *et al.* 2012), the use of which is related to a farmer's personality and the associated attitude to developing and mixing with groups of farmers, and others.

Also worth considering is a farmer's belief in how much of the farm outcomes are controllable through their decisions and actions (referred to as a farmer's locus of control (LOC), (Rotter 1966)). It is related to personality.

Figure 1 portrays all these outcome-determining factors and therefore contains ellipses highlighting the influence of objectives, management style (personality) and biographical background including intelligence.

In that farmers make most decisions intuitively (Nuthall 2012), the accuracy of the intuitive decisions relative to the farmer's objectives is important. Intuition, a component of managerial ability, is constantly developing and dependent on all the factors listed above (Dane and Pratt 2007). It is also dependent on the farmer's ability to learn from experience meaning their learning style (Smith and Kolb 1996) is important.

Figure 1 visually portrays the conceptual framework for the general hypothesis that the variables discussed impact on farmers' choices for the future. Each farmer must employ these components of human capital to decide on the three broad strategic choices in the left-hand box. If the decision is to 'maintain' (consolidate) or to develop, production choices and challenges must be considered and dealt with. These considerations and subsequent action lead to the outcomes observed. In influencing the choices, the top ellipse expresses that environmental factors such as the farm area (size), current and expected prices and costs, current and expected government regulations including taxes all influence any decision. As the centre of this study, the remaining ellipses express the importance of the farmers' personal characteristics.

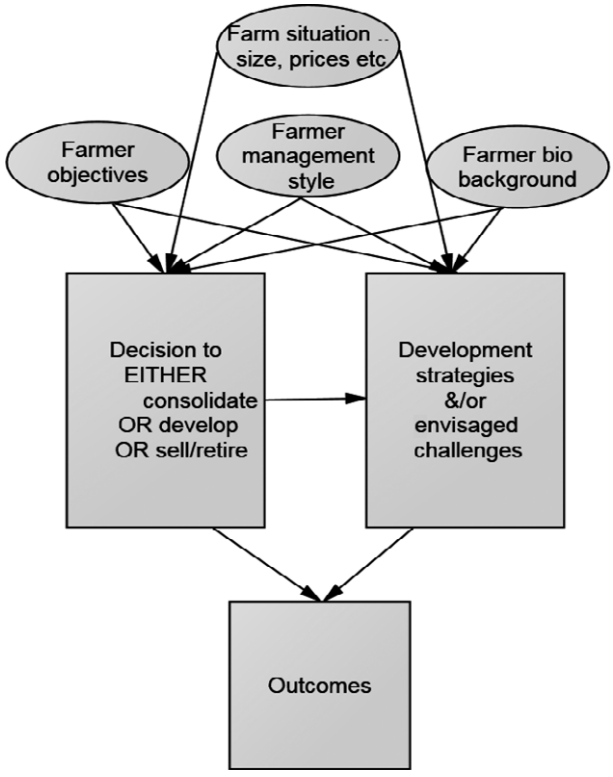

Figure 1 A schematic of the components of small farmer development choices.

2.2 Measuring the farmers' characteristics

To assess the specific hypotheses, information on each farmer's characteristics together with their current situation and intentions is necessary. Obtaining information on a farmer's age and education is straightforward, as is information on technical efficiency through production data, cow numbers and similar. They help to reflect a farmer's managerial ability.

Many tests have been developed to determine a farmer's objectives most of which are readily available. In this case, a modification of a Scottish test was used (Willock *et al*. 1999; Nuthall and Old 2014) as the core of the questions included.

For management style, a well-researched question set (Nuthall 2009a) was used. It is based on the statistically defined five factor model of personality (Matthews and Deary 1998) using the factors openness, conscientiousness, extroversion, agreeableness and neuroticism (anxiety). Similarly, for the farmer's LOC, a farmer-based question set provided relevant questions (Nuthall 2009a). For intelligence, there is a strong correlation between educational achievement and intelligence (Deary *et al*. 2007) allowing the educational achievement to be used as a proxy with minimal bias.

While it would certainly have been useful to have information on a farmer's entrepreneurship, no successful farmer oriented tests are available, and this is also the case for managerial ability, although there are correlations between a farmer's education and management style with ability (Mishra and Morehart 2001). The same is also likely to apply for intuition (Dane and Pratt 2007).

2.3 The farmers' view of the future

After discussing possibilities with industry experts and farmers, a list of possible 'ten year plan actions' was drawn up to represent the major options. Similarly, to determine where extension efforts should be focused, the farmers were asked to rate the 'challenges to their plans' of a number of likely difficulties as well as seeking information on their preferred extension method.

The answers provided information on the decisions the farmers intend to follow and, consequently, enabled assessing the influence of the farmers' personal characteristics. Similarly, information on the farms that have expanded their herds by a significant proportion provided data on past actions.

3. Data collection method

The nature of the questions allowed for a telephone survey to obtain the data. The questions were closed and short with a limited number of defined answers. They were also readily enunciated over a telephone.

Data from two earlier (conducted in 2006 and 2013) surveys containing similar information to the current telephone survey were accessed to allow comparisons between the small and larger dairy farmers. These surveys had been mailed to stratified (type, size, location) samples of all farm types. The telephone questionnaire was designed so that a number of the variables were common to all three surveys providing comparative data. Details of the earlier surveys are available in Nuthall (2009a) and Nuthall and Old (2014) with each involving over 800 farmers. Due to confidentiality, it is not known whether any farmer appeared in more than one survey. It is unlikely the nature of the answers would exhibit any invalidating time trends (see below for the variables used).

The telephone survey used a random selection of dairy farmers obtained from membership lists and electoral rolls. Within the time frame and funds available, 346 regionally stratified completed schedules were obtained from small dairy farmers using trained telephone enumerators. Any farm with at least one full time labour unit and <400 cows was eligible, and this being regarded as a small farm in the NZ context. The average dairy farm in different regions varies from 808 to 272 cows (DairyNZ 2015) with a national average of 419 (5 per cent have 1500+ cows, and an additional 11 per cent 1000+ cows). The average herd size on the 'small farm' sample was 240 cows

(based on an economic size, and the minimum herd for which statistics are kept is 100 cows).

For the comparisons, as the 2006 and 2013 surveys did not collect cow numbers, a nonsmall farm ('large') was defined as one having more than two workers including the manager. The farmers in the telephone survey, all with <400 cows, had an average of 1.83 labour units ('large' farms 3.77).

The 2006 and 2013 mail surveys had 25 questions covering a farmer's management style, and 20 questions covering aspects of a farmer's objectives (the full lists are given in Nuthall 2009a). In the telephone survey, key variables that were correlated with sections of the full sets were included (six questions for management style, and three for objectives). Similarly, a key question from a LOC question set (Nuthall 2009a) was also included. The information obtained was then used in linear regression equations to calculate the core variables making up a farmer's full set of objectives and management style. The LOC was also calculated in the same way (for details of the regression equations used for management style, the objectives and the LOC, see Westbrooke and Nuthall 2015 (which also contains a copy of the questionnaire used)).

4. Analysis of the data

4.1 Analytical methods used

The hypotheses were tested using four analyses: two dealing with outcomes from the past, and two with intentions. If hypothesis 1 is correct, farmers who have in the past increased cow numbers by at least a third should have different personal characteristics than the remainder. Accordingly, a comparison between the two groups is presented. Secondly, farmers clustered (Hair *et al*. 2009) into groups according to their characteristics should have future intentions dependent on which cluster they are in, and, similarly for the challenges they believe they face in carrying out their intentions (hypothesis 2).

Thirdly, as the cluster group comparisons do not rank the importance of each variable, the intentions and challenges expressed by the farmers were factorised and regressed against the farmer characteristics (extending hypothesis 2). Finally, farm and farmer data from the previous surveys were used to compare farmers on larger farms with the current sample. The general hypothesis would suggest these two groups should have different characteristics (hypothesis 3) particularly as some farmers on larger farms will have once been small farmers.

The analysis was based on the farmers' characteristics in contrast to spouse or family data as it has been shown the farmers themselves make the majority of decisions (Nuthall and Old 2014).

4.2 The past. Details of small farmers who have increased production (the Expanders)

Table 1 contains the comparison between the Expanders, who have increased cow numbers by at least one-third, and the Maintainers.

The relatively significant variables are shaded grey (below a probability of 0.201 has been shaded under the concept that an 80 per cent chance of being correct is worth considering from a decision view point (Lindley 1991)). The variables, other than the first five, are key statements taken from the full management style, objective and LOC statement sets (Nuthall 2009a).

Farmer and production data are significantly different between the two groups confirming hypothesis 1. The farmers who increased cow numbers are older. Age and herd increase are correlated ($r = 0.250$, $P = 0.000$) reinforcing that older farmers have had more time to increase their herds. Age is also strongly correlated with equity ($r = 0.484$, $P = 0.000$) providing the means to expand, although age is negatively correlated with education ($r = -0.251$, $P = 0.000$) leading to a slightly negative aspect to knowledge. Historically, however, education creep is continuous.

Two important management style factors (tolerance and anxiety) also influence growth as does the farmers' belief in their control of outcomes. The objectives included in the survey have similar ratings in each group. They are likely aspirational rather than actual.

In terms of farmer groups in the left-hand rectangle in Figure 1, the farmers giving rise to column one in Table 1 are the Expanders. Data were not available for the Retractors as they had left dairy farming. The data compare the Expanders and Maintainers, although some of the latter may well 'retract' in the future.

4.3 Developing treatments for considering farmer intentions. Grouping like farmers using cluster analysis

To consider the impact of the farmers' characteristics on the plans and challenges (the right-hand rectangle in Figure 1), the respondents were clustered into six groups (K means clusters using SPSS (Privitera 2014)) according to their objectives and style variables. The uppermost ellipses in Figure 1 have been divided into six subellipses based on farmer similarities. Table 2 contains the details of the clusters as well as the numbers in each cluster. Selecting six relative to any other number of clusters is somewhat arbitrary, but having reasonable numbers in each cluster for statistical reasons was important. The group means are largely highly significantly different.

For the 'maximum cash returns' objective, and the 'mistake tolerance' management style question, there is very little difference between the clusters. The lack of difference in seeking maximum returns was also evident in the herd size growth groups.

Table 1 A comparison of key variables for farmers from the sample of small farmers that have increased production by at least a third compared with the remainder

Farmer variables	Mean value if cow numbers increased by at least a third	Mean value if cow numbers not increased by a third	*t*-Test significance probability between averages
General			
Farmer age code†	3.30	2.69	0.000
Rurally born and bred (1 = yes, 2 = no)	1.15	1.24	0.076
Education code‡	3.08	3.39	0.046
Production (kg milk solids per hectare)	1008	955	0.200
Financial equity (% in the farm)	71.4	64.9	0.055
Managerial style			
Tolerate mistakes of employees/ contractors§	3.43	3.24	0.142
Don't sleep at night worrying about decisions§	1.87	2.15	0.049
Find new methods exhilarating and challenging§	3.83	3.68	0.253
Don't rest until the job is fully completed§	3.41	3.45	0.764
Speak mind and ask questions at meetings§	3.68	3.56	0.439
Problems are due to factors I can't control§	3.68	3.85	0.163
Objectives			
Important to pass the property onto family§	3.01	2.89	0.484
Reasonable holidays and leisure time essential§	4.28	4.23	0.715
Aiming for maximum cash returns is important§	4.41	4.48	0.447

Note: †1 = <30 years, 2 = 31–40 years, 3 = 41–50 years, 4 = 51–60 years, 5 = >60 years. ‡1 = secondary, 2 = farm cadet, 3 = diploma, 4 = degree, 5 = postgrad. §A score based on 5 = agree with statement, through to 1 = don't agree with statement with varying agreement between these extremes. These are the key variables taken from the full sets.
The greyed values are the most significant and should be concentrated on.

Looking at the average score for each attribute relative to each cluster average, the nature of each cluster becomes clear. For example, cluster 1 farmers are not keen on passing the property to their heirs (less so than any other cluster); believe seeking maximum returns and having reasonable leisure are both important; are ambivalent over tolerating mistakes; do not lose sleep worrying about issues (compared with cluster 3); are moderately excited over new issues; are not particularly keen on working until the job is done (compared with cluster 3 whose members also worry about issues); are forward in that they speak their mind (extroverts); and are somewhat in the middle over their control belief (LOC).

Table 2 Cluster centres for a six cluster grouping of the farmers' objectives and management style variables (the scoring is based on a five step scale ranging from 1 = strong disagreement with the belief to 5 = strongly agree with the belief listed)

Farmer attitudes	Cluster number†						Average score
	One	Two	Three	Four	Five	Six	
Objectives							
Important to pass the property onto family	1.8	3.3	2.2	3.8	4.1	3.0	2.93
Reasonable holidays and leisure time essential	4.5	2.0	4.5	4.6	4.7	3.6	4.25
Aiming for maximum cash returns is important	4.5	4.1	4.6	4.4	4.7	4.0	4.46
Managerial style							
Tolerate mistakes of employees/contractors	3.1	3.3	3.4	3.4	3.5	3.2	3.30
Don't sleep at night worrying about decisions	1.7	2.9	3.8	1.5	1.6	1.3	2.06
Find new methods exhilarating and challenging	3.7	3.4	4.0	3.4	4.5	3.0	3.73
Don't rest until the job is fully completed	2.4	3.5	4.6	2.6	4.1	4.1	3.44
Speak mind and ask questions at meetings	4.2	2.3	3.6	2.0	4.3	3.9	3.60
Problems are due to factors I can't control	3.6	3.2	4.1	4.2	3.9	3.3	3.80
Per cent of farms in each cluster	25.7	8.1	18.0	13.6	21.0	13.6	100

Note: †that the differences between cluster centres are all highly significantly different (*F*-test), except for 'mistake tolerance'.

Notable differences that stand out in the other clusters are that cluster 2 farmers do not believe holidays and leisure are critical, cluster 3 farmers strive to finish jobs once started, cluster 4 farmers do not speak at meetings (introverts), whereas clusters 5 and 6 farmers are not at all anxious over farming operations, and cluster 5 farmers also distinguish themselves by finding new ideas exhilarating and challenging. In the end, however, all farmers do have their unique characteristics.

4.4 The future. A comparison of the clusters relative to the 10 year plans, biographical/production data and development challenges

An analysis of variance with the cluster membership as the experimental treatments is given in Table 3. It confirms hypothesis 2. The important 10 year plan variables are highlighted with shading. The ellipses in Figure 1 reflecting the farmer characteristics have been replaced with clusters of farmers and compared over their view of the various development approaches. Whether they are Maintainers, Expanders or potential Retractors depends on their attitudes to the development options.

Table 3 Significance (*F*-test) of the differences between selected variables for clusters formed from the farmer characteristics as the experimental factors (from Table 2)

Farmer intentions and bio/production information	*F*-test probability
Background information	
Farmer age code (1 = <30 years … 5 = >60 years)	0.340
Rurally born and bred (1 = yes, 2 = no)	0.015
Education code (1 = secondary … 4 = degree)	0.009
Production (kg milk solids per hectare)	0.606
Financial equity (% in the farm)	0.285
Herd increased by at least a third (1 = yes, 2 = no)	0.198
Future, 10 year plans	
Sell the farm	0.001
Sell farm to buy bigger	0.042
Increase existing farm size	0.002
Transferring the farm to heirs	0.040
Employ additional nonfamily staff	0.211
Doing the majority of work yourself	0.052
Investing in work saving technology	0.090
Increase production more than 10%	0.103
Diversify the current business	0.439
Invest in an additional farm	0.002
More than 20% of income from off farm	0.412
Reducing farm debt to very low levels	0.464
Farmer challenges in following 10 year plans	
Level of cash return over last 4 years	0.004
Expected cash returns	0.013
Amount of capital/debt required	0.741
Level of risk involved	0.321
Lack of knowledge	0.339
Environmental regulations to be met	0.005
Lack of suitable technologies	0.034
Difficulties of discussing farm succession	0.486
Finding suitable staff	0.229
Ability to manage staff	0.370

Note: The greyed values are the most significant and should be concentrated on.

The farmers' personal attributes do influence the relative importance of most 10 year plan options and also depend on whether the farmer experienced a rural upbringing and their education. Rural culture does seem to matter. The attribute differences also impact on production increases.

For the perceived development challenges (lower part of Table 3), the cluster differences are not as pronounced relative to the 10 year plan information. The attitude to income as a problem varies between clusters, and similarly for the environmental regulations and the lack of suitable technologies.

The concern over complying with regulations is management style related. At the other extreme, it is surprising that the attitude to capital/debt requirement does not seem to be different across groups. They probably all assume changes lead to greater debt. While the significance probability is 0.229, finding suitable staff can still be regarded as being different across clusters.

4.5 The future. Explaining the farmers' 10 year plans and associated challenges

For the linear regressions of the 10 year plans and the associated 'challenges', the farmers' 10 year plans and perceived challenges were factorised to provide the core underlying variables (Using SPSS, Osborne and Costello 2009).

The factorisation used a Varimax rotation and an Eigenvalue cut-off of 1.0 (Williams *et al*. 2010) with the factors named through their constituent variables and correlation levels (communalities). The 'challenges' reduced to three factors explaining 54 per cent of the variance ((i) 'finance and risk' (the cash return, debt and risk variables featured strongly), (ii) 'labour and knowledge' (the important variables included staff management ability, finding suitable staff and lack of knowledge) and (iii) 'technology and environment' (environmental regulations and lack of knowledge variables featured strongly)).

The 10 year plan options led to four factors explaining 50 per cent of the constituent variance ((i) 'all round Expander' (increase farm size, increase production, invest in another farm, and on farm technology were the main constituent variables), (ii) 'employer' (employ staff and reduce debt were the important subvariables), (iii) 'off farm earner' (the 'at least 20 per cent off farm earnings' was the key component variable) and (iv) 'farm trader' (with sell farm and sell to go bigger being the critical constituents)).

Tables 4 and 5 contain the standardised coefficients for the equations explaining each factor. In interpreting the coefficients, it is important to recognise the factorisation process leads to variables with a mean of zero, standard deviation of 1 and range ± 2.9.

The objective and management style variables are listed in full. These were obtained from the regressions based on the 2006 and 2013 survey data. The farmer's objectives and management style questions factorised into six objective and six management style variables (Nuthall 2009b). Based on Eigenvalues of at least 1.0 and a Varimax rotation, they explained 54 per cent, and 46 per cent of the variance, respectively. Each factor was given a name based on the constituents and their communalities. These are listed in Tables 4–6 as are the comparison results. Similarly, the LOC questions convert to a percentage score with 100 per cent reflecting someone who believes they have perfect control of the outcomes resulting from their decisions.

For the 10 year plans (Table 4), the equations are all highly significant with varying R^2's ranging from 0.275 (off farm earner factor) to 0.547 (employer factor). Generally, the variables significantly explain over a quarter through to half the variance.

Concentrating on the variables with a significance probability of <0.2 (with at least a 80 per cent chance of correctness they are worth considering), and a coefficient of at least plus or minus 0.2, the 'way of life' objective is important in influencing 10 year plans, and perhaps the community and family supporter objective variables. For the management style, no variables stand out across all factors, but when considering the first two factors, the style variables are major contributors. The same cannot be said about the LOC.

Table 4 Standardised linear regression coefficients for equations explaining the four factors expressing the farmers' views of their 10 year plans, and their significance

Variable	Equation independent variable							
	Factor 1: All round expander	*t*-Test probability	Factor 2: Employer	*t*-Test probability	Factor 3: Off farm income earner	*t*-Test probability	Factor 4: Farm trader	*t*-Test probability
Equation R^2	0.375		0.547		0.275		0.327	
Equation significance (*F*-test)	0.000		0.000		0.000		0.000	
Biographical /production data								
Age code (1 = <30 years … 5 = >60 years)†	−2.801	**0.048**	1.970	**0.101**	0.060	**0.968**	−0.272	**0.852**
Rurally born and bred (1 = yes, 2 = no)	0.180	**0.019**	0.026	**0.687**	0.063	**0.444**	0.039	**0.622**
Education code (1 = secondary … 5 = postgrad.)†	1.233	**0.027**	−0.595	**0.207**	0.157	**0.793**	0.009	**0.988**
Per cent of assets as equity	0.097	**0.286**	0.003	**0.972**	0.142	**0.150**	0.041	**0.665**
Herd increased at least a third (1 = yes, 2 = no)	−0.117	**0.131**	−0.036	**0.584**	0.005	**0.955**	0.104	**0.192**
kg MS per labour unit	0.065	**0.446**	−0.200	**0.006**	−0.082	**0.370**	0.019	**0.833**
Total kg MS production	0.246	**0.007**	0.459	**0.000**	−0.231	**0.017**	−0.024	**0.794**
Objectives								
Obj-balanced	−0.346	**0.017**	0.065	**0.596**	−0.215	**0.164**	−0.132	**0.374**
Obj-risk remover	1.059	**0.063**	−0.484	**0.316**	0.118	**0.847**	0.133	**0.820**
Obj-way of life	−0.358	**0.002**	0.262	**0.007**	−0.126	**0.303**	−0.175	**0.140**
Obj-reluctant famer	0.179	**0.225**	0.094	**0.455**	0.164	**0.302**	0.071	**0.643**
Obj-community supporter	0.455	**0.005**	−0.553	**0.000**	−0.219	**0.201**	0.019	**0.907**
Obj-family supporter	−0.098	**0.168**	0.059	**0.328**	−0.186	**0.016**	0.499	**0.000**
Managerial style								
Style-consult logician community	−1.213	**0.123**	0.730	**0.275**	0.123	**0.884**	−0.029	**0.972**
Style-correctness seeker	0.442	**0.115**	−0.303	**0.204**	−0.110	**0.715**	−0.186	**0.521**
Style-consult logician family and friends	3.475	**0.067**	−2.268	**0.159**	−0.225	**0.912**	0.401	**0.837**
Style-conscientious planner	−2.962	**0.060**	1.748	**0.191**	0.145	**0.931**	−0.227	**0.889**
Style-thoughtful creator	−1.069	**0.084**	0.674	**0.200**	0.064	**0.923**	−0.005	**0.993**
Style-benign manager	−1.275	**0.053**	0.880	**0.117**	−0.053	**0.941**	−0.066	**0.923**
Locus of control (%)	0.013	**0.916**	0.138	**0.180**	0.030	**0.818**	0.047	**0.708**

Note: The shaded cells are the most important. †See Table 1 for all codes.
The greyed values are the most significant and should be concentrated on. Bolding is used to highlight which columns give the significance values.

Table 5 Standardised linear regression coefficients for equations explaining the three factors expressing the farmers' views of the major challenges they face in implementing their 10 year plans, and their significance

Variable/Equation independent variable	Factor 1: Finance & risk	*t*-Test probability	Factor 2: Labour& knowledge	*t*-Test probability	Factor 3: Technology available	*t*-Test probability
Equation R^2	0.449		0.283		0.716	
Equation significance (*F*-test)	0.000		0.000		0.000	
Bio/production data						
Age code (1 = <30 years … 5 = >60 years)†	1.526	**0.209**	−1.595	**0.249**	0.422	**0.627**
Rurally born and bred (1 = yes, 2 = no)	0.077	**0.204**	−0.088	**0.206**	0.025	**0.560**
Education code (1 = sec … 5 = postgrad.)†	−0.301	**0.501**	0.592	**0.246**	−0.305	**0.342**
Per cent of assets as equity	−0.061	**0.357**	−0.041	**0.583**	0.013	**0.784**
Herd increased at least a third (1 = yes, 2 = no)	−0.034	**0.571**	−0.025	**0.719**	0.001	**0.982**
kg MS per labour unit	−0.012	**0.857**	0.112	**0.149**	−0.027	**0.579**
Total kg MS production	−0.099	**0.199**	−0.045	**0.608**	−0.023	**0.674**
kg MS per hectare	0.077	**0.274**	0.014	**0.861**	0.061	**0.224**
Objectives						
Obj-balanced	−0.976	**0.000**	−0.438	**0.001**	0.579	**0.000**
Obj-risk remover	−0.492	**0.225**	0.520	**0.260**	−0.175	**0.547**
Obj-way of life	−0.685	**0.000**	−0.483	**0.000**	−0.191	**0.002**
Obj-reluctant famer	0.717	**0.000**	0.214	**0.120**	0.331	**0.000**
Obj-community supporter	−0.246	**0.050**	0.119	**0.403**	0.016	**0.855**
Obj-family supporter	−0.030	**0.587**	−0.001	**0.990**	−0.046	**0.252**
Managerial style						
Style-consult logician community	0.931	**0.115**	−0.348	**0.605**	0.223	**0.598**
Style-correctness seeker	−0.343	**0.103**	0.077	**0.746**	0.089	**0.929**
Style-consult logician family and friends	−1.768	**0.236**	1.915	**0.260**	−0.744	**0.486**
Style-conscientious planner	1.469	**0.237**	−1.409	**0.320**	0.257	**0.773**
Style-thoughtful creator	0.742	**0.135**	−0.525	**0.353**	0.180	**0.613**
Style-benign manager	0.679	**0.175**	−0.629	**0.271**	0.212	**0.554**
Locus of control (%)	−0.072	**0.446**	−0.013	**0.906**	−0.056	**0.410**

Note: †See Table 1 for a full list of the codes.
The greyed values are the most significant and should be concentrated on. Bolding is used to highlight which columns give the significance values.

For the biographical/production variables, mixed results are similarly evident.

If the coefficients are summed for all the variables in a group, the relative importance of the farmer objectives ranges from 16 per cent through to 51 per cent in explaining the 10 year plan factors. For the management style factors, the importance ranges from 50 per cent to 3 per cent, whereas the biographical variables range from 27 per cent to 40 per cent and the production variables from 17 per cent to 6 per cent. On average across the factors, the relative importance is 34 per cent (objectives), 24 per cent (management style), 31 per cent (biographical) and 11 per cent (production). While there is variability across the factors, overall, the farmers' personal features dominate the explanation of the 10 year plans. However, it must be noted that approximately half of the variability is related to nonrecorded factors (in that the equations explain at most 54 per cent of the variance). These might be issues such as the locality of the farm, family size and managerial ability to give three examples.

For the challenges the farmers believe they face (Table 5), the regression equations were all highly significant explaining nearly 50 per cent of the variance of the first factor (finance and risk), 72 per cent of the third factor (technology and environment), but only 28 per cent of the second factor (labour and knowledge). Of the total standardised values for all variables in each of the four factors, the objective factors contribute from 61 per cent, through 36 per cent to 3 per cent (average 33 per cent) to the factors depending on which factor. For the management style factors, the figures are 44 per cent through to 19 per cent (average 32 per cent), and for the biographical variables 52 per cent to 17 per cent (average 32 per cent) and 3 per cent to 1 per cent for the production variables (average 2 per cent). Again, the farmers' personal factors dominate the explanation of the perceived challenges. Hypothesis 2 is not rejected.

Considering the specific variables, it is the objectives 'balanced', 'way of life' and 'reluctant farmer' which are the most notable objective factors. For the management style variables, it is the first challenge factor (finance and risk) for which many of the variables are notable.

Past objective typology research has clearly shown differences between farmers (e.g. Pereira *et al.* 2016), but this work has gone further in showing just how important the typologies are in determining responses, and in quantifying the relative importance of the farmer characteristics.

4.6 The present. A comparison between small and larger dairy farmers

Using the data from the 2006 and 2013 surveys, comparisons were made between the 'large' (as defined above) and small dairy farmers in the current survey. While some of the larger farms will have been smaller in earlier times, many will have always been large following either purchase or inheritance. The comparisons allow assessing overall inherent farmer differences between the groups over and above the small farm type differences.

Table 6 A comparison between small farmers' objectives and management styles, and biographical/production information, relative to larger farms' farmers. Average factor scores for each group with the larger farms coming from survey 2006 and survey 2013

Objective/style Factor†	Smaller farms	Survey 2006 large farms	*t*-Test significance probability (col1/col2)	Survey 2013 large farms	*t*-Test significance Probability (col1/col4)
Objectives					
Obj-balanced	0.999	0.089	**0.000**	0.034	**0.000**
Obj-risk remover	−0.193	−0.007	**0.004**	−0.194	**0.978**
Obj-way of life	−0.628	−0.116	**0.000**	−0.157	**0.000**
Obj-reluctant famer	0.567	−0.099	**0.000**	−0.227	**0.000**
Obj-community supporter	0.174	0.401	**0.007**	0.212	**0.588**
Obj-family supporter	0.282	−0.030	**0.001**	−0.085	**0.000**
Managerial style					
Style-consult-logician community	−0.255	−0.178	**0.388**	−0.272	**0.819**
Style-correctness seeker	0.185	−0.062	**0.001**	−0.072	**0.000**
Style-consult logician family and friends	0.198	−0.082	**0.000**	−0.087	**0.000**
Style-conscientious planner	0.283	0.024	**0.000**	−0.038	**0.000**
Style-thoughtful creator	−0.293	−0.136	**0.031**	0.022	**0.000**
Style-benign manager	−0.410	−0.093	**0.000**	−0.076	**0.000**
Locus of control (%)	67.22	67.55	**0.600**	68.17	**0.008**
Bio/production data					
Hectares per labour unit	59.0	81.4	**0.000**	71.5	**0.000**
Total labour units per farm	1.83	3.77	**0.000**	6.20	**0.000**
kg MS per labour unit	51,290	73,323	**0.000**	80,732	**0.000**
Farmer age code (1 = <30 years…. 5 = >60 years)‡	2.87	3.43	**0.000**	3.59	**0.000**
Education code (1 = sec. … 5 = postgrad.)‡	3.29	3.01	**0.000**	3.65	**0.574**

Note: †Refer to the sections on goals and managerial style for full details of the factors and their calculation (Sections 2.2, 3 and 4.2). Due to the scoring system with 1 meaning tending to the description of the objective or style, and 5 the opposite, a lower score means true. The scores are negative in many cases as they are the factor estimates based on the combinations of the core questions. ‡See Table 1 for a full list of the codes.
The greyed values are the most significant and should be concentrated on. Bolding is used to highlight which columns give the significance values.

Table 6 contains the comparisons. Considering the first two columns (small farms v 'large' farms ex survey 2006), the differences are all significant except for the style factor 'community consultor' and LOC which is, however, significant in the 2013 survey.

When comparing the small farms with the large from survey 2013, again most of the differences are significant other than for the objective factors

'risk remover' and 'community supporter'. For the style factors, it is only the community consultation tendency where the differences are not significant.

It is also interesting that comparing the 2006' and 2013' data shows some variables increase slightly, and others decline. But what is notable is farmers are getting older but better educated.

For the objective factors, there are significant differences between small farm farmers and their larger farm counterparts. The balanced objective is less prominent in the smaller farm group (perhaps they cannot afford to cover all bases), but they certainly have a real interest in the 'way of life' aspect of farming. The small farm farmers are more interested in reducing risk for obvious reasons, and there is less of the reluctant farmer aspect in their objectives. Interestingly, the small farm farmers are less interested in supporting their families, again, perhaps the farm size limits their possibilities for this objective.

The management styles also exhibit differences. Small farm farmers tend to involve themselves in community situations, and are more thoughtful and creative than their counterparts. This is probably an aspect which shows more on small farms due to necessity. On the other hand, the small farm farmers do not stress the need to be correct in their operations and analyses. Furthermore, and somewhat similarly, their nature is not to consult much with family and friends, and they express a lower level of the conscientious personality factor.

With all these highly significant differences, the conclusion that farmers on small farms are inherently different to their colleagues on larger farms is clear (hypothesis 3). This is over and above the Expander, Maintainer and, probably, Retractor, differences amongst the small farm farmers.

If the farmers currently operating smaller farms came from ancestors that similarly were involved in economically marginal farms, it might be suggested inheritance aspects are involved (Miller *et al.* 2003). It would be useful to go back several generations to see the progression into farming and the inheritances that have occurred, similarly for educational differences. The data available suggest the larger farm farmers are older and spend slightly less time in formal education. The latter would follow from the former as younger people tend to stay longer in formal education.

5. Concluding discussion

With the conclusion that dairy farmers managing nonexpanding small farms (the Maintainers) tend to exhibit different personal characteristics relative to the other groups, as do the Expanders, and also farmers on 'large farms' relative to all the smaller property farmers, it is important that farm policy and efforts to assist farmers take this into account. This work enhances the increasing interest in the general field of the influence of measurable human factors in decision-

making. For example, Edward-Jones (2006) reviews decision-making modelling emphasising the need to include farmer psychology.

It also extends other work on small farm persistence such as reported by Bailey *et al*. (2009) who, in reviewing several papers, stress that factors such as diversification, improved marketing and use of subsidies for development have all been important. Calus and Van Huylenbroeck (2010) also stress the importance of government policies.

A significant number of farms remain small with their owners determined to maintain their existing lifestyle (Northcote and Alonso 2011). It is their personal attributes which largely drive these decisions and actions. Staying on the existing farm allows continuing to live in the current district where the farmers and families have familiar facilities and networks. This is reflected in 64 per cent being keen to reduce debt as a form of resilience in contrast to expansion. And only 24 per cent rated highly transferring the farm to heirs suggesting, amongst other things, the farmers are keen to continue their farming life as long as possible. Overall, when the farmers are clustered on the basis of their 10 year plans, 34 per cent are in clusters not expanding farm size in the various ways offered, nor seeking income from off-farm activities.

To maintain an acceptable standard of living, farmers staying on small farms must constantly look to improve their technical efficiency and labour productivity, ensure the factor input mix used gives production at least cost and obtain finance at least cost. Rigg *et al*. (2016) and others (e.g. Zepeda and Kim 2006) comment that as small farms often involve family labour, measured labour productivity does tend to be higher than on larger farms. Farmers with a range of product possibilities should also constantly review prices to ensure the best mix (one choice is organic production) and exploit off farm income sources.

Through measurement of personal characteristics, the results of this research enable identifying which farmers are likely to be content to continue on their existing farm (it must also be noted that if the farm has been in a family many generations this is also likely to be a powerful incentive to remain (Rigg *et al*. 2016)). These farmers can be targeted for assistance in improving the efficiency areas listed above.

The farmers' preferred 10 year plan options, and their view of the likely challenges is similarly related to the personal characteristics. The strong conclusion is extension methods targeted according to farmer characteristics are likely to give greater success. Pannell *et al*. (2006) hint at this idea in a general review of extension considerations.

Overall, this research has demonstrated a strong need to consider farmer attributes in assessing policy options (Landais 1998) and further extends the increasingly important concepts encompassed by behavioural economics (Kahneman 2003). The implication is that members of a population must be profiled according to their personal characteristics and these profiles used in population stratifications similar to other physical strata such as land quality and area. It is also important, however, to acknowledge that individual

farmers are unique and that within strata, the extent of any response to a stimuli will vary between strata members.

Furthermore, in extension work, farmer characteristic differences may be targetable for benefit. Assisting the Maintainers, for example, may involve discussing their particular personal characteristics which could lead to farmers seeking assistance to change. Important examples include anxiety levels and objectives. Similarly, more general policies can assist the Maintainers one example being the provision of assistance and finance to encourage pluriactivity (Knickel *et al*. 2011). Planning laws may also have a part to play.

Given their uniqueness, it is easy to see how face-to-face extension methods (preferred by the farmers) can be targeted to the individual, particularly where a new policy is being introduced. Their uniqueness also means they are unlikely to wholeheartedly respond to simple utility maximising economically rational approaches. In this regard, the work of Waters *et al*. (2009) in segmenting farmer populations using clustering of farmers' individual and situational characteristics for targeted extension work is valuable.

To further research farmer personal characteristics, the Theory of Planned Behaviour (Ajzen 1991) might be used as it adds additional aspects in explaining farmer decisions. The TPB has shown considerable promise in predicting decisions through using information on resource restrictions (Perceived Behaviour Control) as well as societal views (Social Norm) of actions in addition to the farmer's views. To use this theory, information on society's beliefs and the resource restrictions will be necessary to add to the information on the farmers' personal characteristics.

Further study of farmers' human aspects would enhance general economic studies adding to earlier work in this area (e.g. Willock *et al*. 1999). This is particularly important where the maintenance of rural areas is valued for other than economic gains (van de Ploeg *et al*. 2000). Just how important economic factors are relative to a farmer's personal characteristics is, however, yet to be determined. They are intertwined.

Future work must also expand this study to other forms of farming although it would be expected similar conclusions would hold where the farmers come from common societal forms. Many countries do have farmers with characteristics similar to NZ farmers (Ball *et al*. 2001; Temple 2001) suggesting similar results can be expected. Additionally, further studies will reinforce just which personal characteristics dominate given in any one study farmer inconsistencies can influence results (Andrade and Ariely 2009).

Human capital, in all its guises and forms, is an integral part of rural society and its economic and multifaceted outcomes, and consequently deserves to be given further attention in exploring the critical influence of mankind on primary production.

Authors contributions

Dr Westbrooke is responsible for teaching introductory Farm Management and conducting research. Dr Nuthall is responsible for a range of research activities and authoring.

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