

Exiting, Enduring and Innovating: Farm Household Adaptation to Global Zoonotic Disease

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Abstract

Bovine Spongiform Encephalopathy (BSE) has been found in 25 countries, costing billions of dollars in those affected economies, and has had profound social and environmental impacts at multiple scales of organization. As a global phenomenon, the impacts of BSE were mediated directly through the environment (animal and human health) but in Canada the indirect socioeconomic impacts of BSE were far more damaging, especially for farm households. Yet, very little research has been conducted on adaptation to the indirect impacts of global environmental change, such as those mediated through the market and governance. Our goal was to examine how farm households adapted to the Canadian BSE crisis in order to better understand rural adaptations to global zoonotic diseases and to agriculture-related global environmental change as a whole. We conducted our mixed methods research in 2004-2006. Data sources included 826 survey responses, 27 individual interviews and 12 group interviews with farmers and ranchers in western Canada. Factor analysis separated out responses into three general adaptation strategies: ‘innovating’ to pursue new opportunities; ‘enduring’ or adaptations that seek stability; and ‘exiting’ from beef production or agriculture altogether. Farm household and community level innovation was a crucial adaptive strategy in the absence of governmental and expert-based support. Enduring adaptations were important to farm household survival in the short term, yet “chronic enduring” can compromise long-term adaptive capacity. Farm exiting was highly problematic during the BSE crisis as these responses were largely unexpected and often left households more vulnerable. Government support at the farm level promoted stability, with little support provided for change-orientated adaptations. Effective farm adaptation will require support for all three types of adaptive strategies and ones that are both expert-based and grassroots in nature to enable farm households in their pursuit of pluriactive and multifunctional livelihood strategies.

1 INTRODUCTION

1.1 VULNERABILITY TO THE DIRECT AND INDIRECT IMPACTS OF GLOBAL ENVIRONMENTAL CHANGE

Technological progress has driven unprecedented advances in efficiency, productivity and profit in the global agro-food system. However, the paradox of modernity is that the unmet human capacity to manipulate the natural world in the pursuit of progress also results in unpredictable risks. Natural systems have the propensity to “boomerang” back (Beck, 1992) causing global change that can lead to, health and market-related crises. To address these challenges, much effort has been expended on better understanding the vulnerability and adaptive capacity of individuals, communities, industries and institutions in the face of global environmental change (GEC) (see Brooks, 2003; McCarthy et al., 2001; Smit and Wandel, 2006 for reviews).

Vulnerability represents the degree to which an individual or a group is susceptible to harm from stressors associated with GEC (Adger, 2006). Most GEC research has focused on vulnerability to the direct physical or environmental impacts of global environmental problems, namely a changing climate (e.g. Parry et al., 2007) and related extreme weather events including drought (e.g. Wandel et al., 2009) and flooding (e.g. Eakin et al., 2010). Vulnerability to the indirect impacts of environmental change, or those that are manifested through socio-economic and political systems (Kulshreshtha, 2011, Smit et al., 2000) has received much less attention. Where non-climatic stressors have been included in adaptation studies, they are usually treated separately, as the outcomes of non-environmental (e.g. societal, political and economic) change (e.g. Belliveau et al., 2006; O'Brien and Leichenko, 2000). Yet, environmental change often affects economic, political and regulatory change at multiple scales (e.g. Muller, 2011; Oh and Reuveny, 2010), presenting new challenges and opportunities for individuals, communities and society as a whole (figure 1).

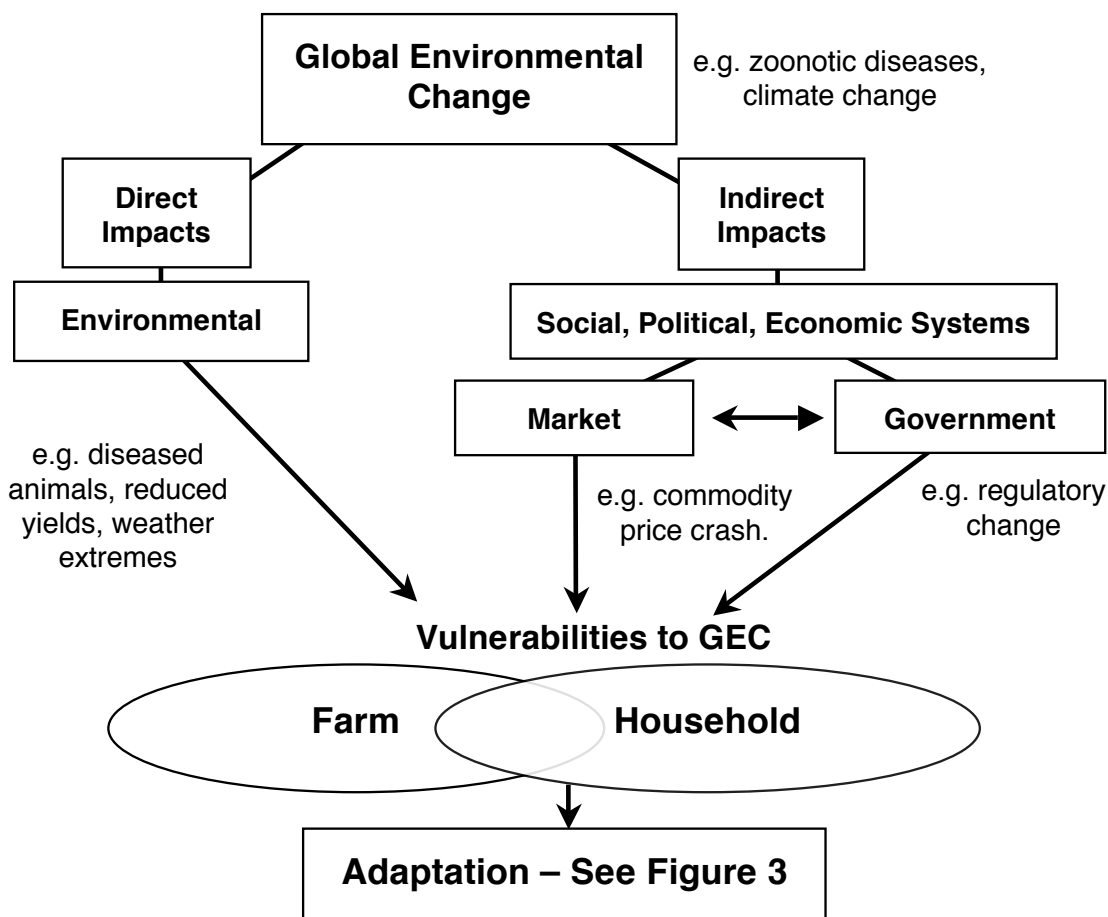


Figure 1 - Schematic outlining farm household vulnerability to the direct and indirect impacts of global environmental change.

This paper examines how farm households adapted to the Canadian BSE (Bovine Spongiform Encephalopathy or mad cow disease) crisis - a global environmental disaster with impacts in Canada that were largely mediated through political and economic systems. Our research approach sought to bring the poorly understood voices, concerns and experiences of farm families to the forefront of our methodology whereby research questions and instruments were developed in active consultation with producers throughout an iterative, mixed methods design. Our goal was to explore how farmers adapted to BSE in Canada, which would, in turn, inform our understanding of farm household adaptation to GEC and improve our ability to facilitate rural adaptation to zoonotic diseases and agriculture-related global change as a whole.

1.2 ZOONOTIC DISEASE AS A GLOBAL ENVIRONMENTAL DISASTER

Global environmental change includes both systemic change in global systems (e.g. climate change) and cumulative change where localized environmental problems aggregate at a global scale (e.g. aggregate pollution of local waterways) (Turner et al., 1990). Global zoonotics (or cross animal-human diseases) represent both cumulative and systemic forms of GEC whereby localized zoonotic epidemics aggregate on a global scale and are also spread through the global agro-food system with direct and indirect impacts that have caused profound changes at a global scale. Along with other livestock-related diseases (e.g. foot-and-mouth, blue tongue), zoonotic diseases (e.g. BSE, avian flu, swine flu) undermine the stability of global trade (Tilman et al., 2002). The speed, scale, and complexity of animal and meat trade have also contributed substantially to the emergence of zoonotic disease as a global environmental problem (WHO, 2004). Despite international efforts to control zoonotic diseases, they continue to spread and reemerge as global livestock trade expands and intensifies (Delgado et al., 1999).

BSE is a global zoonotic disease that has had devastating impacts at multiple scales. First identified in England in 1986, BSE represents one of the most significant environmental disasters associated with the modern agro-food system (Leiss and Nicol, 2006). BSE is a fatal neurodegenerative prion disease (Dalsgaard, 2002) that is transmitted amongst cattle through the ingestion of BSE-infected central nervous system tissue. Although the recycling of animal materials as a high-protein feed source represents an effective way of reducing slaughterhouse waste to increase profits, the introduction of BSE-tainted animal materials into otherwise herbivorous bovine diets provided the BSE agent with a novel anthropogenic infection pathway (Smith and Bradley, 2003).

Once BSE-tainted meat was linked with the fatal human variant Creutzfeldt Jacob Disease (vCJD), the disease escalated from an ostensibly manageable agricultural issue into a zoonotic disease epidemic having devastating socio-economic, animal health and human health consequences around the world. The subsequent global spread of BSE was facilitated by British exports of BSE-tainted meat, bone meal and live cattle incubating the disease (Brown, 2001), and has since been documented in 25 countries across Europe, Asia, and the Americas (World Organization for Animal Health, 2011). Trade moratoria levied on countries found to have BSE infectivity and the

costs associated with eradication programs have led to billions of dollars in economic losses worldwide.

1.3 THE CANADIAN BSE CRISIS

On May 23, 2003, the first of only 19 Canadian cases of BSE was found in the province of Alberta (WOAH, 2011), causing 38 countries to close their borders to Canadian live cattle and beef products. In 2002, almost half of the cattle sold in Canada had been exported as either live animals or meat, the majority of which was destined for the US. In contrast, the US exported only 10% of its beef and cattle, leaving it much less vulnerable to border closures (O'Neill, 2005). In Canada, the loss of these export markets in turn depressed commodity beef prices triggering a socio-economic crisis that devastated the agricultural sector, the Canadian economy and especially farm households and rural communities (Mittra et al., 2009; Stozek, 2008). Losses over the following year averaged \$20,000 per farm household (Mitura and Di Pietro, 2004) and these immediate impacts resonated across the Canadian rural landscape. The overall economic impact on the agricultural sector in 2005 was estimated at \$7 billion (Leiss and Nicol 2006).

The Canadian BSE crisis provides a useful opportunity to explore farm household adaptation to the indirect impacts of GEC. Despite originating as a global environmental disaster (global disease emergence), the environmental impacts (animal and human health) of BSE in Canada, and also in countries including Japan and South Korea, were dwarfed by those mediated through the marketplace. In Canada, only 19 BSE-infected cattle have been detected and only one case of the human variant Creutzfeldt-Jakob disease in contrast to the UK, for example, where 184,607 and 174 detected cases of BSE and vCJD, respectively, have thus far been documented (EUROCJD, 2008; WOA, 2011). It is further estimated that in the U.K. over 900,000 cattle were infected, that 8.54 million high-risk animals were destroyed through the BSE eradication program and, despite these precautions, that over 460,000 infected animals ultimately entered the food system (Valleron, 2001).

Research on the Canadian BSE crisis has focused on public policy and trade e.g. (Le Roy and Klein, 2005; O'Neill, 2005; Rude et al., 2007), risk management and perception of risk (Boyd et al., 2009; Krewski et al.; Leiss et al., 2010; Lemyre et al., 2009)ⁱ, the farm and community level impacts of BSE (Ashraful and McLachlan, 2009; McIntyre and Rondeau, 2009; Mittra et al., 2009; Stozek 2008) and locating the BSE crisis within the context of multiple interacting stressors (Schaufele et al., 2009; Stozek, 2008). The Canadian BSE Integrated Risk Management Framework (IRMF) (Leiss et al., 2010) provides a comprehensive synthesis of research on BSE in Canada and beyond; however, the capacity for farm households to adapt is absent from this framework and from studies on zoonotic disease in general (Anderson and McLachlan, 2009). Indeed, with the exception of one study that characterized the role of Holistic Management in rural adaptation to BSE (McLachlan and Yestrau, 2008) and another that focused peripherally on adaptation amongst young farmers (Cook et al., 2011), there has yet to be a systematic appraisal of farm household

adaptation to BSE in Canada or anywhere else in the world. Yet, the reoccurrence of zoonotic disease is arguably as inevitable as a changing climate – a field within which understanding and facilitating farm household adaptation is now mainstreamed in scientific and policymaking circles.

1.4 TYPIFYING AGRICULTURAL ADAPTATION

Adaptation has been defined as ‘adjustments in ecological-social-economic systems in response to actual or expected’ impacts and opportunities associated with global and local change (Smit et al., 2000). Adaptations are manifestations of adaptive capacity, which represents the potential for actors to absorb and recover from the direct and indirect impacts associated with GEC and further reflects the degree to which they can take advantage of any emerging opportunities associated with these changes (Adger and Vincent, 2005). A number of studies and reviews have suggested a variety of dimensions and typologies of agricultural adaptation, largely in the context of adaptation to climate change.

In their seminal typology, Smit and Skinner (2002) categorized rural adaptation into four types: technological developments, government programs and insurance, farm production practices, and farm financial management. Within this framework, technological developments and government programs emphasize the role of non-farm actors (e.g. government, agri-business), while the later two types emphasize the role of the farm enterprise. Beyond the farm gate, other actors facilitate or undermine on-farm adaptation at a distance by affecting the political, regulatory, technological and economic context within which a farm operates (Carina and Keskitalo, 2009). Many approaches, including that represented in this study, focus on the farm household as our ‘system of interest’ (Smit et al., 2000). From this situated perspective, we can then consider the inter-scalar relations and the broader conditions that affect farm adaptation (Smit and Wandel, 2006).

Adaptations also have temporal dimensions and have been classified as either reactive with respect to current exposures or proactive with respect to anticipated ones (Paavola and Adger, 2002; Pittock and Jones, 2000). Short-term coping responses have been distinguished from long-term strategic adaptations (Berkes and Jolly, 2001). Although temporal dichotomies are useful for classifying some adaptations, these categories tend to break down in practice as farmers use a combination of adaptive actions that interact over time in ways that are both short and long term and that vary in intent, timing and duration as farm households face new challenges and opportunities (Smit and Skinner, 2002). Characterizations of agricultural adaptation in the GEC literature generally emphasize the importance of individual farms in short-term reactive adaptation, focusing on the roles of agri-business and governments in fostering longer-term strategic adaptation (e.g. Kurukulasuriya and Rosenthal, 2003; Smit and Skinner, 2002). This dichotomy arguably denies any influential role for farmers and rural communities in generating long term adaptation strategies and, indeed, can even undermine grassroots adaptations (McLachlan and Yestrau, 2008).

Given the focus on the direct environmental impacts of climate change, GEC research has primarily focused on agronomic farm adaptation strategies that maintain or increase agricultural

productivity (e.g. Bryant et al., 2000; Bradshaw et al., 2004). However, research elsewhere demonstrates that farm households adapt to change by making adjustments both in the farm operation (operational adaptations) as well as the farm household (familial adaptations), often transferring human and material resources between the two (Johnsen 2004; Smithers and Johnson, 2004). It has been long theorized that the interdependence of the farm operation and farm household is a critical source of adaptive capacity that has allowed family farms to persevere as a mode of production and for agriculture to avoid the degree of capitalist industrialization experienced in almost every other sector (Brookfield, 2008; Chayanov, 1987). Policy-makers and scientists often assume that economic rationality alone can explain adaptation as farmers are presumed to pursue adaptations that maintain or increase productivity, efficiency and profitability. Yet, most family farms also pursue extra-economic goals (e.g. way of life, land stewardship, spiritual, cultural) in their adaptation strategies that are central to understanding farm adaptation (Barbieri and Mahoney, 2009; Fairweather and Keating, 1994; Gasson et al., 1988).

2 METHODS

2.1 DESCRIPTION OF STUDY AREA

Our research focuses on adaptation to BSE in the three Canadian Prairie Provinces (figure 2). The impact of the Canadian BSE crisis was greatest in Manitoba (MB), Saskatchewan (SK) and Alberta (AB) in large part because two thirds of Canada’s beef cattle farms are located in these provinces (Statistics Canada, 2006). Indeed, 43% of all Canadian beef cattle production and 64% of all cattle in specialized feedlot production takes place in Alberta alone (MacLachlan, 2001). In comparison, Manitoba and

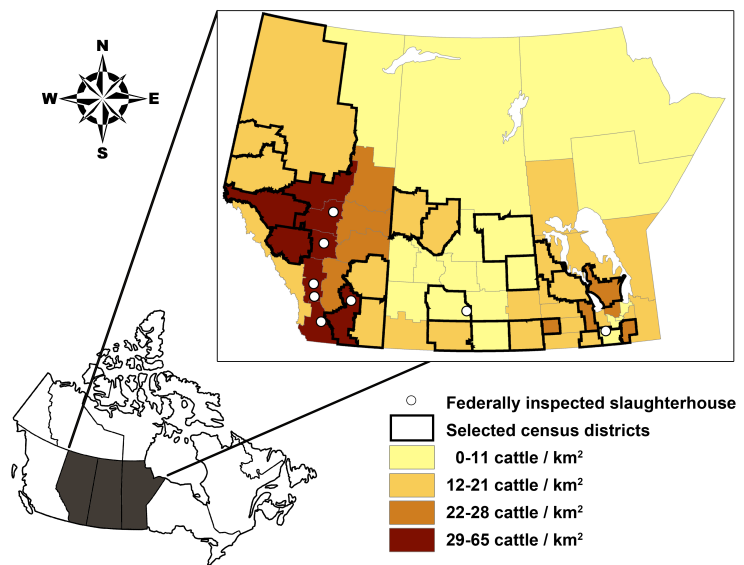


Figure 3 - The Canadian Prairies. Sampling strata, cattle density and location of federally inspected slaughterhouses.

Saskatchewan farmers are primarily involved in cow-calf and backgrounding production with a much a smaller share of feedlot productionⁱⁱ (Statistics Canada, 2006). Alberta is also home to six large federally inspected slaughtering plants that market processed beef and animal products beyond provincial and indeed national boundaries. In contrast, Saskatchewan and Manitoba each only have one smaller federal processing facility and the majority of feeder cattle are shipped to

Alberta or Eastern Canada for finishing and slaughter. While over 100 provincially inspected abattoirs are located in the prairies, they can only market products within provincial borders.

2.2 MIXED METHODS APPROACH

This study used an iterative and sequential mixed methods approach (Teddlie and Tashakkori 2009, p.277) where qualitative and quantitative methods were mixed over three sequential phases. Data collected in earlier phases informed the development of research questions and instruments in each subsequent phase (figure 3). The use of mixed methods also allowed us to collect and analyze data that clarified and complemented the results from one method (e.g. qualitative) with the use of the other (e.g. quantitative) (Green et al., 1989).

A random stratified approach was taken whereby rural regions in the Prairies were stratified according to density (i.e. low and high) of cattle production and proximity (i.e. close and far) to the nearest federally inspected slaughterhouse. Low and high cattle production classes were defined as 0-21 cattle km² and 22-65 cattle km², respectively whereas close and far distance classes were defined as <150 km and > 150km to the slaughterhouses, respectively. All census districts from Alberta, Saskatchewan and Manitoba in which at least 30% of the land-base was used for agricultural production were assigned to each of these four strata. Two census districts were randomly selected from each of the four strata in each of the three provinces (n=24).

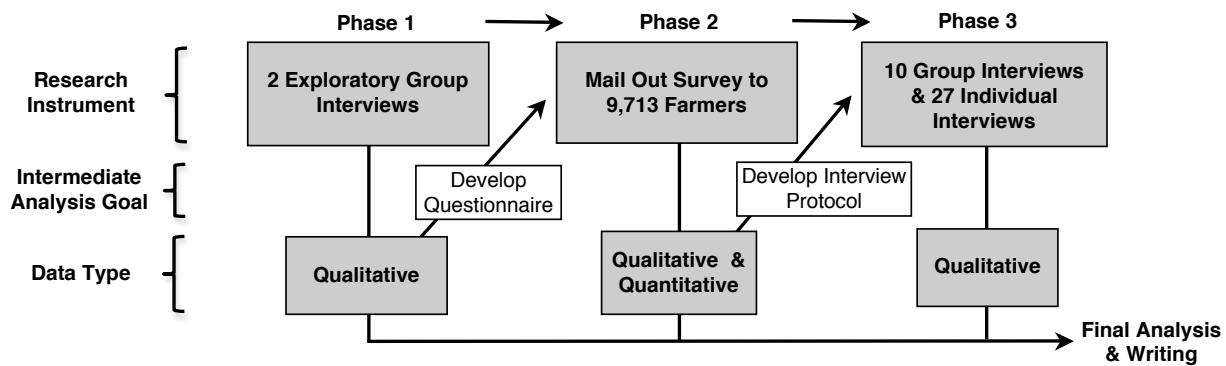


Figure 2 - Iterative sequential mixed methods schematic.

2.3 PHASE I – INITIAL GROUP INTERVIEWS

Because there was so little previous research on adaptation to zoonotic diseases or of the nature of the BSE crisis in Canada, we conducted two preliminary exploratory group interviews in December 2005 with farmers from two of the 12 strata in Manitoba. A diverse group of farmer participants were recruited by snowball sampling through two farm organizations in each stratum - the Harvest

Moon Society and the Riding Mountain Biosphere Reserve. Participants were asked open-ended questions about the impacts of BSE, government response and the adaptation strategies they used in response to the crisis. Important in their own right, these data were also used to develop the subsequent mail-out questionnaire.

2.4 PHASE II – MAIL-OUT QUESTIONNAIRE

The 12-page questionnaire consisted of both likert-scaled and open-ended questions that focused on the following themes: direct and indirect impacts related to BSE, additional risks to farmers and rural communities, attitudes towards Canadian agriculture policy, agricultural structural changes, government responses to BSE, environmental and animal health implications of BSE and farm household adaptation strategies.

Using Canada Post databases, rural post offices were randomly selected throughout each test census district such that no one post office exceeded 80 farms and thus each census district was comprised of 400-410 survey recipients. On March 7, 2006, 9,713 questionnaires were distributed using an unaddressed ‘ad mail’ mailing option to all those who had self-identified as ‘farmers’ in the selected postal regions. Although less than ideal, our use of ad mail was unavoidable since mailing lists are unavailable for farmers for all three provinces. A reminder letter and finally a condensed four-page version of the original larger questionnaire were sent out at one-week intervals after the initial mail-out (Dillman, 2000). The shorter survey was sent in order to provide an additional opportunity for farmers to participate in the research, anticipating that some would have lost or discarded the original questionnaire, especially since the mail outs had been non-addressed.

2.4.1 QUESTIONNAIRE RESPONSE, NON-RESPONSE AND DEMOGRAPHICS

In total, 1,473 completed questionnaires were returned (826 long version, 647 short version), for a 15% absolute response rate. Residents in the test census districts that had been sampled were telephoned, allowing us to assess how many of the questionnaires had actually been received. The resulting adjusted survey response rate was estimated as 33%. Although somewhat low, these response rates are typical of large-scale mail surveys conducted in rural areas and reflect a trend of declining mail survey response rates in rural research (Penning, 2002). Moreover, they reflect our necessary use of anonymous ad mail. This paper focuses on a subset of adaptation-related questions found only on the long version of the questionnaire (n=826).

Non-response bias was assessed by telephoning 10 farmers in each of the test census districts (n=240), five of whom that had already responded and five that had not responded to the questionnaire. All were asked five questions selected from the questionnaire and those that had not responded were also asked to indicate reasons for their failure to participate. We found no significant differences in response between responders and non-responders ($p=0.5612$). Lack of

time and general cynicism about research were the most frequent reasons for not participating. Many of the non-respondents also indicated that they had thrown out the surveys, without opening the envelopes in large part because they were non-addressed and thus perceived as “junk mail”.

Broken down by province, 38.5% of survey respondents were from Manitoba, 31.8% from Saskatchewan and 25.3% from Alberta. Most (80.9%) were male and averaged 53 years of age. Almost half (40.9%) had some form of off-farm income, this slightly lower than the Statistics Canada average for the Prairie Provinces (48.4%) (Statistics Canada, 2006). The average farm size for our sample across all the three provinces was 2313 acres, double that of the Statistics Canada average of 1167 acres (Statistics Canada, 2006). Our sample contained a higher distribution of larger farms and a lower distribution of smaller farms than the Statistics Canada data. These differences likely reflected our stratified sampling technique. Half of the sampling regions were selected for low cattle production density. Farms in these strata would tend to have larger acreages with lower cattle densities, especially for ranches in Alberta and Saskatchewan. The average cattle herd size of our sample was 183 head per farm, very close to the Statistics Canada average of 179 head per farm (Statistics Canada, 2006). In total, 80.1% of respondents self-identified as cow/calf operators and 8.1% operated a feedlot. Many had mixed farms, 57.4% having grain operations in addition to cattle.

2.4.2 QUANTITATIVE ANALYSIS

Self-reported measuresⁱⁱⁱ of adaptation strategies were summarized using mean, proportion agreeing/disagreeing and standard error (SE). Questions with more than four missing values were removed from further analysis leaving 522 useable cases. Eighteen Likert-scaled questions regarding adaptation to BSE were subjected to principal component analysis (PCA) to explore the underlying structure of the data (SPSS version 17). Questions were assigned to components and only selected for further use if the loading was at least 0.400 (Field, 2005), if three questions or more loaded highly on each component, and if the questions loaded onto only one component (i.e. had no cross-loadings). Interpretation of the scree plot revealed inflexions that justified retaining three components, which were interpreted using a varimax rotation. The final three-component solution explained 48.3% of the variance (table 1). The first two components represented reliable scales with Chronbach alpha values greater than the 0.60 considered acceptable for internal consistency (Nunnally and Bernstein, 1994), although the third factor was slightly lower (0.56). Chronbach alpha values are highly dependent on the number of variables in the scale and a low alpha value for a scale with two variables may not be indicative of poor reliability and can still be useful for data interpretation (Cortina, 1993). The three component solution represents a typology of farm household adaptation where component one was termed ‘innovating adaptations’, component two ‘enduring adaptations’ and component three ‘exiting adaptations’.

Secondary analysis was conducted on a set of questions related to animal health and environmental impacts. Respondents were sorted into low, medium, and high categories using the factor scores from each component. The middle 33rd percentile was then eliminated to create binary categories for each of the three general adaptation strategies. We then compared responses to five statements regarding environmental and animal health impacts between those who were categorized as either high or low in each of the three general adaptation strategies.

2.5 PHASE III – GROUP AND INDIVIDUAL INTERVIEWS

A third qualitative phase was used to explore findings from the first two phases to and further develop emerging theory. Group interviews were conducted in communities within each of the 10 remaining test census districts between August-November 2006. Respondents to the survey whom had indicated that they wished to participate further in the research were identified, contacted and invited to participate in a location central to those interested. Overall, 93% of those contacted agreed to participate in these group interviews. Additional data were also drawn from 27 interviews conducted between June and September 2007 with farmers in Manitoba as a part of a complementary study that focused on BSE-related marketing adaptations. Qualitative data from the group interviews, the individual interviews and the open-ended survey questions were coded and provided complementary data that expanded on the typology that emerged from the quantitative analysis.

3 EXITING, ENDURING AND INNOVATING ADAPTATION STRATEGIES

Table 1

Results of principle component analysis (varimax rotation), reliability analysis and descriptive statistics of each individual observed variable in principle component solution. Each observed variable represents the degree to which respondents agreed that the stated adaptation strategy helped their farm adapt to BSE.

	Variance	Eigen Values	Alpha	Factor Loading	Mean ^a (SE)	Mean Ranking	Importance (proportions %)			
							Agree	Neutral	DN/NA ^b	Disagree
Component 1 – Innovating	20.5%	3.129	0.75							
Marketing directly to consumers				0.800	4.48 (.07)	4	51.0	16.8	10.5	21.8
More rotational grazing				0.712	4.76 (.07)	3	54.6	21.7	9.3	14.4
Practice holistic management				0.681	4.07 (.07)	8	26.1	32.3	21.2	20.4
Finding other markets for livestock				0.623	4.90 (.07)	2	61.9	18.9	4.6	14.6
Shifting to organic production				0.567	3.05 (.08)	14	13.4	22.5	16.6	47.4
Fattening more cattle to finish				0.503	3.57 (.08)	11	27.0	19.4	12.5	41.1
Component 2 – Enduring	17.5%	2.147	0.69							
Cashing in family investments				0.728	4.15 (.08)	6	34.9	19.1	3.9	42.2
Selling assets				0.695	4.20 (.08)	5	40.6	22.7	2.4	34.3
Taking out more loans				0.691	4.10 (.09)	7	41.1	17.2	7.1	34.7
Overgrazing some paddocks				0.659	3.61 (.08)	10	33.2	14.0	6.6	46.1
Reducing the number of vet visits				0.434	5.12 (.07)	1	69.3	9.5	4.1	17.0
Component 3 – Exiting	10.6%	1.487	0.56							
Downsizing Herd				0.788	3.46 (.08)	12	28.8	14.3	4.0	52.9
Leaving cattle industry				0.662	3.10 (.07)	13	17.6	20.3	9.4	52.7
Using low calf prices to expand				-0.598	3.65 (.08)	9	41.3	18.8	8.1	31.9

^aVariance, eigenvalues, factor loadings, factor alpha, mean scores and proportion agreed were derived from a 7-point scale, with 1 indicating 'strongly disagree' and 7 indicating 'strongly agree'. Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .711. Bartlets Test of Sphericity Sig. = .000.

^b Don't know / Not Applicable

3.1 INNOVATING ADAPTATIONS

Observed variables that separated onto component one represented a substantial and proactive change in management practices and a move to experiment with new strategies, technologies, partnerships and ideas - ‘innovating adaptations’ (Table 1). These in turn were categorized into “market-oriented” innovating and “production-oriented” innovating. In general, market-oriented adaptations were more important than those that were production-oriented. This is unsurprising, given that the impacts of BSE were largely mediated through the marketplace.

3.1.1 MARKET-ORIENTED INNOVATING ADAPTATIONS

The majority (61.9%) of respondents agreed that ‘finding other markets for livestock’ was an important strategy for adapting to BSE. Half (51%) agreed that marketing directly to consumers was an important adaptive response. One farmer from Manitoba indicated, “When the value of cattle dropped, we responded by direct marketing beef. Our income from beef returned to normal and then increased above pre-BSE levels.” (Survey 1384, MB). The degree of direct marketing as a response to BSE varied. Some farms marketed a small number of animals “out of their freezers.... as a lot of non farmers pitched in and tried to buy from neighbours, relatives, etc.” (Survey 167, MB). Others developed more substantial, value-added direct marketing enterprises to take advantage of emerging opportunities in local markets. One participant from Manitoba, described how selling directly to consumers had reduced his vulnerability to future market risks, “If that (BSE) happened today instead of three years ago, my income would not change.” (Interview 10, MB). However, the extent to which farmers developed these more substantial direct marketing businesses was often undermined by poor access to processing and distribution infrastructure, “Local abattoirs [were] swamped with work, custom slaughtering cull cows.” (Survey 352, SK).

Respondents were asked to respond to a separate question that explored farmer’s attitudes towards the marketing options available in Canada and the role of government in the beef industry (Table 2). Almost all (94%) respondents felt that ‘more alternative international markets for Canadian beef’ were needed.

Table 2
Respondents attitudes towards marketing-oriented statements

Question	% agree	% neutral	% disagree	DN/NA
Government should be facilitating more alternative international markets for Canadian beef	93.4	4.0	1.7	1.0
Canadian agriculture is too dependent on export markets	83.9	4.0	11.4	0.6
Increased dependence on export markets has increased risk in agriculture	77.4	7.5	14.6	0.5
Free trade has given foreign interests too much control over our domestic market	77.0	11.8	9.4	1.8
Better incentives/subsidies towards local slaughter facilities	75.8	10.4	12.4	1.5
Free trade agreements such as NAFTA have generally benefited Canadian Producers	34.0	14.6	48.6	2.7

Proportions were derived from a 7-point scale, with 1-3 indicating disagree, 4 indicating neutral and 5-7 indicating agree

As one respondent from Saskatchewan explained, “[Canada needs] much stronger international beef marketing, with far less reliance upon the US market.” (Survey 1003, SK). Most (84%) respondents felt

that ‘Canadian agriculture is too dependent on export markets’ and most (79%) were concerned about foreign control over the domestic market. One respondent from Manitoba indicated, “*The future will depend on Canada managing and controlling their own slaughter facilities.*” (Survey 145, MB). Respondents identified farmer-owned slaughter cooperatives as an urgently needed adaptation to gain more power in the marketplace, “*Cooperatives and organizations where we can maybe drive our own markets.*” (Focus Group 3, MB). However there was concern about the capacity of farmers to afford the associated start-up costs in light of the BSE-related financial losses. Farmers generally saw a great need for government to financially enable these emerging cooperatives as most (77.1%) respondents also agreed that ‘better incentives/ subsidies toward local slaughter facilities’ were needed. Yet, new and existing food safety regulations undermined the expansion of local slaughter capacity and thus restricted farmer’s ability to develop cooperative slaughterhouses and partnerships with regional packers,

One of the local packers looked into getting a killing plant and upgrading this killing plant... the guy told him it would be 5 to 7 years before he could get all the government bookwork done ...So that’s frustrating. Here I am a producer that wants to market cattle through this and he’s on the packing end of it that wants to provide a service for us...we can’t go to a big multinational [meat packing company] because they don’t want to be bothered with us...our government is our biggest obstacle. (Interview 3, MB).

3.1.2 PRODUCTION-ORIENTED INNOVATING ADAPTATIONS

About half of respondents (54.6%) agreed that rotational grazing was an important innovating adaptation that allowed producers to maximize pasture carrying capacity. Survey respondents were less inclined towards more specialized alternative farm management practices such as holistic management (HM) and organics. About a quarter (26.1%) of respondents agreed that HM was an important innovating adaptation. Although it is being rapidly adopted by many in the prairies as a triple bottom-line approach to agriculture, HM is still relatively uncommon, perhaps indicating why most (53.5%) respondents were neutral or indicated ‘don’t know/ not applicable’. Only 13.4% of respondents felt that switching over to organics was an important adaptation. However, some respondents who already practiced organic livestock production noted that BSE presented new opportunities as some consumers had lost confidence in conventionally produced meat, “*We came thru this better than most beef producers because we are certified organic beef producers. Consumers sought us out for this reason.*” (Survey 1440, AB).

3.2 ENDURING ADAPTATIONS

Questions that separated onto component two emphasized reducing operating and living costs (Table 1) and differ from innovating responses in that they attempt to regain stability on the farm rather than pursuing new opportunities. These enduring adaptations allowed respondents to persist in the short term and, in effect, to avoid making substantial *immediate* changes. These

strategies were relatively common, and many focused on reducing expenditures, “in agriculture, there are only two ways to make money: 1. Increase production and the value of production. 2. Reduce expenses. In the case of BSE, #2 applies in most cases” (Survey 416, MB).

Most producers (69.3%) thought that ‘reducing the number of vet visits’ was an important enduring response, as one respondent illustrated, *‘If she’s going to die, she’s going to die because we ain’t getting no vet out to the farm no more.’* (Focus Group 4, AB). Another farmer from Manitoba described how enduring can negatively affect herd genetics, *‘Now we are not cleaning [our herd] out but we are breeding everything that can be bred and we are getting those bad genetics back...bad feet coming back...all of these other problems coming back.’* (Focus Group 3, MB).

Many (41.1%) of respondents agreed that ‘taking out more loans’ was an important short-term enduring response as many families were forced to go *‘waist deep into debt’* (Survey 308, SK). A producer from Manitoba explained that taking out loans might simply delay the inevitable impacts as, *‘The BSE crisis will devastate the industry in the next few years as producers try to pay back loans taken out in the last 2 years.’* (Survey 1432, MB). Some were critical of government interventions that further indebted farmers, *‘Farmer 1: Instead of that they gave out \$50,000 loans and said they were doing something for farmers when they really weren’t. Farmer 2: I don’t see how adding more debt helps anyone.’* (Focus Group 3, MB).

In total, 40.6% of respondents agreed that selling assets and 34.9% agreed that cashing in family investments were important enduring responses to keep the farm enterprise afloat, however at a great cost, *‘We have used every penny we’ve had saved to help us through this’* (Survey 506, SK). Enduring adaptations undermined quality of life as struggling families cut expenditures on recreation, and *‘ended all of [their] discretionary spending.’* (Focus Group 8, SK). Reduced spending at local businesses and withdrawal from community life also had negative implications for rural communities. One respondent explained, *‘You couldn’t buy needed goods or pay bills, you couldn’t travel around to family or community functions, which is necessary to live a healthy lifestyle’* (Survey 957, MB).

Many who embraced enduring strategies did so in anticipation of market corrections and hoped for a quick reopening of the US border for trade, *‘People are waiting to sell their animals hoping the price goes up’* (Survey 1036, SK), while relying on government support programs and other means of relief in the interim, *‘Just held on, used whatever money the governments handed out to scrape by on.’* (Interview 28, MB). Indeed, enduring adaptations were often dependent on solutions that emerged outside the farm gate, especially those that involved market correction (e.g. reopening the US-Canadian border) and government compensation packages and subsidies.

Some farmers who held back animals from the market in anticipation of higher prices couldn’t afford the additional infrastructure needed to accommodate their larger herds, *‘We do not have the money to build new pens or corrals to handle these extra cattle.’* (Survey 1156, AB). Costs mounted as producers struggled to feed these larger herds, *‘we seeded everything down, started corn, started silage and invested thousands of dollars...Put us up to way too many animals. We did not have the place for that many animals. But yet we did it.’* (Interview 27, MB).

Respondents expressed concerns over the animal health implications associated with increased herd sizes. Indeed, some indicated that ‘animals were under-fed to save money’ (Survey 8, MB) and other concerns that there was “overcrowding in many cases” (Survey 196, MB), which could, in turn, lead to declines in animal welfare, increases in pollution of land and water and increased risk of spread of disease. A farmer from Saskatchewan explained, “Animals were euthanized and not properly rendered or composted and will lead to environmental concerns, further spread of whatever disease by coyotes, etc.” (Survey 39, SK). Another respondent elaborated on some of these environmental consequences, “Overgrazing due to producers retaining more cattle was and still is a major problem” (Survey 568, AB).

In response to a set of Likert-scaled question regarding the animal and environmental health impacts of BSE, significant ($p < 0.001$) differences emerged between those scoring high on enduring adaptations (endurers) versus those who scored low (non-endurers) on enduring adaptations (Table 3). Indeed, a greater proportion of endurers agreed that their animals were stressed (53.9% vs. 30.9%, $p < 0.001$) and that livestock were less healthy (41.8% vs. 16.6%, $p < 0.001$) than did non-endurers. With respect to environmental impacts, endurers were 5X more likely to agree that there were declines in plant biodiversity than were non-endurers (46.1% vs. 8%, $p < 0.001$). Likewise, endurers were 4X more likely to agree that declines in water quality were associated with BSE than were non-endurers (25.5% vs. 6.1%, $p < 0.001$), although only a minority of respondents from each group felt this was the case.

Table 3
Perception of environmental and animal health impact of BSE compared between innovators vs. non-innovators, endurers vs. non-endurers and exiters vs. non-exiters (n=336)

	Innovating		Enduring		Exiting		All
	Innovators	Non-innovators	Endurers	Non-Endurers	Exiters	Non-Exiters	
Impact of BSE¹	+/-	+/-	+/-	+/-	+/-	+/-	+/-
No environmental effects	23.9/50.2	36.7/44.0	30.3/53.3	27.6/44.2	28.7/51.5	29.4/46.6	25.1/36.5
My livestock were stressed	38.7/43.6	31.3/54.8	53.9/30.9²	12.9/73.0	35.3/47.9	35.0/50.9	27.1/37.0
Livestock in area were less healthy	30.7/54.6	28.3/65.7	41.8/44.2	16.6/76.1	27.5/60.5	28.2/61.3	22.3/49.3
Decline in plant biodiversity	32.5/50.9	21.1/63.3	46.1/33.9	8.0/79.8	27.5/56.9	25.2/61.3	10.2/23.7
Water quality in area decreased	22.7/59.5	8.4/80.7	25.5/50.3	6.1/80.4	17.4/64.1	14.1/72.4	15.3/68.5

¹ +/- Proportions were derived from a 7-point scale, with 1-3 indicating disagree (-) and 4-7 indicating agree (+) and 4 indicating neutral.

² Bold indicate significant differences < 0.001 .

Enduring adaptations had long-term psychosocial, environmental and economic costs that in turn increased farm household vulnerability. One farmer from Manitoba explained, “Once a safety net is gone, you face the next crisis vulnerable and unless you have time and opportunity to replenish funds, the next blow will do you in.” (Survey 709, MB). Another respondent from Saskatchewan explained the link between current enduring responses and farm exiting in the future, “All purchases (major) will be sidetracked for a few years or totally non-existent. The greatest possibility is to rid ourselves of the cow herd if

disease, drought, etc, become the factor again.” (Survey 387, SK). Although enduring adaptations provide an important buffer in the short-term, they may simply delay the impacts and even exacerbate vulnerability to future stressors.

3.3 EXITING ADAPTATIONS

Questions reflecting an exit out of the livestock industry separated onto component three, which we refer to as ‘exiting adaptations’ (Table 1). In contrast to enduring and innovating, exiting adaptations were predominately viewed as a last resort.

Downsizing the herd represented a moderate form of exiting and a minority (28.8%) of respondents agreed that it was an important adaptation. Even fewer (17.6%) respondents indicated that “finding the first and best way out of the cattle industry” was an important response. This aversion towards exiting reflected a culture of persistence amongst farmers and the combined status of farming as a “way of life” as well as a business,

Your home is right where your cattle are. You look out your window and you see a cow. You never get away from it - it's who you are, and it is not an easy thing to pull up. Where are you going to go? What are you going to do? You can't get a job tomorrow; it's a very difficult situation. The future doesn't seem that good. (Focus Group 1, MB)

The prospect of farm exiting thus represented much more than the loss of a business to many farmers but also a loss of home, heritage, and for those who out-migrate, a loss of community.

Despite this aversion towards exiting, herd liquidation was an inevitable outcome of the BSE crisis. Some abandoned the cattle enterprise but retained the farm and shifted to other farm enterprises or in many cases to off-farm employment, “We now consider our ranch to be a hobby farm and my husband has a good off-farm job to pay the bills.” (Interview 36, AB). Others quit farming altogether. In the most tragic instances, “[there were] four suicides by male farmers in our area in one year” (Survey 378, SK), these effectively representing the most devastating form of exiting.

In our study, BSE-associated farm exiting was generally reactive in nature and often compromised the economic standing and welfare of these farm families. As one respondent from Saskatchewan indicated, exiting strategies were largely driven by the exhaustion of available cash flow, “The financial and psychological stresses were a catalyst for many to either give up farming or to not enter farming at all” (Survey 137, SK). A sense of hopelessness for the future of the industry also pushed some farm households to exit, “I saw no change in the future of livestock industry so I sold off my herd in March/05” (Survey 302, MB). Farm households that liquidated their cattle herd when cattle prices were severely depressed lost equity and were left financially vulnerable, “Others who sold [cows] at an extremely low price did not enjoy a large bank account.” (Survey 683, AB). Others wanted to exit the industry but were unable to do so, “Myself, I want to sell my cows so that I can go out to work, but can't

get enough money for them, so I feel I am trapped. I can't get out even if I want too. Soon the bank will force me" (Survey 1156, AB).

BSE not only forced established farmers to exit but also discouraged prospective farmers from entering the industry - a phenomenon we refer to as "premature exiting". Many respondents expressed concerns about the implications of BSE for the next generation of farmers. As one respondent from Alberta indicated, "*Young farmers (age 20+) were so discouraged they turned to new careers" (Survey 309, AB).* Being less financially committed and with more years remaining to establish a non-farm career, young and prospective farmers were more able to adopt wage earning employment than older farmers. These sudden premature exits were also highly disruptive to farm succession plans and stressful for aging parents whose transition into retirement was predicated on familial succession, "*We should be retired from farming but our son cannot buy us out and we can't quit because we have more debt than we ever had" (Survey 837, SK).* Farmers worried about the broader impacts that the out-migration of farm youth would have on the community, "*The young people are not going to stay. [They] are what stimulates the communities, builds the schools and buys the groceries...There are no young people left in agriculture."* (Focus Group 8, AB). The loss of 'the next generation of farmers' is viewed by farmers as one of the greatest threats to the future of rural communities (Ashraful and McLachlan, 2009).

3.4 DEGREE OF COMMITMENT AND REVERSIBILITY

Innovating, enduring and exiting adaptations range from minor to major commitment and reversibility (Figure 4). Thus, land dispersal and out-migration represents a higher degree of exiting because it is much harder to re-enter farming once land and any associated infrastructure are sold. Conversely, ceasing agricultural operations while retaining land ownership represents a lower degree of exiting because it then becomes easier to re-enter livestock production. Shifting to organic production represents a relatively high degree of innovating because the transition involves substantial investments of time, infrastructure and money. In contrast, direct marketing to friends and family represents a lower degree of innovating as it builds on existing relationships and requires little additional financial investment. In turn, reducing family recreation spending represents a lower degree of enduring than using all of a household's savings to stabilize the farm enterprise. Our 'degree of commitment' resonates with the coping-adaptation spectrum identified by Berkes and Jolly (2001). Within each of our three adaptation types, specific adaptations that are low in commitment could be considered to be coping strategies and responses that entail higher commitment could be deemed as adaptations. However, we propose that using 'degree of commitment' as a measure of adaptation avoids dichotomizing responses into coping versus adaptation strategies which allows researchers to consider the full range of responses to GEC and monitor the degree to which minor adaptations and major adaptations interact as a part of larger farm adaptation strategy.

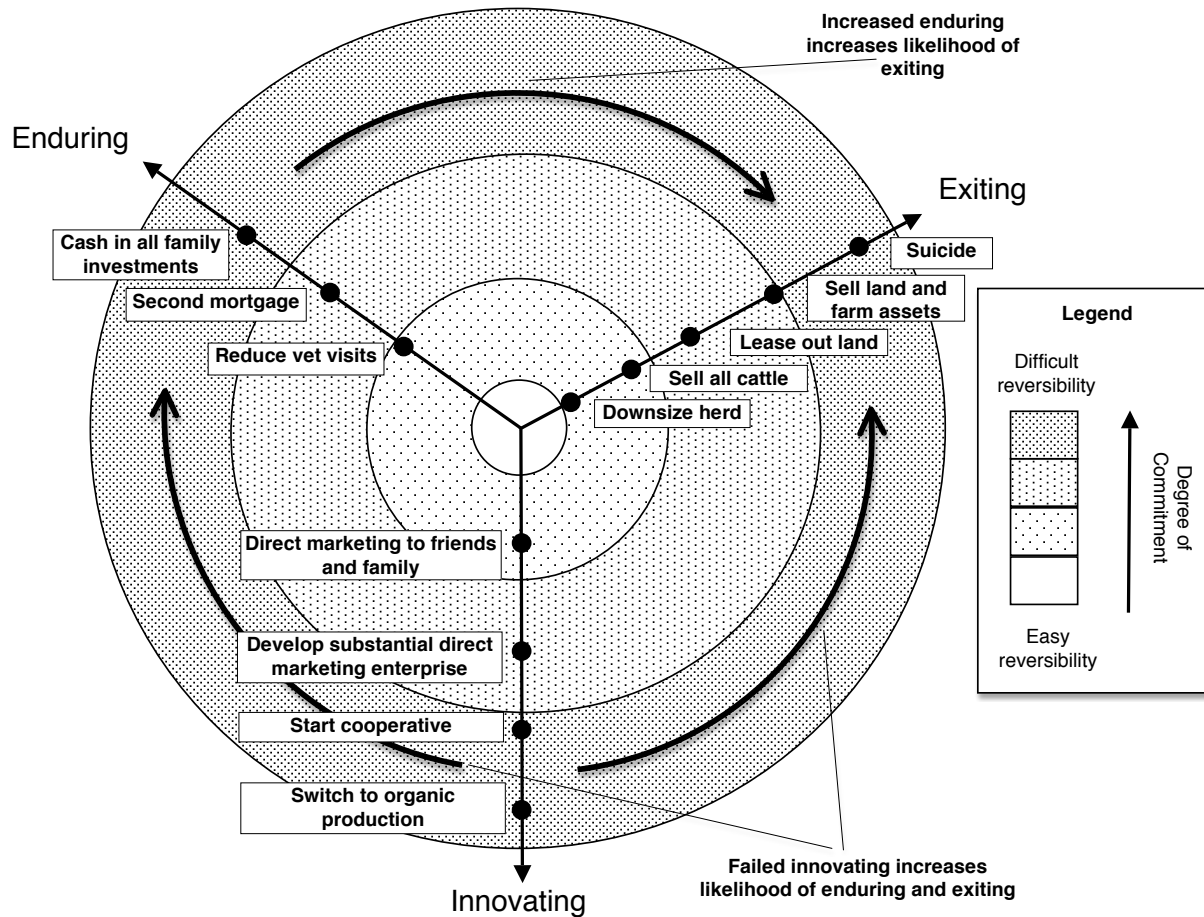


Figure 4 - Conceptual model indicating examples of each adaptation type and the degree of commitment that each adaptation strategy represents.

4 DISCUSSION

In our study, enduring adaptations, those that were used in attempts to retain the status quo, were important responses to BSE yet seem to be less prominent in other GEC research. Although some enduring adaptations entail a minimal commitment on the part of the farm households and could thus be seen as temporary (and less central) coping responses (Berkes and Jolly, 2001), our results suggest that the “chronic enduring”, where one enduring responses leads to the next, erodes adaptive capacity, and undermines the capacity to undertake more proactive adaptations. Enduring adaptations, in our study, were linked to declines in economic, social (e.g. exhaustion, stress) and natural (e.g. over-grazing paddocks) capital. Soil erosion, pollution of waterways and overstocking-associated introduction of disease into wildlife populations were seen as consequences of enduring adaptations that will have long-lasting, although often under-appreciated environmental and social implications. The otherwise important role of farmer as environmental steward and community member is undermined by the pervasiveness of enduring strategies and the associated focus on short-term economic need. In the context of rural decline and recurring crises in the beef sector,

chronic enduring is being reinforced as an accepted norm in Canadian ‘farm culture’ (Mitra et al., 2009) and, indeed, a central farm household adaptation strategy.

Our results demonstrate that familial adaptations occur concurrently with those in farm operations but arguably become critical in times of extreme crisis. The importance of familial adaptations to economic stressors has been well documented outside of the context of GEC (Brookfield, 2008; Chayanov, 1987; Johnsen, 2004; Smithers and Johnson, 2004). However, familial adaptations have been relatively unexplored in the GEC literature (e.g. Bradshaw et al. 2004; Bryant et al., 2000) where the focus has primarily been on technological, agronomic and other operational adaptations (e.g. adoption of novel technology, insurance). In our study, familial adaptation were important in all three adaptation types. Enduring adaptations included economic and social compromises on the part of the family, including cashing in personal savings, reducing expenditures on recreation and withdrawing from community events and functions. Grassroots innovating adaptations (Seyfang 2007) were enabled by interpersonal connections and social networks among families, for example, when farmers engaged in direct to consumer marketing to friends and family, when they participated in holistic management clubs, or when they worked with other farm households to form slaughter or marketing cooperatives (Anderson and McLachlan, 2008). Finally, family members are obviously central in obtaining off-farm employment and while exiting from agriculture and transitioning to a non-farm livelihood. Our findings are reflective of the historic importance of the household in the adaptive strategies of farm families (Brookfield, 2008; Chayanov, 1987). However, others have observed a decoupling of the operation and the family in modern agriculture (Johnsen, 2004), which will present new challenges for farm households, and for agriculture as a whole, that formerly relied heavily on familial adaptations.

Recognition of farm exiting as an option in existing typologies is minimal and farm exits are rarely explored in detail. Because most farm-level adaptation studies focus on the farm enterprise as the system of interest and typically define adaptations as actions that preserve or improve the vitality of the farm *operation* (e.g. Belliveau et al., 2006; Smit and Skinner, 2002), farm exiting may be viewed as maladaptation or a failure to adapt. However, if the farm *household* (enterprise and family) is seen as the system of interest, farm exiting may indeed be an appropriate way of preserving the household if the farm enterprise is no longer seen as viable. The ongoing decline in farm numbers in North America, and indeed around the world suggests that exiting is indeed a pervasive and important form of adaptation. In the Canadian prairies, farm numbers have declined 19.6% from 140,385 in 1996 to 112,814 in 2006 (Statistics Canada, 2006) and these data reflect nothing about downsizing as a more moderate form of exiting nor of the “pre-mature” exiting found in our study and elsewhere (Cook et al., 2011), where young and prospective farmers turn to non-agrarian livelihoods. Farm exiting, farm entry and farm transfers between generations are challenging processes that require further consideration in adaptation research and increased government support (Lobley et al., 2010), especially during times of crisis.

Although our interest was in the farm household, our results also provide insight into the role of government and powerful institutions in shaping local adaptation. In managing the BSE crisis, the

Canadian federal government worked most closely with highly influential actors in the beef industry (e.g. large producer organizations, slaughterhouses, feedlot operators, banks, etc.) while encouraging producers and the general public to wait the crisis out and that a return to normalcy was inevitable and desirable (Charlebois and Labrecque, 2007). One of the predictable outcomes of this top-down process is that it was the larger and more powerful actors that received the most compensation (Stozek, 2008) relative to those that were less influential (e.g. cow calf operators, family farms, direct marketing operations, regional abattoirs). These unequal power dynamics encourage and enable governments to support adaptations that maintain the status quo (Leach et al., 2010) rather than facilitate change-orientated adaptations that have the potential to redistribute power to less influential actors and to affect more proactive adaptations and change.

Indeed, some (e.g. Klein 2007) have argued that crises, such as those associated with zoonotics, allow powerful actors not only to perpetuate the status quo but also to enable change that ensures their dominance in society while marginalizing alternatives. Thus, one-size-fits-all regulatory changes in the meat processing industry, such as those implemented in Canada in response to BSE, disproportionately encumber smaller and start-up processing plants who lack the capital and economies of scale to invest in bringing facilities into compliance (DeLind and Howard 2008). These regulations thus provided a competitive edge to (i.e support adaptation in) the already well established and highly concentrated meat-processing industry in Canada (Hatt and Hatt, In Press). Producers in our study called for governments to support grassroots innovations that would increase domestic slaughter capacity, to facilitate the creation of producer-owned slaughterhouses and to diversify export and domestic market opportunities. Instead, governments predominantly focused on regulation-based mitigation strategies to re-establish pre-BSE trade and production conditions in the cattle industry. Government support for adaptation at the farm level focused on enduring adaptations that were congruent with a desire to return to the status quo (Charlebois and Labrecque, 2007; Ostercamp et al., 2010), and a valuable opportunity to support a wider diversity of rural adaptations was lost.

5 CONCLUSION

In our study, farmers and ranchers adapted to the BSE crisis using three main strategies: ‘innovating’ adaptations in the pursuit of new opportunities and change; ‘enduring’ adaptations that strive towards regaining stability in the farm enterprise; and ‘exiting’ from beef production or agriculture altogether. Our typology compliments those developed in the context of adaptation to climate change (e.g. Berkes and Jolly, 2001; Kurukulasuriya and Rosenthal, 2003; Smit and Skinner, 2002) by emphasizing the under-appreciated role of the family or household in farm adaptation, the relative importance, but often unexplored role of enduring adaptations and the unexplored potential of grassroots innovating adaptations in facilitating multifunctional responses to GEC.

The majority of GEC research focuses on agricultural adaptation to the direct environmental impacts of GEC and particularly those that affect yield and production. In contrast, this study

focused on the indirect impacts of a global zoonotic disease epidemic or those impacts that were mediated through changes in the global market and in agro-food governance. As a whole, GEC will inevitably result in concomitant political, economic and cultural change that, for some groups and individuals, will surpass the challenges associated with the direct environmental impacts of GEC. The indirect impacts of GEC represent an important dimension of vulnerability, especially for farm households and communities that are dependent on global trade and affected by changes in resource management policy and food safety governance. Future research should attend to the relative importance of the indirect impacts (or opportunities) associated with GEC and how these might contribute to or perhaps offset vulnerability across regions, groups and households to GEC.

Whereas agricultural adaptation to climate change tends to be incremental in nature (Smit and Skinner, 2002), the BSE crisis forced farm households to make abrupt enduring, innovating and exiting adaptations. Our findings thus reflect adaptation to a crisis with rapid onset where exiting strategies were more likely, the need for enduring responses more urgent and the stimuli for more drastic innovating responses more visible. Our framework is thus most applicable to evaluating adaptation to the extreme direct or indirect crisis associated with GEC such as the market crash experienced during the BSE crisis or a drought or flood year. Yet, these three adaptation processes are arguably occurring, albeit at a slower rate of implementation, in response to a multitude of stressors and opportunities.

It is well demonstrated that few farm households rely solely on commodity production to support their livelihoods and that most also pursue multifunctional activities (i.e. extra-agricultural) (e.g. van der Ploeg et al., 2009), which often include non-farm employment or pluriactivity (Kinsella et al., 2000). Yet, most GEC adaptation research focuses on (commodity) production-orientated adaptation strategies. This gap likely exists because, in the context of the production risks posed by climate change, policy-makers and scientists are primarily concerned with maintaining and increasing food production at national and international scales of organization. However, by shifting our focus to adaptations that seek to improve farm livelihoods and support rural communities, we highlighted the importance of familial and multifunctional strategies in rural adaptation. Confronted by rural/farm decline and impending stressors associated with GEC and other forms of environmental and socio-political change, farm households are making adaptive decisions that go beyond maintaining (enduring) or improving (innovating) commodity production. They are also adopting strategies that add value to farm products (e.g. van der Ploeg and Renting, 2004), that deliver environmental or agro-tourism services (e.g. van der Ploeg et al., 2009), that glean income from non-farm employment or entrepreneurship (e.g. Kinsella et al., 2000), and that draw from and contribute to the social and cultural capital in rural communities (e.g. McLachlan and Yestrau, 2008).

The challenges associated with predicting and controlling zoonotic diseases are being exacerbated by the intensification of global meat and livestock trade (Delgado et al. 1999) and by climate change as it facilitates their spread (WHO, 2004). Our study focused on BSE, but farm households around the world have been, and inevitably will continue to be, exposed to impacts associated with other known and emerging global zoonotic (e.g. avian and swine flu) and livestock diseases (e.g. foot and

mouth disease). While mitigation strategies are clearly important to lessen risk, support for enhancing farm household and community adaptive capacity is also desperately needed. This can, in part, be facilitated by supporting both expert-driven and grassroots innovating adaptations, by recognizing and assisting farms that are trapped in a cycle of chronic enduring, and by facilitating effective farm exiting and farm entry, especially in times of extreme crisis. By embracing a more balanced and community and regional approach to adaptation, appropriate governmental support would become more proactive and facilitate a much wider diversity of adaptations. Government decision-making would ideally involve those most affected by these crises to help more effectively anticipate the rural consequences of zoonotics like BSE but also to ensure that farmer needs are prioritized and to enable the survival of farm households and rural communities now and into the future.

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8 NOTES

ⁱ Also see two special issues in *Journal of Toxicology and Environmental Health*

ii A cow-calf operator maintains a breeding herd to produce offspring calves that are sold into the feeder market. Backgrounding represent an intermediate stage and typically involves buying smaller calves from cow-calf operators and raising them on pasture until placement in a feedlot. In the final stage of beef production, feedlots add weight to cattle using a specialized high-protein diet and sell finished-cattle for slaughter.

iii Respondents were asked to, *“please indicate the extent to which you agree or disagree with the importance of the following coping strategies you may have adopted in your livestock operation as a result of the BSE crisis.”*