

1 Dairy farm owners, their resilience attributes, and how they relate to their perception and
2 management of risk

3

4 Federico Duranovich

5 Massey University/ Institute of Agriculture and Environment

6 F.N.Duranovich@Massey.ac.nz

7 +64 06 3569099 ext. 84819

8

9 Professor Nicola Shadbolt (Presenting Author)

10 Massey University/ Institute of Agriculture and Environment

11 N.M.Shadbolt@Massey.ac.nz

12 +64 06 3569099 ext. 84793

13

14 Dr Elizabeth Dooley

15 Massey University/ Institute of Agriculture and Environment

16 A.E.Dooley@Massey.ac.nz

17 +64 06 3569099 ext. 84827

18

19 Dr David Gray

20 Massey University/ Institute of Agriculture and Environment

21 D.I.Gray@Massey.ac.nz

22 +64 06 3569099 ext. 84805

23

24 **Abstract**

25 *Coping with risk will be a major challenge for farmers in the years to come. In this context,*
26 *farmers must develop resilience. Resilience requires the ability to mitigate threats, capture*
27 *opportunities, and adapt to change as required. However, little is known about what is*
28 *required to become resilient, or if resilience is associated with different perceptions of risks*
29 *or risk management behaviours. This research was set up to answer two questions. First,*
30 *what are the attributes that define a resilient farmer and second, do different resilient farmer*
31 *types differ in their perceptions of the farm business environment and their strategic risk*
32 *management behaviour? Firstly, a literature review on resilience was used to identify the*
33 *attributes that could be used to define a resilient farmer, risks and risk strategies. Secondly, a*
34 *survey was designed and sent out to a random sample of New Zealand dairy farmers in order*
35 *to measure the attributes of resilience identified in the literature and farmer perceptions of*
36 *risks and risk management behaviour. Thirdly, principal components analysis and cluster*
37 *analysis was performed in order to typify farmers according to their resilience attributes.*
38 *Finally, differences between farmer types were linked to their perceptions of risk and their*
39 *risk management behaviour. Five attributes of resilience (general self-efficacy, willingness to*
40 *change, locus of control, social sense-making, and strategic thinking focus) differentiated two*
41 *resilient farmer groups: high resilient and low resilient farmers. High resilient farmers*
42 *perceived more opportunities in risk than low resilient farmers. They also made greater use*
43 *of, and gave more importance to, strategies that were associated with visualising and*
44 *positioning their business in the future, and with strategies associated with the prevention,*
45 *mitigation, flexibility and diversity to risks, compared to low resilient farmers. These findings*
46 *were consistent with resilience theory. The resilience profile and management strategies used*
47 *by high resilient farmers identified in this research can be used by those in the industry to*
48 *support farmers in building resilience and encouraging the use of management strategies*
49 *associated with resilience.*

50 *Key words: resilience attributes, adaptive capacity, risk management, dairy farmers, New*
51 *Zealand*

52 **Introduction**

53 Over the last few years, there has been increasing concern about the instability of the business
54 environment in which dairy farmers operate (Gray, Dooley, & Shadbolt, 2008; Shadbolt,
55 Rusito, Gray, & Olubode-Awasola, 2011). A number of factors, such as the increased
56 variability in milk and input prices, international trade policies, global policies on bio-fuels,
57 increasing consumer awareness of sustainable food systems, government regulations on
58 animal welfare and the environment, and the consolidation of the dairy industry, have been
59 attributed to the instability in the business environment (Conforte, Garnevska, Kilgour,
60 Locke, & Scrimgeour, 2008; Gray et al., 2008). This instability has brought about increased

61 variability in the financial performance of dairy farm businesses posing significant risk to the
62 survival of these businesses (Gray et al., 2008). Many farm management scholars (Boehlje,
63 Akridge, & Downey, 1995; Boehlje, Gray, & Detre, 2005; Boehlje & Roucan-Kane, 2009;
64 Gray et al., 2008; Parsonson-Ensor & Saunders, 2011) acknowledge an increase of risk in the
65 farm business environment and recognise that coping with risk is a major challenge for
66 farmers. Gray et al. (2008) suggest that New Zealand dairy farmers are entering a new era in
67 relation to risk, which is characterised by increased uncertainty in the farm business
68 environment; a description that fits that of the theoretical “turbulent” business environment
69 proposed by Emery and Trist (1965, p. 26). Gray et al. (2008) also noted that operating in this
70 type of environment poses an important question: how best can New Zealand dairy farmers
71 manage in a turbulent environment?

72 Several authors (Crawford, McCall, Mason, & Paine, 2007; Darnhofer, 2014; Darnhofer,
73 Bellon, Dedieu, & Milestad, 2010a; Gray et al., 2008; Shadbolt et al., 2011) concur that in
74 order to cope with a turbulent environment, farmers must build resilient farm systems. In
75 dairy farming, resilient farm systems have been described as “those with the capacity to not
76 only adapt to change in the environment, but also take advantage of opportunities created by
77 a disturbance while maintaining productive capacity in the face of variability in production,
78 financial and market related factors” (Shadbolt et al., 2011, p. 8). This definition, which is the
79 definition used in this paper, emphasises the idea that in order to build resilient farm systems,
80 management should focus not just on achieving robustness and stability through their ability
81 to buffer threatening disturbances (i.e. buffer capacity), but also focus on being able to adapt
82 to changes in the environment (i.e. adaptive capacity). More importantly, Shadbolt et al.’s
83 (2011) definition of resilient farm systems suggests that disturbances may also represent
84 opportunities that these businesses can take advantage of. Despite growing interest in
85 resilience in the farm management literature (Crawford et al., 2007; Darnhofer, 2014;
86 Shadbolt et al., 2011), little empirical research has been undertaken. Indeed, many farm
87 management scholars (Darnhofer, 2014; Darnhofer, Gibbon, & Dedieu, 2012; Love, Sharma,
88 Boxelaar, & Paine, 2008; Miller, Dobbins, Pritchett, Boehlje, & Ehmke, 2004) suggest that
89 farm management research has primarily focused on efficiency and optimizing system
90 performance during short-term periods of stability, rather than focusing on the development
91 of long-term adaptive capacity. As such, the discipline struggles to provide practical theory
92 that helps farmers cope effectively with a turbulent environment (Darnhofer, 2014;
93 Darnhofer, Bellon, Dedieu, & Milestad, 2008).

94 Although resilience has been identified as a necessary property of farm systems to cope with
95 a turbulent environment, a milestone for the development of practical theory for farm systems
96 resilience is its measurement (Crawford et al., 2007; Darnhofer et al., 2012; Shadbolt et al.,
97 2011). Despite the fact that measuring resilience as a whole is probably an impossible task,
98 the measurement of resilience can be approached by measuring its elements (buffer capacity,
99 adaptive capacity, and transformability) individually. Recently, Shadbolt et al. (2011)

100 identified resilient dairy farms in New Zealand through the indirect measurement of their
101 buffer capacity. In order to gain more knowledge about how resilience works, further
102 research is required to develop a measurement, or indicator, of adaptive capacity.

103 Adaptive capacity is linked to an individual's attributes. Folke, Carpenter, Walker, Scheffer,
104 Elmqvist, Gunderson, and Holling (2004) describe adaptive capacity as "the ability of actors
105 in a system to influence resilience" (p. 5). Therefore, understanding adaptive capacity of farm
106 businesses is about knowing how a farmer deliberately adapts their business in response to
107 changes in the environment so that the business is well positioned to capture opportunities
108 without relegating the mitigation of threats also present in the environment. Indeed, farmers
109 have a crucial role in building the resilience of farm systems through their roles as decision-
110 makers with regard to the choices they make regarding their risk management strategies in
111 order to achieve their goals (Darnhofer, Fairweather, & Moller, 2010b). Little is known about
112 the adaptive capacity of dairy farmers in New Zealand. Likewise, little is known about how
113 farmers with different degrees of resilience, and therefore adaptive capacity, can be
114 identified, and whether different resilient farmer types differ in their perceptions of risk in the
115 farm business environment and their risk management behaviour. Identifying, farmers based
116 on the attributes that confer resilience, with a focus in their adaptive capacity, would provide
117 a milestone in the quest to build resilience in dairy farm businesses.

118 Six attributes are relevant for individual resilience: self-efficacy; locus of control; willingness
119 to accept uncertainty and change; open-mindedness; sense-making; and strategic
120 management.

121 *Self-efficacy*

122 Much of the literature on psychological resilience indicates that resilient people have a strong
123 sense of self-efficacy (Reich, Zautra, & Hall, 2010; Schwarzer & Warner, 2013), which is
124 defined by Bandura (2000) as "the belief in one's capabilities to organise and execute the
125 courses of action required to produce given levels of attainments" (p. 18). Schwarzer and
126 Warner (2013) and Reich et al. (2010) state that people with a strong belief in their capacity
127 to overcome stressful situations are more able to bounce back than people with weak self-
128 efficacy beliefs. Likewise, strong self-efficacy beliefs about the ability to successfully adapt
129 are an indicator of adaptive capacity (Grothmann & Patt, 2005). Self-efficacy is linked to
130 decision-making by regulating goal setting (Bandura, 2010; Gist, 1987). In this respect,
131 people with strong self-efficacy beliefs are more likely to set more challenging goals.
132 Moreover, self-efficacy beliefs affect the way risk is perceived: people with strong self-
133 efficacy beliefs are more likely to perceive a source of risk as an opportunity rather a threat
134 (Bandura, 2010; Gist, 1987).

135 *Locus of control*

136 Resilient people have what has been named an “internal locus of control” (Skodol, 2010, p.
137 114). Locus of control theory classifies individuals in one of two categories, internal or
138 external, based on their general expectancy of where control over events and outcomes is
139 located (Rotter, 1966). People with an internal locus of control believe that they have
140 considerable control over external events and, therefore, their behaviour is the main factor
141 responsible for their situation. In contrast, people with an external locus of control usually
142 believe that they have little control over external events, and therefore external factors such
143 as “fate” or “bad luck” are responsible for their situation (Skodol, 2010, p. 114). An internal
144 locus of control is associated with skills which are useful for coping with uncertain
145 environmental events (Skodol, 2010). People with an internal locus of control are often more
146 motivated and committed to finding solutions, or learning about unexpected problems than
147 people with an external locus of control (Skodol, 2010). Moreover, Van Kooten, Schoney,
148 and Hayward (1986) and Tanewski, Romano, and Smyrnios (2000) suggested that farmers
149 with a strong internal locus of control place significant importance on planning during
150 decision making. Van Kooten et al. (1986) argued that a farmer’s strong belief about their
151 ability to control future events would give them the confidence to adopt planning in their
152 decision making. In contrast, farmers with a strong external locus of control would be less
153 likely to plan because of their negative belief about their ability to control external events.

154 *Willingness to accept uncertainty and change*

155 Boxelaar, Sharma, and Paine (2006) suggested that a dairy farmer’s degree of resilience is a
156 construct of their ability to face reality, particularly when confronted with a situation of
157 significant change. Boxelaar et al. (2006) argued that in the case of agriculture, where many
158 of the changes are inherently uncertain, a farmer’s willingness to face the reality of
159 uncertainty and ambiguity is an attribute that would indicate their level of resilience.
160 Boxelaar et al. (2006) suggest that the willingness to accept uncertainty and ambiguity is
161 linked to the ability of a person to learn, and hence it is related to their adaptive capacity.
162 They argue that recognising that uncertainty and ambiguity are inevitable is a first step to
163 learning about a situation in order to reduce the level of uncertainty in the environment.

164 *Open-mindedness*

165 Open-mindedness has been described as a defining attribute of resilient people (Webb, 2013).
166 Darnhofer (2010) suggests that this attribute is relevant for farmers in the process of adapting
167 to changes in the environment. Darnhofer (2010) argues that farmers with an open-minded
168 attitude understand strategy as an unfolding process. That is, they acknowledge that a certain
169 plan may be changed for a new and better one if the conditions require this. An open minded
170 person tends to be accepting of, and values the opinion of others. Likewise, open-minded
171 people tend to mirror themselves on others and see them as learning partners rather than
172 competitors or experts. They consider this mutual behaviour as beneficial to both parties

173 (Rogers, Luton, Biggs, Biggs, Blignaut, Choles, Palmer, & Tangwe, 2013). Darnhofer (2010)
174 argues that that although open mindedness seems to be an attribute of most people, it is less
175 usual in the case of farmers, since many farmers tend to hold on to traditional farm
176 management practices or social norms of how a farm should be.

177 *Sense-making*

178 Another attribute of resilient farm managers is their ability to understand, and to put into
179 perspective, situations that are new to them and to be aware of changes that occur in the farm
180 business environment (Shadbolt et al., 2011). Sense-making is described as a process that is
181 triggered by extracting and bracketing of “cues” (Weick, Sutcliffe, & Obstfeld, 2005).
182 According to Weick et al. (2005), “environments are talked into existence” (p. 409) and it is
183 during this process of talking that cues are extracted from narratives or stories (Mantere,
184 2000; Weick et al., 2005). The process of making sense also involves retrospection, and an
185 ongoing effort of making connections in order to create order and understand a situation.
186 Likewise, the ability of making sense favours plausibility over accuracy, and involves a range
187 of social activities where stories and narratives that contain information for sense-making, are
188 stored, preserved and shared (Weick, 1995; Weick et al., 2005). Sense-making involves
189 scanning and interpreting large amounts of diverse information that is then used to form
190 hypotheses or mental models about emerging conditions. As such, sense-making is a relevant
191 process for the planning aspect of decision-making in situations of change and in identifying
192 business opportunities (McCann, Selsky, & Lee, 2009). However, in order to be effective in
193 adaptation, sense-making should be followed by a quick reaction from management aimed to
194 implement a suitable strategy to capture an opportunity or adapt to a change (McCann et al.,
195 2009). Sense-making is an important ability for management because the lack of this ability
196 can result in the loss of a business opportunity or in the over exposure of a business to a
197 threat, which ultimately might lead to the failure of the business (McCann, 2004; McCann et
198 al., 2009).

199 *Strategic management*

200 Much of the literature on resilience (Carmeli, Friedman, & Tishler, 2013; Darnhofer et al.,
201 2010b; Fazey, 2010; Folke, Stephen, Brian, Marten, Terry, & Johan, 2010; Walker & Salt,
202 2006) suggests that, in order to adapt, individuals must develop holistic thinking and to the
203 ability to develop strategic foresight by exploring all possible futures so as to implement the
204 most appropriate course of action relative to their goals. These characteristics match the
205 capabilities described for strategic thinking (Graetz, 2002; Liedtka, 1998a) and those of
206 successful leaders with a strategic mind-set (Pisapia, Reyes-Guerra, & Coukos-Semmel,
207 2005). The link between strategic thinking and resilience was proposed by Sloan (2013) who
208 associated strategic thinking with the adaptive capacity of individuals. Similarly, Sorgenfrei

209 and Wrigley (2005) indicated that strategic thinking was a facilitator of adaptive capacity in
210 organisations facing turbulent environments.

211 Heracleous (1998) suggests that strategic thinking is a thought process that is interrelated and
212 complementary to the strategic planning process, which refers to a formal and analytical
213 means of forming strategy. Graetz (2002) proposed that good strategic management practice
214 requires balanced strategic thinking and strategic planning.

215 Most of the work describing the attributes of a person with strategic thinking capabilities
216 (e.g. Bonn, 2005; Kamangar, Rohani, Salavati, & Karimi, 2013; Moon, 2013; van der Laan,
217 2010) is based on the work of Liedtka (1998b), who believes that strategic thinking has five
218 main elements: a systems perspective; intent-focused; thinking in time; hypothesis driven;
219 and intelligent opportunism. Bonn (2005) suggested that these five attributes can be reduced
220 to three categories (systems thinking, creativity and vision) which, in essence, integrate the
221 elements described by Liedtka (1998a; 1998b).

222 **Research questions and objectives**

223 This research set out to answer two research questions: First, what are the attributes that
224 define a resilient farmer? And second, do different resilient farmer types differ in their overall
225 perceptions of the farm business environment and their risk management behaviour? Given
226 these questions, the objectives were: to define the attributes that would differentiate farmers
227 based on the resilience attributes of a farm manager; to identify different farmer types based
228 on the resilience attributes previously defined; and to investigate any differences between
229 resilient farmer types regarding their use of, and importance given to, strategies for managing
230 risks in their farm businesses and to explore their overall perceptions of sources of risks in the
231 farm business environment.

232 **Methodology**

233 The resilience attributes identified in the literature review were used to design a survey which
234 was conducted on 1559 randomly selected dairy farmers in New Zealand. 89% of these dairy
235 farmers were farm owners and the remaining 11% were herd-owning sharemilkers.

236 Resilience attributes were assessed by using 20 Likert scale type questions, where
237 respondents were asked to evaluate using a scale which ranged from “strongly disagree” to
238 “strongly agree”. The questions were adapted from similar questions obtained mainly in the
239 business literature (refer to table 1A in the appendix for the questions used and their
240 references).

241 Farmer perceptions of risk in the farm business environment were assessed by asking farmers
242 if they believed that common sources of risk present in the farm business environment
243 presented an opportunity, a threat, or both an opportunity and a threat for their farm business
244 in the last 10 years. The sources of risk were drawn from previous studies on risk perception
245 undertaken in New Zealand (Martin, 1994; Pinochet-Chateau, Shadbolt, Holmes, & Lopez-
246 Villalobos, 2005; Pinochet Chateau, 2005; Shadbolt & Olubode-Awosola, 2013) (refer to
247 Table 2A in the appendix for the list of risk sources used in this survey). Then, overall indices
248 for risk perception were developed as follows:

249 A. *Overall opportunity index*_{*i*} =
$$\frac{\text{Number of risk sources perceived as an opportunity}_i}{\text{Total number of risk sources}_i}$$

250

251 B. *Overall threat index*_{*i*} =
$$\frac{\text{Number of risk sources perceived as a threat}_i}{\text{Total number of risk sources}_i}$$

252

253 C. *Overall opportunity/threat index*_{*i*} =
$$\frac{\text{Number of risk sources perceived as an opportunity and a threat}_i}{\text{Total number of risk sources}_i}$$

254 Where *i* represented an individual response.

255 In order to assess farmer risk management behaviour, farmers were questioned on 27 risk
256 management strategies drawn from previous studies on risk management undertaken in New
257 Zealand (Martin, 1994; Pinochet-Chateau, Shadbolt, Holmes, & Lopez-Villalobos, 2005;
258 Pinochet Chateau, 2005; Shadbolt & Olubode-Awosola, 2013) (refer to Table 3A in the
259 appendix for the list of risk management strategies used in this survey). For each risk
260 management strategy, participants were asked whether they had used the strategy or not, or if
261 it was applicable for its use in their farm business. In addition, farmers were asked to assess
262 the importance of the risk management strategy for managing risk using a 5 point Likert-type
263 scale ranging from “very low importance” to “very high importance”.

264 The design of the survey was pre-tested with three farmers. After amendments, the survey
265 was sent out by post and online on 25 July 2014. Farmers returned 364 complete usable
266 responses that were used for data analysis. Principal components analysis (PCA) was used to
267 identify and derive underlying attributes from the answers to the resilience attributes
268 questions grouped by attribute.

269 PCA also weighted the importance of the questions for defining attributes according to the
270 variance in the responses to each question. Two-step cluster analysis was used to segregate
271 farmers with respect to the principal components scores obtained from the derived attributes
272 obtained during PCA. A resilient farmer typology was developed based on the findings of the
273 cluster analysis. Finally, Chi-square tests, and Mann-Whitney U tests were performed to
274 determine whether there were differences between resilient farmer types, farmer perceptions

275 of risk in the overall indexes, and farmer use of, and importance given to strategies for
 276 managing risk in their farm businesses.

277 **Results and discussion**

278 *Derived resilient attributes and resilient farmer typology*

279 Results from the principal components analyses indicated that one or two principal
 280 components (PCs) explained most of the variance in farmer responses to the resilience
 281 attributes questions (Table 1).

282 **Table 1. Relationships between resilience attribute questions and principal components, and the resilience**
 283 **attributes that derived from PCA results**

Attribute in the literature	Resilience attribute question from the survey		Component loadings		Derived attribute from PCA results†
			PC1	PC2	
Willingness to accept uncertainty and to change	1	I intend to make time to implement changes required in my farm business.	-0.204	-0.734*	Willingness to change (Q1,Q2) Willingness to accept uncertainty (Q3)
	2	I am willing to make changes to my farm business.	-0.115	-0.639*	
	3	I am willing to accept uncertainty in my farm business	-0.972*	0.230	
Open-mindedness	4	I value the knowledge of others from inside and outside the farm business.	-0.240		Open-mindedness(Q5)
	5	I consider everyone in the dairy industry learns from each other.	-0.971*		
Self-efficacy	6	It is easy for me to stick to my aims and accomplish my goals.	-0.605*		General self-efficacy (Q6, Q7, Q8)
	7	No matter how hard I try, I struggle to solve difficult problems.	0.426*		
	8	I am confident that I can deal efficiently with unexpected events.	-0.673*		
Locus of control	9	The success of my farm business is mostly determined by factors outside of my control.	0.909*		Locus of control (Q9,Q10)
	10	The weather and commodity prices can knock the business around in the short term, but in the long term, there is still a lot I can do to stay ahead of the game.	-0.416*		
Sense-making	11	I am not good at making sense of ambiguous and uncertain situations.	0.274	0.836*	Individual sense-making (Q11) Social sense-making (Q13,14)
	12	I do not pay close attention to conditions outside the dairy industry.	0.384	0.357	
	13	I have regular contact with other farmers where we discuss trends in the industry.	-0.647*	0.297	
	14	I have regular contact with other members of the industry to acquire knowledge.	-0.572*	0.284	
	15	When confronted with a new situation, I review past experiences to assess the situation.	-0.177	0.063	
Strategic management	16	My decision-making is driven by my vision for my farm business.	-0.554*	0.437*	Strategic thinking focus (Q16, Q17, Q18) Strategic planning focus (Q16,Q20)
	17	I do not search for patterns when confronted with rich information.	0.697*	0.339	
	18	I consider how different parts of the farm system impact on each other.	-0.401*	0.237	
	19	When resolving a strategic problem, I consider a range of possibilities.	-0.195	0.024	
	20	No matter what happens, I always stick to my original plans	0.130	0.798*	

* Resilience attribute question which explain most of the variance in the responses contributing to the PC (component loading ≥ 0.4)

† Questions associated with the derived resilience attributes between brackets

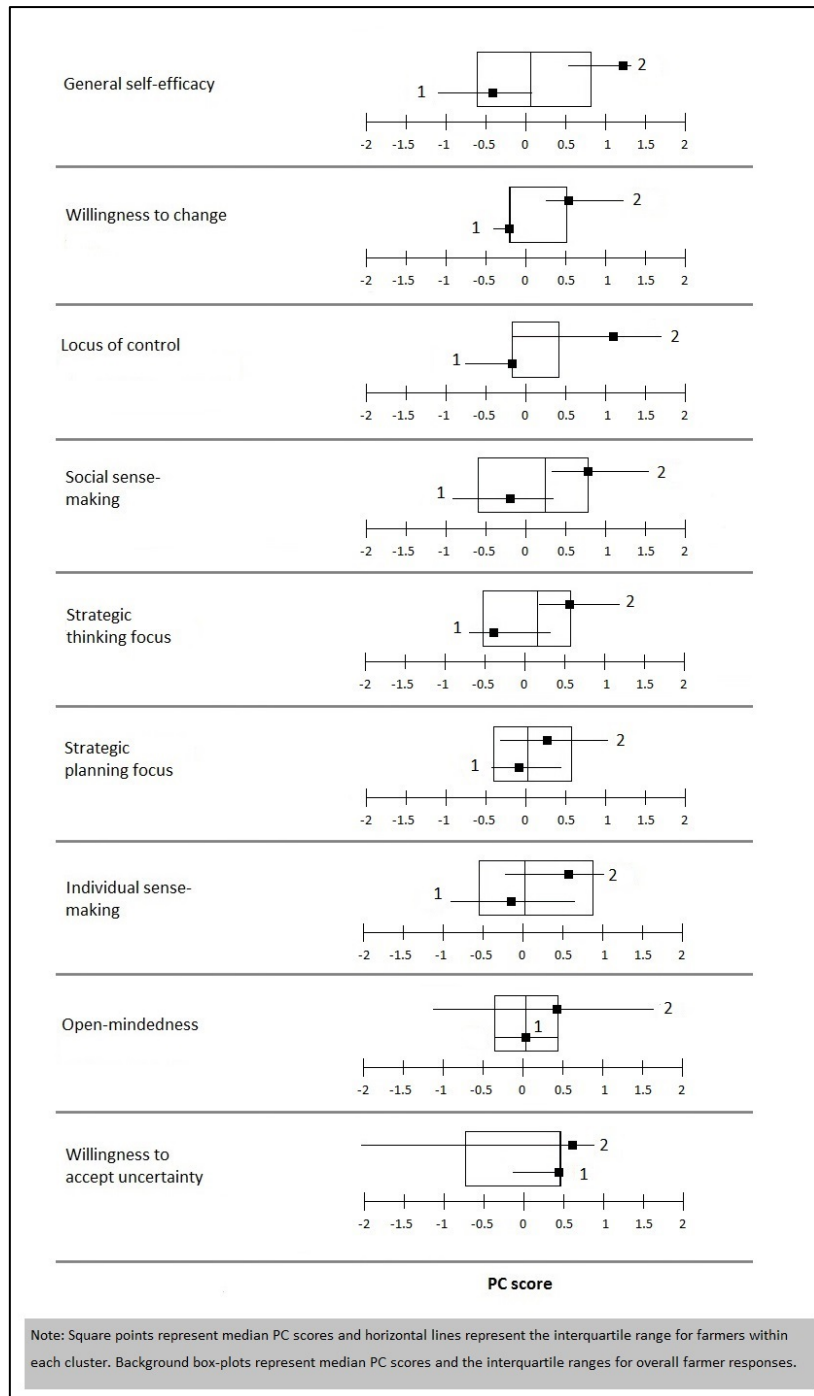
284 Table 1 shows the component loadings that indicate how much of the variation in farmer
285 responses to a question was explained by a principal component. The Table also shows the
286 nine derived resilience attributes (willingness to change, willingness to accept uncertainty,
287 open mindedness, general self-efficacy, locus of control, individual sense-making, social
288 sense-making, strategic thinking focus, and strategic planning focus) that resulted from the
289 interpretation of the principal components and their relationship with the resilience attributes
290 questions.

291 The cluster analysis performed on the set of PC scores for the derived resilience attributes
292 resulted in two clusters of farmers. Based on the profiles to be discussed, the farmers in each
293 cluster were named as follows:

- 294 • Cluster 1, which grouped 245 farmers (67.3%) who were typified as the “low resilient
295 farmer”.
- 296 • Cluster 2, which grouped 119 farmers (32.7%) who were typified as the “high
297 resilient farmer”.

298 The average Silhouette coefficient obtained for the cluster model was 0.2¹, which reflects
299 weak to moderate significant evidence of cluster structure (Kaufman & Rousseeuw, 1990).
300 Five derived resilience attributes were particularly important in defining the two clusters:
301 general self-efficacy, willingness to change, locus of control, social sense-making, and
302 strategic thinking focus (Figure 1). Because farmers in cluster 1 had lower values for the
303 attributes that were used to define the resilient farmer type than farmers in cluster 2, farmers
304 in cluster 1 were termed “low resilient farmers” and farmers in cluster 2 were termed “high
305 resilient farmers”.

¹The Silhouette coefficient is a measurement of the degree of cohesion and separation of clusters (Kaufman & Rousseeuw, 1990). This coefficient ranges from -1 to 1; the closer the measurement is to 1, the more different the clusters are from each other.



306
307

Figure 1. Comparison between resilient farmer clusters 1 and 2.

308 Figure 1 shows the variability in the PC scores for each of the attributes for the farmers in
 309 clusters 1 and 2, and in overall responses. The variability in overall farmer response is
 310 displayed as background boxplots showing the overall median and the interquartile range.
 311 The variability in response for farmers in each cluster is displayed as overlaid boxplots in
 312 which square point markers and horizontal lines indicate the median value and the
 313 interquartile range, respectively. Farmers in cluster 2 had higher median PC scores for all of
 314 the attributes compared to farmers in cluster 1. The median PC scores for most important
 315 attributes: general self-efficacy, willingness to change, locus of control, social sense-making,

316 and strategic thinking focus were 1.12, 0.46, 0.81, 0.72, and 0.53, respectively, for farmers in
317 cluster 2, and 0.10, -0.19, -0.10, -0.28, and -0.48, respectively, for farmers in cluster 1 (Figure
318 1). Although there were differences between clusters in their median PC scores for the
319 remaining attributes (strategic planning focus, individual sense-making, open-mindedness
320 (shared learning), and willingness to accept uncertainty), their interquartile ranges tended to
321 overlap, which indicated that farmers in both clusters were not significantly different one
322 from another with respect to these derived attributes (Figure 1).

323 The findings from this cluster analysis were consistent with the description of resilient people
324 provided by Coutu (2002), Reich et al. (2010), and Schwarzer and Warner (2013) who
325 identified a direct link between perceived self-efficacy and a resilient personality. Likewise,
326 these results were consistent with the findings described by Connor and Davidson (2003) and
327 Coutu (2002), who found a direct relationship between a resilient person and their willingness
328 to change, and Skodol (2010) who suggested that an internal locus of control is as an
329 important attribute of resilient individuals. Moreover, a resilient personality was also linked
330 to an enhanced networking ability due to its relationship with sense-making, as described by
331 Darnhofer (2010), Goldstein (2009) and Hahn, Schultz, Folke, and Olsson (2008). The results
332 from this research are also consistent with Fazey (2010) and Walker and Salt (2006) who
333 suggested that strategic thinking is an important prerequisite of resilience.

334 *Resilient farmer types and their overall perceptions of risk*

335 The median values for the overall opportunity/threat index were .39 and .41 for high resilient
336 farmers and low resilient farmers, respectively. This difference was non-significant ($U=$
337 13598.5 , $p>.05$, $r=-.04$). There was a significant difference between the median values for the
338 overall opportunity index between high and low resilient farmer types, .28 and .24,
339 respectively ($U=12115.5$, $p<.05$, $r=-.12$). This higher proportion of risk sources being seen as
340 “opportunities” by high resilient farmers was counter to their perceptions of “threats” in the
341 environment. In this regard, high resilient farmers had a lower overall threat index .28 (28%
342 of risk sources) compared to low resilient farmers .33 (33%), $U=12522$, $p<.05$, $r=-.1$. The
343 results are consistent with Cooper, Estes, and Allen (2004) and Manzano-García, Calvo, and
344 Carlos (2013) who described resilient people as often seeing opportunities where others see
345 threats. Manzano-García et al. (2013) linked this characteristic to a particular type of resilient
346 personality, which they termed the “resilient entrepreneurs”.

347 *Resilient farmer types and their risk management strategies*

348 Figure 2 shows the difference between high resilient and low resilient farmers with respect to
349 the use of strategies and the importance given by these farmers to each strategy for managing
350 risk in their farm businesses. Results identified that there were three groups of strategies as
351 shown in Figure 2 below. Only strategies that were significantly different ($p<.05$) in their use

352 and importance between high and low resilient farmers are shown; levels of adoption and
 353 importance for each of the strategies for both groups: high and low resilient farmers, are
 354 shown between brackets.



355

356 **Figure 2. Main differences between high and low resilient farmers in the use of, and importance given to,**
 357 **strategies for managing risk.**

358 The strategies in group 1 were among the least important for managing risk for both high
359 resilient and low resilient farmers (Figure 2). High resilient farmers were more likely to adopt
360 the strategy of geographic diversity than low resilient farmers. This is consistent with
361 resilience theory that suggests that diversity, on its many forms, is a key strategy for
362 spreading risks and creating buffers against variability, and thus strengthening systems
363 resilience (Folke et al., 2010, Darnhofer et al. 2010a).

364 The second group of strategies is important because it shows the difference in the focus that
365 the two resilient farmer types placed on strategies they used interchangeably. This finding
366 can be used in further research to identify differences in the implementation of these
367 strategies between high and low resilient farmer types.

368 The differences identified across the three groups of strategies showed that high resilient
369 farmers used, and placed more importance on, strategies that coped with risk in a more
370 proactive way than low resilient farmers (Figure 2). High resilient farmers placed relatively
371 higher importance on strategies for coping with risks from a strategic management
372 perspective compared to low resilient farmers. These strategies are related to planning where
373 the business is heading and why. This is explained by the greater strategic thinking focus of
374 high resilient farmers compared to low resilient farmers. These findings are consistent with
375 Miller et al. (2004) who suggested that having a strategic purpose or implementing SWOT
376 analysis were proxies for the capability of a farm business to recognise when strategic
377 adjustments are necessary, and thus a reflection of their adaptive capacity. Likewise, high
378 resilient farmers used and identified flexibility as an important strategy for coping with risks
379 in the long term; once again, this may have been explained by high resilient farmers' high
380 strategic thinking focus. A high strategic focus may be related to recognising that positioning
381 the farm business for flexibility is important for coping with downside and upside risks
382 (Darnhofer et al., 2008, 2010a; Miller et al., 2004). Darnhofer et al. (2010a) and Miller et al.
383 (2004) suggested that positioning a firm for flexibility was an important strategy for
384 responding to changing circumstances, and thus is a strategy related to adaptive capacity.

385 High resilient farmers were likely to use, and give more importance to, the strategy of
386 gathering market information than low resilient farmers. This may have been a reflection of
387 their higher social sense-making skills and, therefore greater farmer learning about the
388 environment, in this case related to the market. The gathering of any kind of information for
389 decision making is also described as an important strategy that ensures adaptive capacity
390 through learning (Darnhofer et al., 2008; Folke et al., 2010)

391 Another important characteristic of high resilient farmers was that they used, and placed
392 relatively high importance on, managing debt and planning capital spending, which meant
393 that these farmers were less concerned about having debt. Instead, they were more concerned
394 about doing something "useful" with that debt. This was consistent with Parsonson-Ensor and

395 Saunders (2011) who described that as farming in New Zealand has become more intensive
396 over time, acquiring debt is a strategy that has been adopted by most farms in New Zealand
397 (70%), and is an important means of overcoming periods of economic hardship. Therefore,
398 farmers may have been relying on debt as a strategy for financing investments or expenses.
399 This finding challenges Darnhofer (2010) who described keeping debt low, rather than
400 having and managing debt, as a sign of resilient farms. However, it is important to note that
401 Darnhofer (2010) described keeping debt low strategy as being important for building
402 resilience in farms in Austria where farmers are less exposed to the external environment
403 because their agricultural policy subsidises farms so that farm businesses can remain
404 operating regardless of the environment. New Zealand farmers, however, operate in a non-
405 subsidised environment in which finance may be needed.

406 High resilient farmers were also more likely to adopt, and give more importance to,
407 implementing technological innovations. This may be related to these farmers' willingness to
408 change, and thus results in adaptation in the form of new techniques or approaches to cope
409 with risk in the form of either threats or opportunities. However, the idea that these
410 innovations result in a resilient farm business can be debated because it depends on how
411 useful or successful the implementation of the innovation is. Parsonson-Ensor and Saunders
412 (2011) identified that being innovative and adopting new technologies was a source of farms'
413 adaptive capacity. However, they also argued that innovations can also present a source of
414 risk if farmers are not able to implement them properly, and that quickly changing trends
415 means that technology can also become obsolete rapidly and result in loss of markets and
416 revenue.

417 Low resilient farmers placed relatively more importance on strategies which were more
418 reactive and targeted to buffering the negative effect of risks such as not producing to full
419 capacity and keeping debt low, strategies that aimed to reduce the threats to production and
420 financial risks, respectively. These results suggest that low resilient farmers were not seeking
421 opportunities; rather, they felt more comfortable in managing what they knew. This is
422 consistent with resilience theory which suggests that although buffer capacity is a key aspect
423 of resilience, resilience goes beyond being simply a buffer for retaining and maintaining the
424 status quo, but that it is also about being able to adapt to new situations (Folke et al., 2010).
425 Moreover, the results from this study were consistent with Darnhofer et al. (2010a) and
426 Miller et al. (2004) who identified that not producing to full capacity and keeping debt low
427 were suitable strategies for coping with threats in the short-term and, therefore were a
428 reflection of a farm's buffer capacity. Shadbolt and Olubode-Awosola (2013) also found that
429 these two strategies were thought to be of relatively high importance to farmers who they
430 termed "experienced but cautious" and of relatively lower importance to those they termed
431 "entrepreneurs"; the former being more a successful farmer type than the latter, which
432 suggested that the "experienced but cautious" identified by Shadbolt et al. (2011) might be
433 related to the high resilient farmer types identified in this study.

434 **Conclusions**

435 This research identified two farmer types (high and low resilient farmers) based on five
436 different attributes. Moreover, the findings in this research highlighted the greater orientation
437 of high resilient farmers to prevent, react to, and adapt to risks, which was consistent with
438 resilience theory that suggests that since uncertainty is an inherent part of managing systems,
439 managers should be ready to prevent, react to and adapt to risks (Darnhofer et al., 2010b;
440 Folke et al., 2004; Folke et al., 2010).

441 In order to build resilience, farmers should be encouraged to develop soft skills that help
442 foster the resilience attributes that were identified as being more important to high resilient
443 farmers: general self-efficacy, willingness to change, internal locus of control, social sense-
444 making, and a strategic thinking focus. Activities that may be undertaken could be to
445 encourage: participation of farmers in discussion groups, encouraging farmer networking,
446 encourage farmers to interact with other actors from inside and outside the industry, and
447 promote opportunities for learning. Finally, farmers should be encouraged to consider a range
448 of choices to address a problem.

449 The typology developed in this research can be used in further empirical research, aiming to
450 understand the processes that high resilient farmers go through in order to build resilience.

451 **Acknowledgements**

452 The authors would like to thank all the dairy farmers who participated in this project.
453 Likewise, we appreciate the sponsorship given by DairyNZ, and the Ministry for Primary
454 Industries of New Zealand who provided the funds for this project through a Primary Growth
455 Partnership.

456 **References**

- 457 Bandura, A. (2000). Self-Efficacy: The Foundation of Agency¹. *Control of human behavior,*
458 *mental processes, and consciousness: Essays in honor of the 60th birthday of August*
459 *Flammer*, 16.
- 460 Bandura, A. (2010). Self-Efficacy *The Corsini Encyclopedia of Psychology*: John Wiley &
461 Sons, Inc.
- 462 Boehlje, M., Akridge, J., & Downey, D. (1995). Restructuring agribusiness for the 21st
463 century. *Agribusiness*, 11(6), 493-500.
- 464 Boehlje, M., Gray, A. W., & Detre, J. D. (2005). Strategy development in a turbulent
465 business climate: concepts and methods. *International food and agribusiness*
466 *management review*, 8(2), 21-40.
- 467 Boehlje, M., & Roucan-Kane, M. (2009). Strategic decision making under uncertainty:
468 Innovation and new technology introduction during volatile times. *International Food*
469 *and Agribusiness Management Review*, 12(4), 199-209.

- 470 Bonn, I. (2005). Improving strategic thinking: a multilevel approach. *Leadership &*
471 *Organization Development Journal*, 26(5), 336-354.
- 472 Boxelaar, L., Sharma, M., & Paine, M. (2006). *Sustaining our social and natural capital:*
473 *enhancing the resilience of dairy farmers*. Paper presented at the Proceedings of the
474 12th ANZSYS conference-Sustaining our social and natural capital. Katoomba, NSW
475 Australia, 3rd-6th December.
- 476 Carmeli, A., Friedman, Y., & Tishler, A. (2013). Cultivating a resilient top management
477 team: The importance of relational connections and strategic decision
478 comprehensiveness. *Safety Science*, 51(1), 148-159. doi: 10.1016/j.ssci.2012.06.002
- 479 Conforte, D., Garnevska, E., Kilgour, M., Locke, S., & Scrimgeour, F. (2008). *Key elements*
480 *of success and failure in the NZ dairy industry*: Lincoln University. Agribusiness and
481 Economics Research Unit.
- 482 Connor, K. M., & Davidson, J. R. (2003). Development of a new resilience scale: The
483 Connor-Davidson resilience scale (CD-RISC). *Depression and anxiety*, 18(2), 76-82.
- 484 Cooper, N., Estes, C. A., & Allen, L. (2004). Bouncing back: How to develop resiliency
485 through outcome-based recreation programs. *Parks & Recreation*, 39(4), 28-35.
- 486 Coutu, D. L. (2002). How resilience works. *Harvard business review*, 80(5), 46-56.
- 487 Crawford, A., McCall, D., Mason, W., & Paine, M. (2007). *Industry adaptation-challenges*
488 *when building resilient farming systems*. Paper presented at the Proceedings,
489 Australasian Dairy Science Symposium.
- 490 Darnhofer, I. (2010). Strategies of family farms to strengthen their resilience. *Environmental*
491 *Policy & Governance*, 20(4), 212-222. doi: 10.1002/eet.547
- 492 Darnhofer, I. (2014). Resilience and why it matters for farm management. *European Review*
493 *of Agricultural Economics*, 41(3), 461-484.
- 494 Darnhofer, I., Bellon, S., Dedieu, B., & Milestad, R. (2008). *Adaptive farming systems: a*
495 *position paper*. Paper presented at the EUROPEAN IFSA SYMPOSIUM:
496 empowerment of the rural actors: a renewal of farming systems perspectives.
- 497 Darnhofer, I., Bellon, S., Dedieu, B., & Milestad, R. (2010a). Adaptiveness to enhance the
498 sustainability of farming systems. A review. *Agronomy for sustainable development*,
499 30(3), 545-555.
- 500 Darnhofer, I., Fairweather, J., & Moller, H. (2010b). Assessing a farm's sustainability:
501 insights from resilience thinking. *International journal of agricultural sustainability*,
502 8(3), 186-198.
- 503 Darnhofer, I., Gibbon, D., & Dedieu, B. (2012). *Farming systems research into the 21st*
504 *century: The new dynamic*: Dordrecht : Springer Netherlands, 2012.
- 505 Emery, F. E., & Trist, E. L. (1965). The causal texture of organizational environments.
506 *Human Relations*, 18(1), 21-32. doi: 10.1177/001872676501800103
- 507 Fazey, I. R. A. (2010). Resilience and higher order thinking. *Ecology and Society*.
- 508 Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., & Holling, C.
509 S. (2004). Regime shifts, resilience, and biodiversity in ecosystem management.
510 *Annual Review of Ecology Evolution and Systematics*, 35, 557-581. doi:
511 10.1146/annurev.ecolsys.35.021103.105711
- 512 Folke, C., Stephen, R. C., Brian, W., Marten, S., Terry, C., & Johan, R. (2010). Resilience
513 Thinking: Integrating Resilience, Adaptability and Transformability. *Ecology and*
514 *Society*(4), 20.
- 515 Gist, M. E. (1987). Self-efficacy: Implications for organizational behavior and human
516 resource management. *Academy of management review*, 12(3), 472-485.
- 517 Goldstein, B. (2009). Resilience to surprises through communicative planning. *Ecology and*
518 *Society*, 14(2), 33.

- 519 Graetz, F. (2002). Strategic thinking versus strategic planning: towards understanding the
520 complementarities. *Management Decision*, 40(5), 456-462.
- 521 Gray, D., Dooley, E., & Shadbolt, N. M. (2008). *Risk and dairy farm management in New*
522 *Zealand : a review of literature*. Palmerston North, N.Z.: AgResearch : Massey
523 University.
- 524 Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: the process of
525 individual adaptation to climate change. *Global Environmental Change*, 15(3), 199-
526 213.
- 527 Hahn, T., Schultz, L., Folke, C., & Olsson, P. (2008). Social networks as sources of resilience
528 in social-ecological systems. *Complexity theory for a sustainable future*, 119-148.
- 529 Heracleous, L. (1998). Strategic thinking or strategic planning? *Long range planning*, 31(3),
530 481-487.
- 531 Kamangar, F., Rohani, R., Salavati, A., & Karimi, M. S. (2013). Developing Strategic
532 Thinking.
- 533 Kaufman, L., & Rousseeuw, P. (1990). Finding groups in data, 1990. *New York*.
- 534 Liedtka, J. M. (1998a). Linking strategic thinking with strategic planning. *Strategy and*
535 *leadership*, 26(4), 30-35.
- 536 Liedtka, J. M. (1998b). Strategic thinking: can it be taught? *Long range planning*, 31(1), 120-
537 129.
- 538 Love, S., Sharma, M., Boxelaar, L., & Paine, M. (2008). Enhancing the resilience of dairy
539 farm business: Melbourne: University of Melbourne.
- 540 Mantere, S. (2000). *Sensemaking in strategy implementation*. Helsinki University of
541 Technology.
- 542 Manzano-García, G., Calvo, A., & Carlos, J. (2013). Psychometric properties of Connor-
543 Davidson Resilience Scale in a Spanish sample of entrepreneurs. *Psicothema*, 25(2).
- 544 Martin, S. (1994). *Risk perceptions and management response to risk in pastoral farming in*
545 *New Zealand*. Paper presented at the PROCEEDINGS-NEW ZEALAND SOCIETY
546 OF ANIMAL PRODUCTION.
- 547 McCann, J. (2004). Organizational effectiveness: Changing concepts for changing
548 environments. *Human Resource Planning*, 27(1), 42-50.
- 549 McCann, J., Selsky, J., & Lee, J. (2009). Building agility, resilience and performance in
550 turbulent environments. *People & Strategy*, 32(3), 44-51.
- 551 Metselaar, E. E. (1997). Assessing the willingness to change: Construction and validation of
552 the DINAMO.
- 553 Miller, A., Dobbins, C., Pritchett, J., Boehlje, M., & Ehmke, C. (2004). Risk management for
554 farmers. *Staff paper*, 04-11.
- 555 Moon, B.-J. (2013). Antecedents and outcomes of strategic thinking. *Journal of Business*
556 *Research*, 66(10), 1698-1708.
- 557 Neill, S., McKee, D., & Rose, G. M. (2007). Developing the organization's sensemaking
558 capability: Precursor to an adaptive strategic marketing response. *Industrial*
559 *Marketing Management*, 36(6), 731-744.
- 560 Parsonson-Ensor, C., & Saunders, C. (2011). *Exploratory research into the resilience of*
561 *farming systems during periods of hardship*. Paper presented at the New Zealand
562 Agricultural and Resource Economics Society Conference.
- 563 Pinochet-Chateau, R., Shadbolt, N., Holmes, C., & Lopez-Villalobos, N. (2005). *Changes in*
564 *risk perception and risk management strategies in New Zealand dairy farming*. Paper
565 presented at the International Food and Agribusiness Management Association: 2005
566 World Food and Agribusiness Congress.
- 567 Pinochet Chateau, R. E. (2005). *Risk in New Zealand dairy farming: perception and*
568 *management: a thesis presented in partial fulfilment of the requirements for the*

- 569 *degree of Master of Applied Science in Agricultural Systems and Management at*
570 *Massey University, Palmerston North, New Zealand.* The author.
- 571 Pisapia, J., Reyes-Guerra, D., & Coukos-Semmel, E. (2005). Developing the leader's
572 strategic mindset: Establishing the measures. *Leadership Review*, 5(1), 41-68.
- 573 Price, J. C., & Leviston, Z. (2014). Predicting pro-environmental agricultural practices: The
574 social, psychological and contextual influences on land management. *Journal of Rural*
575 *Studies*, 34, 65-78.
- 576 Reich, J. W., Zautra, A. J., & Hall, J. S. (2010). *Handbook of adult resilience*: Guilford Press.
- 577 Rogers, K. H., Luton, R., Biggs, H., Biggs, R., Blignaut, S., Choles, A. G., . . . Tangwe, P.
578 (2013). Fostering Complexity Thinking in Action Research for Change in
579 Social–Ecological Systems. *Ecology and Society*, 18(2). doi: 10.5751/ES-
580 05330-180231
- 581 Rotter, J. B. (1966). Generalized expectancies for internal versus external control of
582 reinforcement. *Psychological monographs: General and applied*, 80(1), 1.
- 583 Schwarzer, R., & Jerusalem, M. (1995). Generalized self-efficacy scale. *Measures in health*
584 *psychology: A user's portfolio. Causal and control beliefs*, 1, 35-37.
- 585 Schwarzer, R., & Warner, L. M. (2013). Perceived self-efficacy and its relationship to
586 resilience *Resilience in Children, Adolescents, and Adults* (pp. 139-150): Springer.
- 587 Shadbolt, N., & Olubode-Awosola, F. (2013). *New Zealand dairy farmers and risk:*
588 *perceptions of, attitude to, management of and performance under risk and*
589 *uncertainty*. Palmerston North, New Zealand: One Farm: Centre of Excellence in
590 Farm Business Management.
- 591 Shadbolt, N., Rusito, B., Gray, D., & Olubode-Awasola, F. (2011). *Resilience of New*
592 *Zealand dairy farms in a turbulent environment: Definition and measurement*. Paper
593 presented at the Proceedings of the International Food and Agribusiness Management
594 Association 21 st Annual World Symposium.
- 595 Skodol, A. E. (2010). The resilient personality. *Handbook of adult resilience*, 112-125.
- 596 Sloan, J. (2013). *Learning to think strategically*: Routledge.
- 597 Sorgenfrei, M., & Wrigley, R. (2005). *Building analytical and adaptive capacities for*
598 *organisational effectiveness*: International NGO Training and Research Centre.
- 599 Tanewski, G., Romano, C., & Smyrnios, K. (2000). *Owner characteristics and business*
600 *planning as determinants of Australian family farm performance*. Paper presented at
601 the Agribusiness Association of Australia: Agri Food 2000 Conference, Melbourne,
602 Victoria.
- 603 van der Laan, L. W. (2010). *Foresight competence and the strategic thinking of strategy-level*
604 *leaders*. University of Southern Queensland.
- 605 Van Kooten, G. C., Schoney, R. A., & Hayward, K. A. (1986). An alternative approach to the
606 evaluation of goal hierarchies among farmers. *Western Journal of Agricultural*
607 *Economics*, 40-49.
- 608 Walker, B., & Salt, D. (2006). *Resilience thinking: sustaining ecosystems and people in a*
609 *changing world*: Island Press.
- 610 Webb, L. (2013). *Resilience: How to cope when everything around you keeps changing*: John
611 Wiley & Sons.
- 612 Weick, K. E. (1995). *Sensemaking in organizations* (Vol. 3): Sage.
- 613 Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of
614 sensemaking. *Organization science*, 16(4), 409-421.

615

616

617 **Appendix**618 **Table 1A. Resilience attributes questions.**

Attribute	Item in the survey*	Original item	Original context	Reference
Willingness to accept uncertainty and change	I intend to make time to implement changes required in my farm business. (+)	Intention to make time to implement the change	Organisations	Metselaar (1997)
	I am willing to make changes to my farm business. (+)	Our organisation is open to change	Business	McCann et al. (2009)
	I am willing to face uncertainty in my business. (+)	Derived from the question above	Business	McCann et al. (2009)
Open-mindedness	I value the knowledge of others from inside and outside the farm business. (+)	Encounter every person with equal respect, listen for their specific needs, knowledge, and ways of knowing	Social ecological systems	Rogers et al. (2013)
	I consider everyone in the dairy industry learns from each other. (+)	Accept everyone as colearners, not experts or competitors	Social ecological systems	Rogers et al. (2013)
Self-efficacy	It is easy for me to stick to my aims and accomplish my goals. (+)	It is easy for me to stick to my aims and accomplish my goals.	Psychology	Schwarzer and Jerusalem (1995)
	No matter how hard I try, I struggle to solve difficult problems. (-)	I can always manage to solve difficult problems if I try hard enough.	Psychology	Schwarzer and Jerusalem (1995)
	I am confident that I can deal efficiently with unexpected events. (+)	I am confident that I could deal efficiently with unexpected events.	Psychology	Schwarzer and Jerusalem (1995)
Locus of control	The success of my farm business is mostly determined by factors outside of my control. (-)	The success of the farm is mostly determined by factors outside of my control	Agricultural systems	Price and Leviston (2014)
	The weather and commodity prices can knock the business around in the short term but in the long term there is still a lot I can do to stay ahead of the game. (+)	The weather and commodity prices can knock you around in the short term, but in the long run there is still a lot you can do to stay	Agricultural systems	Price and Leviston (2014)

* The sign between brackets indicates the sense of the direction between farmer response to an item and their degree of skills in the related attribute. Thus, a (+) indicates that the higher a farmer agrees to the item, the greater their skills in the related attribute. In contrast, a (-) indicates that the higher a farmer agrees to the item, the lesser their skills in the related attribute.

Attribute	Item in the survey*	Original item	Original context	Reference
Sense-making	I am not good at making sense of ambiguous and uncertain situations. (-)	Our organisation is good at making sense of ambiguous, uncertain situations	Business	McCann et al. (2009)
	I do not pay close attention to conditions outside the dairy industry. (-)	We pay close attention to conditions outside of our industry	Business	Neill, McKee, and Rose (2007)
	I have regular contact with other farmers where we discuss trends in the industry. (+)	We have regular interdepartmental meetings to discuss market trends and developments.	Business	Neill, McKee, and Rose (2007)
	I have regular contact with other members of the industry to acquire knowledge. (+)	Marketing personnel in our business spend time discussing customers' future needs with other functional departments.	Business	Neill, McKee, and Rose (2007)
	When confronted with a new situation, I revise past experiences to assess the situation. (+)	Consider your own experiences in applying your own knowledge to any problem	Organisations	Pisapia et al. (2005)
Strategic management	My decision-making is driven by my vision for my farm business. (+)	Overall, my company's decision-making is vision-driven.	Business	Moon (2013)
	I do not search for patterns when confronted with rich information. (-)	Search for patterns when confronted with rich information	Organisations	Pisapia et al. (2005)
	I consider how different parts of the farm system impact on each other. (+)	Consider how different parts of the organization influence the way things are done	Organisations	Pisapia et al. (2005)
	When resolving a strategic problem I consider a range of possibilities. (+)	Ask yourself and others to map out different strategies needed to map out the resolution of a problem	Organisations	Pisapia et al. (2005)
	No matter what, I always stick to my original plans (+)		Business	Adapted from Graetz (2002)

* The sign between brackets indicates the sense of the direction between farmer response to an item and their degree of skills in the related attribute. Thus, a (+) indicates that the higher a farmer agrees to the item, the greater their skills in the related attribute. In contrast, a (-) indicates that the higher a farmer agrees to the item, the lesser their skills in the related attribute.

619 **Table 2A. Sources of risk listed in the survey and their classification in six risk**
 620 **categories.**

Source of risk in the survey*	Classification of risk
Milk price Input prices and availability Business relationships (within supply chain) Dairy industry structure The global economic and political situation Global supply and demand for food Global competitors & competition Reputation and image of the dairy industry	Market risk
Interest rates Land values Availability of capital	Financial risk
Climate Pasture/crop/animal health	Production risk
Government laws and policies Local body laws and regulations	Regulatory risk
Availability of labour (self and family, employees, contractors) Skills and knowledge of those associated with the business	Human risk
Technological changes	Technology risk

* The list drew upon a number of risk sources used in other studies on risk management for farm business in New Zealand (Martin, 1994; Pinochet-Chateau et al., 2005a; Pinochet-Chateau et al., 2005b; Shadbolt & Olubode-Awosola, 2013).

621 **Table 3A. Risk management strategies and the type of risk the strategy aims to manage.**

Risk management strategy*	Type of risk the strategy aims to manage
Maintaining feed reserves Monitoring programme for pest and diseases Routine spraying and/or drenching Irrigation Geographic diversity through having properties in different areas	Production risk
Using futures markets Forward contracting Gathering market information Spreading sales (reducing seasonality in milk production)	Market risk
Arranging overdraft reserves Maintaining financial reserves: having cash and easily converted financial assets Main farm operator or family working off property Managing debt Keeping debt low Planning of capital spending	Financial risk
Having personal and/or business insurance	Human risk
Having short term flexibility to adjust quickly to weather, price and other factors Having long term flexibility Having more than one type of animal or other enterprises on your property Using practical planning steps in your business Assessing strengths, weaknesses, threats and opportunities Having a clear and shared vision or strategic purpose for your operation Using financial ratios for decision making Not producing to full capacity so there are reserves in the system	Overall risk
Implementing technological innovation(s)	Technology risk

Adjusting production methods/system to comply with laws and policies	Regulatory risk
--	-----------------

* The list of risk management strategies drew upon a number of strategies used in other studies on risk management for farm business in New Zealand (Martin, 1994; Pinochet-Chateau et al., 2005a; Pinochet-Chateau et al., 2005b; Shadbolt & Olubode-Awosola, 2013).